

Developing a fuzzy inference system for predicting bank productivity in Iran

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Abstract: The main purpose of this study is to develop a Fuzzy inference system for predicting bank productivity in Iran and help investors in their investment decisions. For this purpose, the main effective variables on the bank productivity were recognized including facilities, deposits, manpower costs, and assets. In the next step, the data of 13 banks were collected from 2001 to 2012. The membership functions and Fuzzy rules were developed in the MATLAB and then Fuzzy inference system was developed. The findings revealed that the system has appropriate performance in predicting productivity of Iran's banks and has rare error in this area. The predicted productivity of many banks has been increased during time and also predicted productivity of private banks was more than public banks. The bank of Industry and Mine and Entrepreneurship Bank had the least productivity and Mellat Bank had the most productivity. Finally, Post Bank had the most error and Mellat Bank had the least error.

Key words: *Fuzzy inference system; Bank profitability; Membership function; Linguistic labeling; Facilities*

1. Introduction

Prediction of financial variables is one of the main challenges of economic and investment studies. Several studies have been conducted in terms of prediction such as share price, return on investment, etc. However, productivity is one of the most interesting issues for economists and financial researchers. The reason is that correct prediction of productivity-related variables helps investors in predicting their future.

Many of the studies, which have been done for predicting financial variables, have used statistical analysis and regression models. However, review of the last articles showed that many researchers have employed modern problem-solving methods in their problems. Such methods are known as soft techniques that can be categorized in three groups including Soft Computing, Neural Networks, and Fuzzy Logic (Kia, 2010). In addition, several studies have been done in terms of the effective factors on bank productivity and different methods of their formulation. All in all, the present study aimed to develop a Fuzzy inference system for predicting bank productivity in Iran. This logic is consistent with uncertainty of real world.

The Fuzzy methods aimed to consider possible combinations of input variables to achieve the most precise estimations of output variables. For this purpose, input variables of system were collected through review of literature, financial statements of banks, and existing statistical data.

2. Review of literature

Profit and profitability are the main effective factors on the economic decisions. Many studies have been done in this area. However, profitability is one of the most important parameters in the financial analysis of bank performance. Indeed, profit is the fundamental factor in measuring divided profit and management effectiveness and evaluating decisions. This is why that profitability is considered by investors, managers, and financial analysts. For this reason, the authors have attempted to recognize the effective factors on the profitability of banks and other financial institutes. Indeed, investors prefer to deposit and invest their assets in the banks with increasing profitability.

Generally, profitability is a variable by which results of all financial and productive plans, activities, and decisions can be observed. A large part of necessary data for evaluating administrative activities of company can be collected through profit and loss statement directly. Indeed, profit and loss statement is summary of results of financial operations of company. However, administrative operations should have relationship with assets creating profit and loss. Additionally, the operations have to show perception of external individuals of administrative operations and company income. Comparison of profit and loss statements of different periods provides useful information about efficiency of management performance and financial conditions of company. It should be noted that organizational stakeholders consider profit and profitability.

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Obviously, profitability is one of the main considerations in the financial analysis of all businesses. Indeed, profitability is so important that it can be said that profitability determines success or loss of the organization. Managers of classic school consider profit and profitability as important issues. According to Rabenz (2009), effectiveness is degree of achievement. Profitability is one of the main parameters in this achievement. Friedman (1962) refers to profitability as oxygen of organization.

Profit = incomes - costs (Mojtahedzade and Tabari, 1998).

3. Literature review

The past studies are presented in this section of article. Molyx and Thourenton (1992) investigated the relationship between liquidity and profitability. They found that there is a significant negative relationship between liquidity and profitability. Hester and Zoellner (1996) studied the relationship between different items of balance sheet and income of 300 banks in the city of Kansas. Their findings revealed that variations in the items of balance sheet affect bank income considerably. Although capital part of balance sheet affects bank income positively, but the effect of other items such as liabilities and saved deposits affect bank income negatively.

Abro and Mendes (2002) investigate the effect of variables on the banks profitability in some European countries. They found that inflation and capital are the main effective factors on the profitability of European banks.

Gouro et al. (2003) investigate the effective factors on the profitability of Malaysian banks from 1986 to 1995. They found that costs management affects profitability positively. In addition, their findings revealed that liquidity and capital affect profitability rarely. Also they found that inflation and company size (as two main macro-economic variables) affect profitability rarely. Wood and Staikouras (2003) study the determinants of profitability in European countries through OLS and fixed effects. They found that bank profitability can be affected through other variables such as changes in the economic environment.

Ben Naceur (2003) studies profitability of 10 banks in Tunisia. He found that internal factors such capital, over-head costs, and loans affect bank profitability and size positively and negatively. Also he found that external factors such as gross domestic production and inflation are the main effective factors on the bank profitability. Kabir and Bashir (2004) investigate the effective factors on the profitability of Islamic banks. For this purpose, they study 43 banks in 21 countries from 1994 to 2001. They found that there is a significant positive relationship between profitability and increase in the capital. They also found that there is a significant positive relationship between profitability and loan rate. Godardt et al. (2004) investigate efficiency of six European banks and found that the relationship between bank size and profitability is not significant.

Al-Haschimi (2007) studies the determinants of profit margin in 10 countries. He found that validity risk and operational inefficiency affect bank profitability more than other factors. He also concluded that macro-economic factors affect bank profitability rarely. Athanasglou et al. (2008) investigate the effect of productivity growth, cost management, and inflation on the profitability. They found that there is a significant relationship among productivity growth, cost management, inflation, and profitability. They reported that domestic gross production, ratio of costs to income, and inflation are more important than other factors. Kosmidou (2008) investigate the effective factors on bank productivity in Greece. He found that quality of investment affects bank profitability significantly. In addition, bank size affects profitability rarely. Doubtful accounts, liquidity, and ratio of cost to income affect bank profitability negatively. Finally, their findings showed that gross domestic production positively and inflation negatively affects bank profitability respectively. Ramlal (2009) study the determinant factors of bank profitability in Taiwan from 2002 to 2007. He found that validity risk and doubtful accounts are the main factors that affect profitability negatively. Also he found that capital affects capital affects bank profitability positively. Lee and Shen (2008) investigate the effect of ownership on the risk and profitability of bank. Their findings revealed that profitability of commercial banks is more than public banks. Woo et al. (2007) investigates the effect of financial development and bank characteristics on the efficiency of 19 Chinese commercial banks. Their findings revealed that return on assets (ROA) of small commercial banks is more than other public ones. Fedzelan and Khesanah (2009) investigate the determinants of profitability of four public and 12 commercial banks from 2000 to 2007. Their findings revealed that bank size, risk, validity, and investment have a significant positive relationship with profitability. In addition, they found that liquidity, per cost, and being in the network are the main factors that affect bank profitability negatively. Their findings also showed that the positive effect of economic growth and inflation on the profitability of Chinese banks was rare from 1997 to 2004. They infer that investment, share of deposits, and efficiency has positive relationship with bank profitability. Finally, their findings indicated that concentration and aggregation affect profitability considerably. Haffernon and Fu (2002) used economic added-value and gross profit as determinant factors of efficiency in four banks. Their findings revealed that list of banks and operational efficiency affect bank efficiency positively. Also actual growth rate of gross domestic production and unemployment rate affect bank profitability significantly. Emery (1971) used market stability as a sample for competition in measuring its effect on the bank profitability. His findings revealed that competition does not affect bank efficiency significantly.

Rostami (2011) in his study “examining the internal effective factors on the bank profitability” investigate the internal effective factors on the ROA in the Keshavarzi Bank. Their findings revealed that costs management, liquidity management, and risk management are the main factors which affect ROA significantly. Oni (2006) studies the effective factors on the profitability of Refah Bank. He found that ratio of deposits, economic growth, and inflation is the main effective factors on the profitability of Refah Bank. Bagheri (2006) investigate the effective factors on the bank profitability in an 18 years period. He found that assets, cost efficiency, liquidity management, and capital are the main internal factors and economic growth is the main external factor that affects bank profitability. Heydari (2006) investigate the relationship between sufficiencies of capital with financial variables in the banking system. Their findings revealed that there is a significant relationship among sufficiency of capital, risk, profitability, bank size, and ratio of deposits to facilities. Bagheri (2011) investigate the effect of inflation on the bank profitability. The statistical population of this study consists of the listed banks in Tehran Stock Exchange. For this purpose, data of 10 banks were collected from 2002 to 2011. In order to test the hypothesis, multi-variable regression model based on the combinative data was employed. The findings revealed that there is not any significant relationship among concentration, productivity cost, and development of equity market, liquidity, risk, and profitability. Also the findings showed that there is significant negative relationship among tax, modern activities, inflation, and profitability. The relationship among manpower, present value of capital, and profitability is significant. Finally, it should be noted that he measured profitability through return on assets.

Oni (2010) investigates the effective factors on profitability ratios in the commercial banks of Iran. For this purpose, the effect of independent variables of model on the return on assets and return on equity was investigated. These factors include internal characteristics of banks (bank risk, bank size, and number of automatic teller machines), especial characteristics of industry (market concentration of bank and bank share) and macroeconomic measures (inflation and domestic gross production). For this purpose, the data of sample banks were collected from 2002 to 2008. The data were combinative data which were analyzed in the Eviews. The findings revealed that market concentration of bank; bank size, bank risk, and development of electronic banking (which was measured through ATM) affect profitability measures of Iran banks negatively. Also their findings showed that market share of bank, inflation, and gross domestic production affect profitability rates significantly.

Talebzade investigates the effect of macroeconomic variables on the bank profitability. He also investigates the relationship between macroeconomic variables (price, gross domestic

production, unemployment rate, and index of Tehran Stock Exchange) on the profitability of Parsian Bank from 2004 to 2008. For this purpose, correlation test and linear regression model were used. The findings revealed that there is a significant negative relationship among price, gross domestic production, and index of Tehran Stock Exchange, and profitability of Parsian Bank.

4. Methodology

The theory of Fuzzy sets is theory of acting in uncertain conditions. The theory can formulate many of uncertain variables, concepts, and systems mathematically and thereby paves the way for inference, reasoning, control, and decision-making in the uncertain conditions. Obviously, a large part of our decisions and activities are in uncertain conditions and there is a few obvious situations (Kia, 2010). Fuzziness means multiplicity. In other words, fuzziness refers to this fact that there are several alternatives for each question (Azar and Farhi, 2010). The process of creating a Fuzzy inference system consists of five steps. These steps are described in the following section.

4.1. Fuzzification of input variables

The hierarchical construct of decision-making variables such as secondary criteria and rules should be developed in the first step of process. Also entrance of inputs and their membership degree should be determined in the first step. Indeed, hierarchical construct is developed through considering overall goal as root of decision-making tree and main criteria as subsets of the tree. For this purpose, a list of criteria is developed and the criteria are weighted. Such weights show importance of the criteria. Sum of the weights should not be more than 1. Output of first step is a Fuzzy degree which determines degree of inputs membership in the Fuzzy set. It should be noted that the output should be a number between 0 and 1.

4.2. Applying the operators (or-and)

This step refers to scoring and prioritizing the factors and criteria of a measure and calculating weight of each criterion through comparative methods after fuzzification of inputs. The degree of accuracy of variables is supposed in this step. If the supposed part has different parts, the fuzzy operators should be used for combining degree of accuracy of parts and creating a number as overall degree of accuracy. The number should be applied in the output function. In this regard, rational operators (or-and) should be used for explaining operators.

4.3. Inference from introduction to conclusion

In order to determine fuzzy set and membership functions of quantitative characteristics, weight of

each rule should be defined. Every defined rule has a weight (between 0 and 1). These values should be applied in the value of past step. The conclusion part of determined fuzzy set is defined through membership function. Input of implication process is a number and its output is a fuzzy set. The implication process is implemented for each rule. The membership functions should be adapted through quantitative characteristics (between 0 and 1). Final score of the factor will be calculated through multiplying the score in its weight.

4.4. Combination of results of rules

Since the decisions of fuzzy inference system are made based on the evaluation of all rules, the rules should be combined. Indeed, combination is a process in which fuzzy sets of each output are combined in a fuzzy set. In other words, fuzzy judgment matrix is calculated through multiplying fuzzy number of each criterion in weight of the criterion and sum of the criteria. Accordingly, fuzzy rank of the criteria will be calculated. Also overall score will be calculated through summing scores of each factor weight. The combination is done only one time per each output variable. Indeed, list of output functions creates combination process. However, output of this step is a fuzzy set per every output variable.

4.5. Fuzzification of input variables

Input of this step is a fuzzy set and its output is a number. Indeed, fuzzy logic helps evaluation of rules, but desirable output is a number per every variable. The reason is that combinative set of fuzzy sets is a range of output values. In this regard, fuzzy value of output variable is calculated in this step and then rank of the variable will be collected. Accordingly, an advice will be calculated based on the maximum of overall score (Kia, 2010; Rashidmoy et al, 2009).

Fuzzy inference system can be used as a prediction model especially when input or output variables have higher levels of uncertainty. The reason is that the traditional model of prediction such as regression model will not be applicable in such conditions. In other words, traditional model of prediction do not consider existing uncertainties of data (Korepazan and Dezfoli, 2008).

Different types of membership functions (such as triangular, trapezoidal, rectangular, gamma forms) can be used for analysis. However, triangular and trapezoidal membership functions can be used for calculating and determining data validity and quantifying uncertainty of decisions. The reason is simplicity, understandability, and computational efficiency of these methods. This is why that triangular and trapezoidal membership functions are the most applicable and important functions in the fuzzy logic (Esmaeilpour, 2009).

Because of public acceptance of triangular membership function, this type of membership function is used in the present study. Indeed, this

function helps us to define linguistic variable in a correct, simple, and rational method. Triangular fuzzy function is a continuous fuzzy set of "X" which is depends on the parameters of "a", "b", and "c". The mathematical formula and form of triangular membership function is presented in Fig. 1.

$$f(x; a, b, c) = \begin{cases} 0, & x \leq a \\ \frac{x-a}{b-a}, & a \leq x \leq b \\ \frac{c-x}{c-b}, & b \leq x \leq c \\ 0, & c \leq x \end{cases}$$

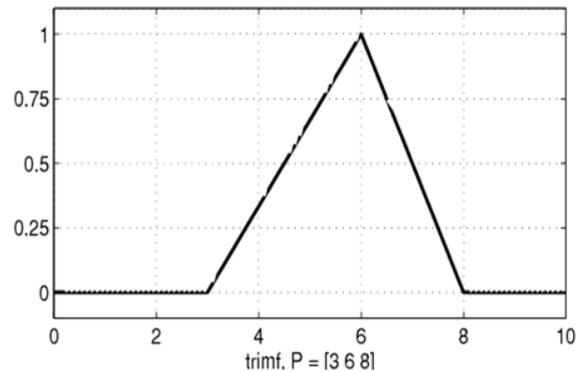


Fig. 1: Triangular membership function

5. Research variables

The main variables of this study include input variables (assets, deposits, facilities, manpower costs) and output variable (profitability).

Since the present study aimed to develop a fuzzy inference system, the final output will be a system based on the input variables of banks. Indeed, the model aimed to predict banks profitability through input variables (assets, deposits, facilities, manpower costs). For this purpose, the following hypotheses were developed.

- 1: the developed fuzzy inference system is successful in predicting banks profitability.
- 2: the predicted profitability of private banks is more than public banks.

6. Data analysis

In order to predict bank profitability through input variables (assets, deposits, facilities, manpower costs), the statistical data were collected from 2001 to 2012. The present study is a practical research from goal perspective and is a descriptive-survey one from research methodology view. For this purpose, the data of research variables were collected through banking reports and statistics during 11 years (from 2001 to 2012.). Indeed, the present study aimed to develop a fuzzy inference system for predicting bank profitability in a given year. The process of fuzzy inference system development is presented in Fig. 2.

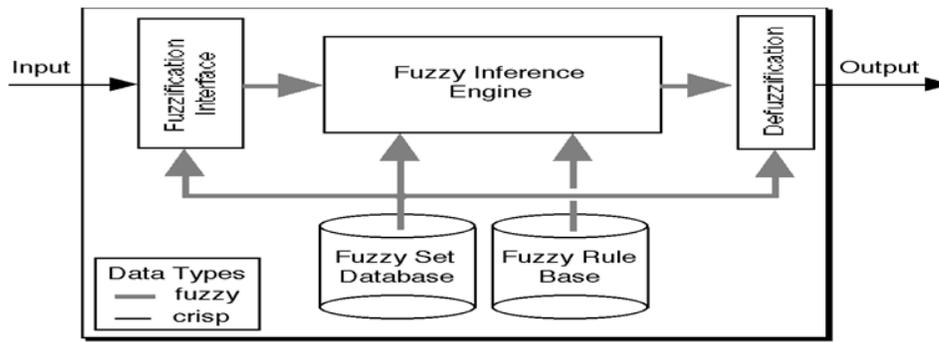


Fig. 2: The process of fuzzy inference system development

Table 1: The descriptive statistics of research variables

		Statistics				
		Assets	Facilities	Deposits	Manpower costs	Profit
N	Number	140	140	140	136	140
	Fixed value	0	0	0	4	0
Average		211983.81	258246.19	143319.94	2680.99	1630.02
Standard error		19339.448	26683.430	13522.012	320.951	191.198
Medium		149318.50	132206.00	100635.50	853.50	865.00
Standard deviation		228827.435	315722.598	159994.609	3742.901	2262.290
Variation		5.236E10	9.968E10	2.560E10	1.401E7	5117956.453
Skewness		1.793	1.891	1.932	2.328	2.459
Error standard deviation of skewness		.205	.205	.205	.208	.205
Elongation		3.514	3.611	4.424	6.422	8.326
Error standard deviation of elongation		.407	.407	.407	.413	.407
Range		1181365	1543799	827857	21602	16252
Minimum		374	1	46	21	-1546
Maximum		1181739	1543800	827903	21623	14706

a. Multiple modes exist. The smallest value is shown

In the next step, it is necessary to test normal distribution of variables. This test has been done in

the SPSS through Kolomogorov-Smirnof test. The results of this test have been presented in Table 2.

Table 2: The results of testing normal distribution of variables

Tests of Normality						
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Assets	.179	136	.000	.809	136	.000
Facilities	.208	136	.000	.771	136	.000
Deposits	.186	136	.000	.796	136	.000
Manpower costs	.239	136	.000	.706	136	.000
Profit	.217	136	.000	.737	136	.000

a. Lilliefors Significance Correction

In order to test the relationship between research variables, correlation test was used. The results of this test have been presented in Table 3.

Table 3: The results of correlation test

Correlations						
		Assets	Facilities	Deposits	Manpower costs	Profit
Assets	Pearson Correlation	1	.919**	.965**	.834**	.501**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	140	140	140	136	140
Facilities	Pearson Correlation	.919**	1	.855**	.748**	.436**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	140	140	140	136	140
Deposits	Pearson Correlation	.965**	.855**	1	.870**	.544**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	140	140	140	136	140
Manpower costs	Pearson Correlation	.834**	.748**	.870**	1	.312**

	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	136	136	136	136	136
Profit	Pearson Correlation	.501**	.436**	.544**	.312**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	140	140	140	136	140

** . Correlation is significant at the 0.01 level (2-tailed).

The results of Table 3 revealed that there is significant correlation among assets, facilities, deposits, manpower costs, and profit.

Table 4: Determining range of research variables

Variables	Very low	Low	Moderate	High	Very high
Assets	(0 22307)	(22307 90182)	(90182 202805)	(202805 405248)	(40524877 1543800)
Facilities	(0 16976)	(16976 59213)	(59213 134955)	(134955 223491)	(223491 827903)
Deposits	(0 224)	(224 495)	(495 1461)	(1461 4098)	(4098 21623)
Manpower costs	(0 31417)	(31417 90890)	(90890 190336)	(190336 335151)	(335151 1181739)
Profit	(-1546 168)	(168 493)	(493 1165)	(1165 2694)	(2694 14706)

Table 5: The parameters of membership function for research variables

Variables	Very low	Low	Moderate	High	Very high
Assets	A= 0 B= 22307 C= 44614	A= 22307 B= 90182 C=124119.5	A=90182 B= 202805 C=259116.5	A= 202805 B=405248 C= 506469.5	A=405248 B= 1543800 C=2113076
Facilities	A=0 B=16976 C=3395	A=16976 B= 59213 C= 80331.5	A= 59213 B= 134955 C=179223	A=134955 B= 223491 C= 267759	A=223491 B=827903 C=8430109
Deposits	A= 0 B= 224 C=448	A= 224 B= 495 C=630.5	A= 495 B=1461 C=1994	A= 1461 B=4098 C=5416.5	A=4098 B=21623 C=30385.5
Manpower costs	A=0 B=31417 C=62834	A=31417 B=90890 C=120626.5	A=90890 B=190336 C=240059	A=190336 B=335151 C=407558.5	A=335151 B=1181739 C=1605033
Profit	A=-1546 B=168 C=336	A=168 B= 493 C=655.5	A=493 B=1165 C=1501	A=1165 B=2694 C=3458.5	A=2694 B=14706 C= 20712

Based on the results of Tables 4 and 5, membership function of five linguistic groups is presented in Fig. 2. Based on the Fig., very high is the

biggest range. Indeed, dispersal of this group is the most dispersal.

Table 6: The rules of fuzzy inference

Rules	Assets	Manpower costs	Deposits	Facilities	Profit	Repetition of rule
1	Moderate	Low	Moderate	Moderate	Very high	1
2	Moderate	Moderate	Moderate	Moderate	Very high	2
3	High	Low	High	High	Low	1
4	High	Low	High	High	Moderate	1
5	High	Moderate	Very high	High	Moderate	1
6	Very high	Moderate	Very high	Very high	Moderate	2
7	Very high	Moderate	Very high	Very high	Moderate	2
8	Very high	Very high	Very high	Very high	Low	3
9	Very high	Very high	Very high	Very high	Moderate	1
10	Very high	Very high	Very high	Very high	Low	3
11	Very high	Very high	Very high	Very high	Low	3
12	Low	High	Low	Low	Moderate	1
13	Low	High	Low	Low	High	1
14	Moderate	High	Low	Moderate	Very low	1
15	Moderate	High	Moderate	Moderate	Low	3
16	Moderate	High	Moderate	Moderate	Low	3
17	High	High	High	Moderate	Low	1
18	High	High	High	High	Low	1
19	High	High	High	High	Very low	1
20	High	Very high	High	High	Very low	3
21	High	Very high	High	High	Very low	3

22	High	Very high	High	High	Very low	3
23	Moderate	High	Moderate	Moderate	Moderate	1
24	Moderate	High	High	Very high	High	1
25	High	Very high	High	Very high	High	1
26	High	Very high	Very high	High	High	1
27	Very high	Very high	Very high	High	High	1

Table 7: The results of bank profit estimation for 2012

Banks	Facilities	Deposits	Manpower costs	Assets	Actual profit	Predicted profit
Melli Bank	1116892	820611	21623	1064375	8548	9240 (cen)
Sepah Bank	422347	285271	7420	368573	376	752 (cen)
Saderat Bank	726586	524339	13077	715020	6019	6458 (cen)
Tejarat Bank	735382	482061	9173	611745	8200	9210 (cen)
Mellat Bank	1543800	827903	10623	1181739	14706	14700 (lom)
Refah Bank	240878	159938	4450	179259	486	567 (lom)
Post Bank	14091	20707	829	22968	170	241 (lom)
Keshavarzi Bank	419714	219320	97	373310	231	242 (lom)
Industry and Mine Bank	149750	36783	543	190336	736	658 (cen)
Entrepreneurship Bank	47374	172343	643	77055	2795	1380 (cen)
Parsian Bank	254881	299327	1354	369509	7972	8690 (cen)
Maskan Bank	1442798	307523	4129	875063	1752	2840 (som)
Eghtesad Novin Bank	157078	191193	2002	226261	8200	8950 (cen)

The last column of the Table shows the method de-fuzzifying. This method was used randomly. The

results of Table 8 refer to the comparison of results of Tables 4 and 5 and their error.

Table 8: The results of comparison of actual and predicted profits for 2012

Banks	Actual profit	Label of actual profit	Predicted profit	Label of predicted profit	Error
Melli Bank	8548	Very high 0.487	9240	Very high 0.545	8.09
Sepah Bank	576	Low 0.64	752	Low 0.512	30.5
Saderat Bank	6019	Very high 0.277	6458	Very high 0.313	7.29
Tejarat Bank	8200	Very high 0.458	9210	Very high 0.542	12.31
Mellat Bank	14706	Very high 0.999	14700	Very high 0.999	0
Refah Bank	486	Low 0.978	567	Moderate 0.110	16.66
Post Bank	170	Low 0.006	241	Low 0.225	41.76
Keshavarzi Bank	231	Low 0.194	242	Low 0.228	8.22
Industry and Mine Bank	736	Moderate 0.362	658	Moderate 0.246	10.59
Entrepreneurship Bank	1295	High 0.850	1380	Very high 0.141	6.56
Parsian Bank	7972	Very high 0.439	8690	Very high 0.499	9
Maskan Bank	2752	Very high 0.005	2840	Very high 0.012	3.19
Eghtesad Novin Bank	8200	Very high 0.458	8950	Very high 0.521	9.15

Table 8 shows the results of comparing actual and predicted values of the banks profit for 2012. The last column shows numerical error of prediction.

7. Analysis of the results of fuzzy inference system

In terms of linguistic labeling system, 12 items of 13 predictions were correct. The only error is about

Refah Bank and its error is 16.66%. it can be said that the system accuracy in linguistic labeling is 92.30%. In terms of numerical prediction error, Post Bank has the most prediction error (41.76%) and Mellat Bank has the least error (0%). About seven errors were less than 10%. The average of numerical error is 12.56% which is very desirable for a fuzzy system. In order to de-fuzzy, the methods of Centroid, Lom, and Som were used 7 times, 4 times, and one times respectively. These methods have the

least error. All in all, it can be concluded that the developed fuzzy inference system has desirable performance in predicting bank profitability.

8. Conclusion

The results of this study can be summarized as following:

1. The main effective factors on the bank profitability are facilities, deposits, manpower costs, and assets. The findings revealed that there are significant relationships among facilities, deposits, manpower costs, assets, and profitability.
2. Facilities, deposits, manpower costs, and assets have been considered as input of fuzzy inference system and profitability was output of this system.
3. The data were collected from sample banks from 2001 to 2011. Based on the data, membership functions and fuzzy inference rules were developed.
4. The findings showed that the system is success in predicting bank profitability. The success percentage is 92.30% and its error is 12.56%.

Based on the results of this study, it can be said that the developed system is successful in predicting profitability. The results of this study showed that banks can recognize effective factors on their profitability and then utilize this system for predicting their profitability. Such a system also can be used by investors in their decisions considerably. Based on the results of this study, the following suggestions have been developed for future researchers and authors.

1. Investigating generalization possibility of the developed system in other organizations and institutes.
2. Considering other criteria such as return on investment as indicators of performance or profitability.
3. Adding new factors as inputs of the fuzzy inference system and calculating system success.
4. Using fuzzy-neurotic inference system for developing system.
5. Developing a system for optimizing bank profit through neurotic networks and Genetic Algorithm.

Based on the findings of this study, the following empirical suggestions can be developed.

1. Given the increasing trend of profitability and inflation in the country, it is suggested that policy-makers utilize such systems to predict their profit and select the best portfolio.
2. Utilization of such system can help managers to predict bank performance and profitability correctly.
3. With regard to this fact that average of private bank profit is more than public banks, it is suggested that private banks utilize such systems in their predictions.

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