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A Comparative Study on the Application of Fuzzy Logic Model Among the Selected Banks (Foreign, Private & Public Banks in Indore Division)

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Abstract

The study has examined the impact of Fuzzy logic model applied in the banking sector to make data more complete, precise and accurate. The aim of this model to control risk and enhanced database of customers to emphasize the customized services, competitiveness, increasing customer database, cost effectiveness and enhancing efficiency. These parameters are an essential for the bank performance so this study has chosen three segments of Banks i.e. Foreign banks, Private and Public Banks. This methodology has also been used in the field of banking, with regard to the specific field of banking in managing crises, the footprint of fuzzy logic has been almost imaginary as when the environment is uncertain then through the various opinions some factors are explored to make precise information from the raw data. Since the market is complex undergone ups and downs so banks frae the strategies to create its own space and face the competitiveness. This study would be beneficial for the Government Officers of the Academia world in managing the risk through the application Fuzzy logic model in defining the strategies which are important for the performance. The Fuzzy logic Model presents the model on which working banks lead to the efficient pathway. The study has conducted a comparative research among the selected Banks (Foreign, Private and Public) for the risk management through the application of Fuzzy Logic Model.

Keywords: Fuzzy Logic Model, customized services, competitiveness, increasing customer database, cost effectiveness and enhancing efficiency

Introduction

Given the importance of the bail-in tool in the new banking regulatory landscape, it is critical to comprehend its potential effects on the real economy. As previously stated, we propose delving deeper into this topic later in this work. Only after a thorough understanding of the risk transmission mechanism between the banking sector and the real economy will it be possible to conclude that post-global financial crisis

regulation is effectively improving the soundness of the European economy. This stability, however, does not yet exist, and the new European resolution framework has yet to be tested. The significance and complexity of this topic justify the need to seek out new techniques to improve knowledge on it. In response to this need, we identified fuzzy logic as an appropriate tool to perform such tasks in an attempt to apply nonlinear advanced methods to assess the potential impact of the new resolution framework on the real economy. To the best of the authors' knowledge, there is no available, up-to-date, comprehensive literature review of fuzzy logic in finance.

In line with the foregoing, the purpose of this paper is to critically examine fuzzy logic as an effective, useful method for financial research, specifically for analysing banking crises and resolution events. For these reasons, we conducted a bibliometric and literature review of a large group of articles indexed in Web of Science and Scopus that used fuzzy logic in finance. Furthermore, we discuss the potential applications of fuzzy logic in four areas: banking crisis prevention, assessments of the impact and management of banking crises, institutional settings and banking regulation, and banking crisis resolution.

Literature Review

Several authors have conducted literature reviews on fuzzy logic applied to various knowledge fields, such as decision making (Liu, W.; Liao, H. A, 2017), social policy (Lee, et al., 2006), and medical sciences (Mahfouf, et al., 2001), demonstrating a wide range of applications for fuzzy logic. However, published literature reviews of the use of fuzzy logic in finance are neither complete nor comprehensive, with some examples focusing on the application of neuro-fuzzy systems in business (Rajab and Sharma, 2018) or the uses of fuzzy logic in insurance (Shapiro, 2004). Some interesting books on the subject are mentioned, though they focus on specific applications rather than providing a general overview of fuzzy logic applied to finance.

There are several approaches to conducting a literature review, with theoretical background literature reviews being the most common, and thus the method used in this study. Within-study literature analyses and between-study literature studies are two essential forms of analysing the literature on a given topic (Onwuegbuzie, 2012). The former refers to analysing a specific work, whereas the latter involves comparing and contrasting the content of various sources. A theoretical background literature review has several advantages, including highlighting what has been explored in a given area and what remains to be explored, identifying links between key concepts, and listing the main analyses and methodologies that have been successfully used (Onwuegbuzie 2010).

The majority of the articles in the table above focused on early warning systems for preventing banking crises or predicting bank failure. One area where fuzzy logic and other AI techniques clearly outperform traditional analysis methods is bankruptcy prediction. (Ravi-Kumar and Ravi, 2006) presented a comprehensive list of bankruptcy prediction methods, including statistical techniques, neural networks, decision trees, evolutionary algorithms, and fuzzy logic techniques. Focusing on the use of fuzzy logic for bankruptcy prediction tasks in particular, the authors highlighted how this method successfully manages

imprecision and ambiguity by combining it with human expert knowledge. Surprisingly, bankruptcy forecasting has traditionally been studied as a classification problem. Regressions, linear discriminant analysis (LDA), multiple discriminant analysis (MDA), neural networks, support vector machines, and decision trees have all been used to predict firm defaults. Altman (Altman, 1968) proposed a multivariate discriminant analysis technique to classify firms as solvent or bankrupt in one of the pioneering studies on bankruptcy prediction. (Sinkey, 1975) used MDA to detect failing banks while focusing solely on bank default prediction, while Altman [88] later published a study focusing on bank insolvency prediction. Another example is the use of a fuzzy-clustering algorithm to predict bank failure (Alam, 200). Overall, the academic literature on bankruptcy prediction has tended to agree that neural networks outperform other methods most of the time (Boyacioglu,.; Kara, Baykan, , 2009). Support vector machines, on the other hand, produce better results when the samples are smaller or more transparency is desired (Shin.; Lee, Kim, 2005). (Ravi-Kumar and Ravi, 2006) used an ensemble of classifiers to predict bank failures in Spain and the United States, highlighting ANFIS as one of the top performers. From the standpoint of decision support systems, the best system to predict a bank's failure should not be a single classifier, but rather a combination of them (Olmeda, and Fernandez , 1997). As a result, combining two or more classifiers appears to be the best technique for predicting which banks will fail in the short or medium term. A combination of fuzzy-SVM and ANFIS could be a useful tool for determining whether a bank should be classified as "failing or likely to fail" and placed into liquidation or resolution.

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Methodology

L. A. Zadeh first proposed the Fuzzy Sets Theory in 1965, and it can be described as a logic for dealing with uncertainty and imprecision. The term "fuzzy" describes a mathematical environment in which there are no well-defined boundaries between the variables under consideration (Venkat; Kushal, and Sangam, 2017). The goal of fuzzy logic is to use mathematical tools to express the ambiguity and imprecision of human thought. Because the human way of thinking and reasoning is not binary, with everything being either yes (true) or no (false), Boolean logic is not always the most efficient way to deal with real-world problems [14]. Concepts such as "danger–safe" or "hot–cold" are difficult to define, and even humans will use fuzzy language expressions such as "very", "a little", or "a lot" to describe temperature or dangerous situations.

The fuzzy logic theory is founded on the concept of "fuzzy sets," a generalisation of classical set theory (Werro , 2008). A crispy set can be defined by a mathematical function that only accepts binary values, which means it can only represent elements that fully belong to the set (represented by the value 1) and elements that do not belong to that set (represented by the value 0). (represented by 0). A fuzzy set is defined by a membership function that allows each element to be represented by a different "grade of membership," which specifies the extent to which the element belongs to the set. It is important to note that membership grades are subjective and depend on the context. Consider a cow, which may be labelled as a "big animal" if the universe of disclosure is "farm animals," but will most likely be labelled as a "medium-size animal" if elephants and hippopotamuses are added to the universe of disclosure.

A fuzzy set is defined as the universe of discourse that comprises the reference set and cannot be fuzzy. Being U = x1, x2,..., xn the universe of disclosure, a fuzzy set F (F U) is always defined as a set of ordered pairs, with the second part of the pair being the degree of membership (xi, F(xi)) and A always taking a value between 0 (not belonging to the set) and 1 (belonging to the set) (fully belonging to the set).

The study was conducted on 200 Managers (34 from each Bank) of Both Public (SBI and PNB), Private Banks (33 from each bank HDFC and ICICI) and Foreign Banks (33 from each Bank Standard Chartered Bank and Citibank) in Indore Division.

Objective of the Study

To study the dimensions related to the decision making capabilities of fuzzy logic Model on the assessment of technological innovation.

Determining Weights of Alternatives with respect to Criteria

After achieving the normalized non-fuzzy relative weights for criteria, the same methodology is applied to find the respective values for alternatives. But now, the alternatives should be pair wise compared with respect to each criterion particularly. That means, this analysis should be repeated for 5 more times for each criterion.

Pair wise comparison of alternatives with respect to "Customized Services" criterion is calculated from the mean score and the following Table 1 is achieved.

Table 1: Comparison matrices of alternatives with respect to "Customized services" criterion

ALTERNATIVES	$\widetilde{r}_i$			$\widetilde{w}_i$		
FB	2.22	2.29	2.35	0.579	0.621	0.663
PUB	0.871	0.935	1.000	0.227	0.253	0.282
PB	0.450	0.467	0.488	0.117	0.127	0.138
Total	3.541	3.692	3.838			
Reverse (power of -1)	0.282	0.271	0.261			
Increasing Order	0.261	0.271	0.282			

In the last step; the non fuzzy Mi and normalized Ni values are obtained by using centre of area method and shown in Table 2. Averaged and normalized relative weights of each alternative with respect to "Customized Services" criterion.

Table 2: Non Fuzzy Mi and normalized Ni values on Customized Services

ALTERNATIVES	Mi	Ni
FB	0.621	0.620
PUB	0.254	0.253
PB	0.127	0.127

Table 3: Comparison matrices of alternatives with respect to "Competitiveness" criterion

ALTERNATIVES	$\widetilde{r_i}$			$\widetilde{w_i}$		
FB	0.803	0.903	1.000	0.291	0.358	0.434
PUB	1.000	1.070	1.149	0.363	0.425	0.499
PB	0.500	0.544	0.608	0.182	0.216	0.264
Total	**2.303**	**2.517**	**2.757**			
Reverse (power of -1)	0.434	0.397	0.363			
Increasing Order	0.363	0.397	0.434			

In the last step; the non fuzzy Mi and normalized Ni values are obtained by using centre of area method and shown in Table 4. Averaged and normalized relative weights of each alternative with respect to "Competitiveness" criterion.

Table 4: Non fuzzy Mi and normalized Ni values on Competitiveness

ALTERNATIVES	Mi	Ni
FB	0.361	0.357
PUB	0.429	0.424
PB	0.221	0.219

Table 5: Comparison matrices of alternatives with respect to "Cost effectiveness" criterion

ALTERNATIVES	$\widetilde{r_i}$			$\widetilde{w_i}$		
FB	1.888	2.036	2.169	0.504	0.588	0.683
PUB	0.757	0.844	0.922	0.202	0.244	0.290
PB	0.530	0.582	0.660	0.142	0.168	0.208
Total	**3.175**	**3.462**	**3.751**			
Reverse (power of -1)	0.315	0.289	0.267			
Increasing Order	0.267	0.289	0.315			

In the last step; the non fuzzy Mi and normalized Ni values are obtained by using centre of area method and shown in Table 6. Averaged and normalized relative weights of each alternative with respect to "Cost effectiveness" criterion.

Table 6: non fuzzy Mi and normalized Ni values on Cost Effectiveness

ALTERNATIVES	Mi	Ni
FB	0.592	0.586
PUB	0.245	0.243
PB	0.173	0.171

Table 7: Comparison matrices of alternatives with respect to "efficiency" criterion

ALTERNATIVES	$\widetilde{r_i}$			$\widetilde{w_i}$		
FB	1.552	1.552	1.552	0.441	0.411	0.441
PUB	0.415	0.415	0.415	0.118	0.118	0.118
PB	1.552	1.552	1.552	0.441	0.441	0.441
Total	**3.519**	**3.519**	**3.519**			
Reverse (power of -1)	0.284	0.284	0.284			
Increasing Order	0.284	0.284	0.284			

In the last step; the non fuzzy Mi and normalized Ni values are obtained by using centre of area method and shown in Table 8. Averaged and normalized relative weights of each alternative with respect to "efficiency" criterion.

Table 8: non fuzzy Mi and normalized Ni values on Efficiency

ALTERNATIVES	Mi	Ni
FB	0.441	0.441
PUB	0.118	0.118
PB	0.441	0.441

Table 9: Comparison matrices of alternatives with respect to "Reduction in Client Influx" criterion

ALTERNATIVES	$\widetilde{r_i}$			$\widetilde{w_i}$		
FB	1.000	2.605	3.201	0.147	0.654	1.888
PUB	0.384	1.000	2.605	0.056	0.251	1.537
PB	0.312	0.383	1.000	0.046	0.096	0.590
Total	**1.696**	**3.988**	**6.806**			
Reverse (power of -1)	0.590	0.251	0.147			
Increasing Order	0.147	0.251	0.590			

In the last step; the non fuzzy Mi and normalized Ni values are obtained by using centre of area method and shown in Table 10. Averaged and normalized relative weights of each alternative with respect to "Reduction in Client Influx" criterion.

Table 10: Non fuzzy Mi and normalized Ni values on Reduction in Client Influx

ALTERNATIVES	Mi	Ni
FB	0.896	0.511
PUB	0.615	0.350
PB	0.244	0.139

Based on these explanations, the normalized non-fuzzy relative weights of each alternative for each criterion are found and tabulated in Table 11.

Table 11: Normalized non-fuzzy relative weights of each alternative for each criterion

ALTERNATIVES	Customized Services	Competitiveness	Cost Effectiveness	Efficiency	Reduction in Client Influx
Foreign Banks	0.620	0.357	0.586	0.441	0.511
Public Banks	0.253	0.424	0.243	0.118	0.350
Private Banks	0.127	0.219	0.171	0.441	0.139

Table 12: Aggregated results for each alternative according to each criterion

Criteria	Scores of Alternatives with respect to related Criterion			
	Weights	A1 (Foreign Banks)	A2 (Public Banks)	A3 (Private Banks)
Customized Services	0.365	0.620	0.253	0.127
Competitiveness	0.348	0.357	0.424	0.219
Cost Effectiveness	0.123	0.586	0.243	0.171
Efficiency	0.107	0.441	0.118	0.441
Reduction in Client Influx	0.057	0.511	0.350	0.139
Total		**0.503**	0.278	0.219

Depending on this result, Alternative 1 (Foreign Banks) has the largest total score. Therefore, it is suggested as the best banks among three of them, with respect to 5 criteria and the fuzzy preferences of decision makers.

Findings

The study has set five parameters (customized services, competitiveness, cost effectiveness, efficiency and reduction in client flux) based on technological innovation in the Foreign Banks, Private and Public Banks. The result indicated that for all the five parameters together, Foreign Banks are performing excellent. For the customized services, Foreign Banks have marked best as these banks have Personalized of Internet banking services by simply allowing individual customers to customize the layout of the webpage so that every customer can have his or her unique Internet banking webpage after logging onto the Internet banking server. Service personalization providing the creation of a new service that meets a specific need of an individual customer. Banks provide online personalized financial advice to individual customers based on their transaction history and their personal preferences. Foreign Banks' officials constantly touch with their customers regarding to get the feedback on services for making better improvements. Whereas in Public and Private Banks, their mean score is bit low as these banks somewhere lack in offering the advanced customization of services. It may be happened as customers' segmentation has vast differences. Those customers are associated with Foreign Banks, they involve in big transactions and they are well educated

belonging to affluent class so Foreign Bans cater to meet their expectations accordingly where as in Private and Public Banks, rural and urban both customers are segmented so these types of Banks have different perspectives in offering the services.

For the factor of competitiveness, Public Banks have secured the highest mean score compared to Foreign and Private Banks. Findings revealed that competitiveness has significant contribution towards customer satisfaction because there are other factors as well. Those factors are brand or company image, customer experience, Price, bank internal and external environment, service delivery/ performance (fast or slow) the behaviour and appearance of the service providers effect the most. It can be concluded that customers demand the quality of service together with all factors that directly or indirectly effect the services to make him satisfied so Public Banks have focused on the competitiveness attribute and want to create its position in the market. It is stated that Public Banks evaluate the market position and the expectations of their customers so accordingly these are prepare for the competition. Also, competitiveness should be viewed in a broader context, that is, not only as the ability to operate and survive in a competitive environment, but also as the ability to offer such products and services (or even create demand for them) that will allow the bank to achieve satisfactory financial results notwithstanding the challenges and limits imposed by the nature of local market activities.

For the cost effectiveness, the Foreign Banks have secured the highest mean value as Bank managers establish an equilibrium between bank inputs and outputs while keeping input prices in mind. This would enable them to take advantage of the favourable economic climate while also surviving the unfavourable economic situation. Further examination of the efficiency reveals that technical inefficiencies are the result of operating at the inappropriate scale. Due to involvement of technology, the chances of occurring error is very less and this resulted into reduction of cost in managing the customers.

The result indicated that for the factor of efficiency, Foreign and Private banks have equally inclination towards enhancing the perfection. Both Banks have outperformed and these have balanced non-performing assets so efficiency is increased. On the other hand, public sector banks have larger share in NPA because of implementation of many Government schemes, these offer loans and subsidies to the rural areas in the field of agriculture, but the slow process of repayment decreases efficiency in building the capital.

Regarding the reduction in client influx, Foreign Banks are able to retain their customers for a longer time. Technological innovation on banking industry and customer management seems to be of great relevance in retaining the clients. Foreign Banks pay great attention towards information and e-service dimension; online reputation and incentives to deliver more value to the customers.

Concluding Remarks

This study has relevant implications not only for researchers but also for practitioners. From an academic viewpoint, the main contributions of this paper are linked to identifying in which fields of financial research fuzzy logic has been utilized and extrapolating the results to suggest other areas where the use of fuzzy logic could bring positive advances, such as in trading and behavioural finance. It also adds value regarding the management of banking crises, since a group of articles are analysed to identify the most adequate fuzzy logic techniques to deal with specific problems linked to banking crises research. From a practitioner's standpoint, this work discussed several studies where fuzzy logic has been applied in the financial field with successful results, including financial forecasting, stock markets and public finance. It could also be useful for banking regulatory and supervisory bodies, since this work briefly explores the potential use of fuzzy logic in the field of banking regulation.

In conclusion, since banking crises are among the most devastating events from an economic viewpoint, we acknowledge the relevant efforts undertaken by the academic community to better understand the existing mechanisms to prevent and manage banking crisis. Due to the nature of the data involved in such studies, we consider fuzzy logic and its combination with neural networks particularly appropriate for the analysis of banking crises and banking resolution mechanisms. This work contributes to easing the integration of fuzzy logic into the analysis of banking crises through a comprehensive literature review and identification of the key areas for development.

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