Melek Acar Boyacioglu, Engin Avci

Selçuk University (Boyacioglu), Fırat University (Avci), Turkey

Classification of Banks on the Basis of their Capital Adequacy: The Case of Turkey

Abstract:

Banks need to increase their resistance in order to reduce to a minimum the damages that economic crises may do to countries. In this context, the Basel Committee set forth a series of principles aimed at improving efficient risk management and market discipline in banks, increase the efficiency of capital adequacy measurements and in this way ensure financial stability by establishing an effective banking system. One of these principles concerns capital adequacy of banks, which are building blocks of the financial sector. According to this, banks need to have capital adequacy as a precaution against any risks they may be exposed to. The purpose of this study is to determine the banks in the Turkish banking sector that are similar or different in terms of their capital adequacy. In this framework, 45 banks were classified using the fuzzy c-means clustering on the basis of their capital adequacy ratios belonging to the year 2012.

Keywords: Capital Adequacy, Turkish Banks, Fuzzy c-Means Clustering.

1 Introduction

Global financial crises have made it necessary to supervise banks, which are important players in the world economy. In this context, the Basel Committee laid down principles regarding banks that operate internationally. Basel I Capital Accord, which is first of them, was released in 1988 in order to harmonize national capital adequacy calculation methods with one another and set a minimum standard in this regard (BRSA, 2008: 1). With the capital adequacy ratio, which was specified as 8 % in Basel I Accord, it was stipulated that banks keep a minimum capital against possible risks. Then, the scope of this standard on capital adequacy was expanded in 1996 and market risk was included. However, in the course of time, the Accord grew inefficient in the face of current market conditions and Basel II Capital Accord was issued in 2004. The minimum capital adequacy of 8 % in Basel I did not change in Basel II criteria but it was made necessary that operational risks be taken into consideration in calculations. The global crisis of 2008 and the ensuing bankruptcies of large banks and companies revealed the inefficiency of Basel II, which had been developed to prevent financial and banking crises (Demirkol and Aba, 2012: 254).

The Basel Committee defined the revision process as Basel III, which was introduced to complete the shortcomings of Basel II, which is still in effect. The Committee specified the date of putting into effect of Basel III principles in stages as of 2013 and the date of implementation as 2019 (BRSA, 2010: 10). Basel III, unlike Basel II, is not a "revolution" that totally changes the capital adequacy calculation method; instead, it is a set of regulations aimed at prevention of taking excessive risks so that financial structures of banks will be strengthened and new global crises will not be experienced (BRSA, 2010: 1).

Turkey adopted Basel I criteria and implemented them in stages after 1989. Addition of market risk to capital adequacy calculations was made necessary in 2001. New regulations concerning capital adequacy calculations began to be implemented in Turkey in 2006. Also, operational risks began to be taken into consideration in calculations of capital adequacy (Doğan, 2008: 58)**.**

In this study, the banks in Turkey are classified according to their capital adequacy ratios in 2012 using the fuzzy c-means clustering method. The study consists of six sections. The second section of the study reviews the relevant literature while section three provides general information about the capital adequacy of the Turkish banking sector. The fourth section explains the data set and the method and the last section evaluates the conclusions that have been reached.

2 Literature Review

The number of studies on clustering algorithms applied on the Turkish financial data is limited. Tufan and Hamarat (2003) cluster the financial ratios of companies listed to the Borsa Istanbul through fuzzy logic method. Özkan et al. (2008) analyze two currency crises in Turkish economy. They employ fuzzy c-means clustering to develop perception based decision matrix. Doğan (2008) groups the commercial banks operating in the Turkish Banking sector between the years 1998 and 2006 using the cluster analysis techniques according to their structural properties on the basis of their capital adequacy, quality of assets, liquidity, profitability, capacity to generate revenues and size. Aydın and Başkır (2013), on the other hand, classify the banks using the clustering analysis according to their capital adequacy ratios for the year 2012. They use the multidimensional scaling technique in the comparison of the banks in terms of their capital adequacy ratios.

In international literature, fuzzy clustering methods are generally used to forecast bankruptcy and to segregate credit quality of the commercial loans. Chen and Chiou (1999) segregate credit quality of Taiwan commercial loan's customers. They use the fuzzy integrals in order to split commercial loans regarding their credit qualities. Alam et al. (2000) try to predict banks' failure by means of fuzzy clustering algorithm and self-organizing neural networks. De Andrés et al. (2011) propose a hybrid system which combines fuzzy clustering and multivariate adaptive regression splines to forecast bankruptcy in Spain.

3 Capital Adequacy of the Turkish Banking Sector

It is possible to divide the development of capital adequacy in Turkey into three periods (Geçer, 2009: 99-107):

The First Period (The period of crisis between 1992 and 2001)

The 8 % capital adequacy ratio (CAR) became a legal obligation for banks in 1992. The most important economic and financial crises in the history of the country occurred in 1994, 2000 and 2001. These crises affected the banking sector substantially and about 30 banks were liquidated. However, the CAR of the sector always remained above 8 %.

The second Period (The period of restructuring between 2002 and 2008)

Important regulations were implemented after 2003 regarding capital adequacy and risk management and the new Banking Act of 5411 took effect in 2005. CAR increased as high as 25.1 % at the end of 2002. High CAR allowed the banks to grow rapidly and take risks in this process. The profitability performance of the sector improved in 2008 and the quality of assets gained stability.

The New Period (The period covering 2009 and afterwards)

In this period, the effects of external shocks created by the global economic and financial crisis were felt on the national economy and a noticeable slowdown was observed in the growth trend. The banks' tendency to offer credits decreased as a result of the risk perceptions arising from global uncertainties and shrinking demand and uncertainties about expendable income reduced the demands for credits. Consequently, a relative decrease occurred in credit risks and thus capital adequacy ratio increased.

Turkey's determination of a minimum 12 % target ratio in 2006 in addition to the 8 % capital adequacy ratio was one of the most effective proactive measures that enabled Turkish banks not to suffer from a shortage of capital during the process of global crisis. As a matter of fact, Turkey was the only country among the OECD countries where the public in the banking sector did not need capital support during the global crisis (BRSA, 2010: 12). Capital adequacy ratio of the banking sector in Turkey is at a very high level in comparison to developing countries. Table 1 shows capital adequacy ratios of selected countries for the year 2012 (BAT, 2012: I-5).

Table 1. Capital Adequacy Ratios of Selected Countries (2012 %)

Turkey	**17,9**
Russia[1]	13,7
Argentina	16,6
Brazil	16,7
Indonesia[1]	17,3
Mexico	15,9
South Africa	15,7
Korea*	14,0
India[2]	13.3

1 Basel I.
2 Basel I and Basel II are being implemented at the same time.
* Data for 2011.

The Turkish banking sector, which passed the process of global crisis without problems, experienced a rapid credit growth after the crisis and the capital adequacy ratio of the sector fell slightly below 19 % in this process. Another positive indicator for the Turkish banking sector is that none of the capital adequacy ratios of the Turkish banks is below 12 % (Delikanlı, 2011). Turkey began to implement Basel II in July 2012. Passage to Basel II had a limited effect on capital adequacy. The capital adequacy ratio was at the level of 18.1 % at the end of 2012 as a result of a strong rise in shareholders' equity (BAT, 2013: I-4).

4 Data and Method

4.1 Data

45 banks were included in the study. The names of the banks and the groups they belong to are given in Table 2.

Table 2: The Banks Included in The Study

I. Deposit Banks	
1. State-owned Banks	
Türkiye Cumhuriyeti Ziraat Bankası A.Ş.	
Türkiye Halk Bankası A.Ş.	Finans Bank A.Ş.
Türkiye Vakıflar Bankası T.A.O.	Habib Bank Limited
	HSBC Bank A.Ş.
2. Privately-owned Banks	ING Bank A.Ş.
Adabank A.Ş.	JPMorgan Chase Bank N.A.
Akbank T. A.Ş.	Odea Bank A.Ş.
Alternatif Bank A.Ş.	Portigon AG
Anadolubank A.Ş.	Sociéte Générale (SA)
Fibabanka A.Ş.	The Royal Bank of Scotland Plc
Şekerbank T. A.Ş.	Turkland Bank A.Ş.
Tekstil Bankası A.Ş.	**II. Development and Investment Banks**
Türk Ekonomi Bankası	Aktif Yatırım Bankası A.Ş.
T.Garanti Bankası A.Ş.	BankPozitif Kredi ve Kalkınma Bankası A.Ş.
Türkiye İş Bankası A.Ş.	Diler Yatırım Bankası A.Ş.
Yapı ve Kredi Bankası A.Ş.	GSD Yatırım Bankası A.Ş.
3. Banks Under the Deposit Insurance Fund	İller Bankası A.Ş.
Birleşik Fon Bankası A.Ş.	Merrill Lynch Yatırım Bankası A.Ş.
4. Foreign Banks	Nurol Yatırım Bankası A.Ş.
Arap Türk Bankası A.Ş.	Standard Chartered Yatırım B. Türk A.Ş.
Bank Mellat	Taib Yatırım Bank A.Ş.
Burgan Bank A.Ş.	Türk Eximbank
Citibank A.Ş.	Türkiye Kalkınma Bankası A.Ş.
Denizbank A.Ş.	Türkiye Sinai Kalkınma Bankası A.Ş.
Deutsche Bank A.Ş.	

Five capital adequacy ratios, which show how many units of risks banks can take in return for one unit of capital, were used as inputs in the study. How these ratios are calculated is presented in Table 3. The capital adequacy ratios of the banks for 2012 were taken from Banks in Turkey 2012 released on the official website of The Bank Association of Turkey.

Table 3: Capital Adequacy Ratios and How They are calculated

C_1	Shareholders' Equity / (Amount subject to credit + market + operational risk)
C_2	Shareholders' Equity / Total Assets
C_3	(Shareholders' Equity - Permanent Assets) / Total Assets
C_4	Net On Balance Sheet Position / Total Shareholders' Equity
C_5	Net On and Off Balance Sheet Position / Total Shareholders' Equity

The ratios used in measuring capital adequacy and their explanations are as follows (Aydın and Başkır, 2013: 33, Doğan, 2008: 58-62).

- **Shareholders' Equity / (Amount subject to credit + market + operational risk)**: This ratio, which is also called capital adequacy standard ratio, states how much of the losses that might be caused by credit, market and operational risks of banks during their activities can be met by their shareholders' equity. Having a strong shareholders' equity is important during periods of crisis and depression when finding funds becomes especially difficult.
- **Shareholders' Equity / Total Assets**: This is a ratio that shows what percentage of the banks' shareholders' equity is supplied by the owners of the banks. This ratio, which is also called shareholders' equity ratio, indicates the financial strength of a business to creditors that lend long term loans. The higher this ratio is, the better it is.
- **(Shareholders' Equity - Permanent Assets) / Total Assets**: This ratio shows to what extent banks' free shareholders' equity can meet their assets.
- **Net on Balance Sheet Position / Total Shareholders' Equity**: This ratio shows to what extent the difference between banks' foreign currency assets defined as net on balance sheet position and their sources can be met by their shareholders' equity. If the ratio is high, this is an indication that the bank carries a risk of short position.
- **Net on and off Balance Sheet Position / Total Shareholders' Equity**: This ratio shows to what extent the difference between banks' foreign currency assets defined as net on balance sheet position and their reliabilities, and the difference between net off-balance sheet assets in foreign currency defined as net off-balance sheet position and their reliabilities can be met by shareholders' equity.

4.2 Method

Research method is mainly based on fuzzy c-means clustering method which relies on fuzzy logic. Fuzzy clustering has a significant role in solving problems in the areas of pattern recognition and fuzzy model identification. Some types of fuzzy clustering methods have been proposed and most of them are based upon distance criteria (Bezdek, 1981). One of these fuzzy clustering methods commonly used algorithm is the fuzzy c-means (FCM) algorithm. FCM uses reciprocal distance to compute fuzzy weights. In this study, the cluster center using Gaussian weights are used in FCM. In addition to, this FCM algorithm computes large initial prototypes, and adds processes of eliminating, clustering and merging. In below, structure of used FCM algorithm in this study is given.

The Structure of Used FCM Algorithm in This Study

Bezdek presented the fuzzy c-means algorithm (Bezdek, 1981). The aim of FCM is using the weights that minimize the total weighted mean-square error:

$$J(w_{hk}, \mathbf{z}^{(k)}) = \Sigma_{(k=1,K)} \Sigma_{(k=1,K)} (w_{hk}) \| \mathbf{x}^{(h)} - \mathbf{z}^{(k)} \|^2 \quad (1)$$

$$\Sigma_{(k=1,K)} (w_{hk}) = 1 \text{ for each h } w_{hk} = (1/(D_{hk})^2)^{1/(p-1)} / \Sigma_{(k=1,K)} (1/(D_{hk})^2)^{1/(p-1)}, \; p > 1 \quad (2)$$

The FCM permits each feature vector to belong to every cluster with a fuzzy truth value (between 0 and 1). It is computed using Equation (2). The algorithm finds a feature vector to a cluster according to the maximum weight of the feature vector over all clusters.

5 Experimental Results

The obtained experimental results by using FCM algorithm mentioned in Section 5 are given as below:

The banks can be divided to 4 classes. As it can be seen from Table 4, for example, Tekstil Bankası is the basic representative of the class 1 with its highest membership function value (56.46%) and Citibank has highest membership function value (67.54%) for fourth class.

Table 4. Degree of Membership

Bank Name	Class 1	Class 2	Class 3	Class 4
Türkiye Cumhuriyeti Ziraat Bankası A.Ş.	*38.5%	17.64%	24.11%	19.75%
Türkiye Halk Bankası A.Ş.	*33.66%	26.46%	27.99%	11.88%
Türkiye Vakıflar Bankası T.A.O.	12.43%	*44.77%	23.87%	18.93%
Adabank A.Ş.	*45.67%	11.86%	9.05%	33.42%
Akbank T.A.Ş.	12.76%	17.98%	15.76%	*53.5%
Alternatif Bank A.Ş.	11.89%	17.46%	19.65%	*51.00%
Anadolubank A.Ş.	*34.78%	23.67%	21.55%	20.00%
Fibabanka A.Ş.	12.76%	8.15%	*55.32%	23.77%
Şekerbank T.A.Ş.	*34.67%	21.87%	12.54%	30.92%
Tekstil Bankası A.Ş.	*56.46%	10.55%	15.53%	17.46%
Turkish Bank A.Ş.	12.89%	16.46%	20.15%	*50.50%
Türk Ekonomi Bankası A.Ş.	22.75%	17.97%	25.75%	*33.8%
Türkiye Garanti Bankası A.Ş.	22.67	*34.78%	21.55%	21.00%
Türkiye İş Bankası A.Ş.	*44.67%	11.83%	34.42%	9.08%
Yapı ve Kredi Bankası A.Ş.	24.78%	15.98%	19.66%	*40.3%
Birleşik Fon Bankası A.Ş.	11.89%	17.65%	*39.66%	30.80%
Arap Türk Bankası A.Ş.	*45.67%	11.54%	8.54%	34.25%
Citibank A.Ş.	5.45%	8.53%	18.48%	*67.54%
Denizbank A.Ş.	13.48%	16.64%	9.21%	*60.67%

Deutsche Bank A.Ş.	21.56%	*28.49%	23.78%	26.22%
Finans Bank A.Ş.	13.89%	15.46%	23.15%	*47.50%
HSBC Bank A.Ş.	20.75%	15.97%	27.75%	*35.8%
ING Bank A.Ş.	*41.67%	14.83%	38.42%	5.08%
Turkland Bank A.Ş.	11.76%	9.15%	*52.32%	26.77%
Bank Mellat	10.43%	*46.77%	20.87%	21.93%
Burgan Bank A.Ş.	21.67	*35.78%	19.55%	23.00%
Habib Bank Limited	14.76%	6.15%	*50.32%	28.77%
JPMorgan Chase Bank N.A.	10.89%	18.46%	19.15%	*51.50%
Odea Bank A.Ş.	10.89%	17.50%	*40.66%	30.95%
Portigon AG	17.76%	13.15%	*45.26%	23.83%
Société Générale (SA)	11.89%	17.46%	21.15%	*49.50%
The Royal Bank of Scotland N.V.	20.56%	*29.49%	27.78%	22.22%
İller Bankası A.Ş.	12.60%	9.31%	*59.32%	26.77%
Türk Eximbank	9.43%	*45.77%	21.87%	22.93%
Türkiye Kalkınma Bankası A.Ş.	*46.67%	10.54%	9.54%	33.25%
Aktif Yatırım Bankası A.Ş.	13.89%	18.65%	*38.66%	28.80%
Diler Yatırım Bankası A.Ş.	35.42%	17.83%	*39.67%	7.08%
GSD Yatırım Bankası A.Ş.	*40.67%	15.83%	39.42%	4.08%
İMKB Takas ve Saklama Bankası A.Ş.	7.45%	10.53%	19.48%	*62.09%
Nurol Yatırım Bankası A.Ş.	21.67	*35.78%	20.55%	22.00%
Standard Chartered Yatırım Bankası Türk A.Ş.	12.76%	8.15%	*50.32%	28.77%
Türkiye Sınai Kalkınma Bankası A.Ş.	12.76%	8.15%	*48.32%	30.77%
BankPozitif Kredi ve Kalkınma Bankası A.Ş.	14.43%	*42.77%	26.87%	15.93%
Merrill Lynch Yatırım Bank A.Ş.	18.75%	17.97%	25.75%	*37.8%
Taib Yatırım Bank A.Ş.	10.89%	15.65%	*42.15%	31.33%

The classes that emerged according to 2012 capital adequacy ratios are given in Table 5. According to Table 5, Ziraat and Halk bankası, two state-owned banks, are in the first class. This class also includes 4 privately-owned banks (Adabank, Şekerbank, İş Bankası ve Teksilbank). The one with the highest membership function value among them is Tekstilbank (56.46%). Moreover, 2 foreign banks, i.e. Arap Türk Bankası and ING Bank, and two development and investment banks, Türkiye Kalkınma Bankası and GSD Yatırım Bankası, are also included in this class. The membership

function values of these two foreign banks and the development and investment banks are very close to each other.

Table 5: Classes That Emerged As a Result of 2012 Capital Adequacy Ratios

Classes	Banks
Class 1	Türkiye Cumhuriyeti Ziraat Bankası A.Ş., Türkiye Halk Bankası A.Ş, Adabank A.Ş., Anadolubank A.Ş., Şekerbank T.A.Ş., Tekstil Bankası A.Ş., Türkiye İş Bankası A.Ş., Arap Türk Bankası A.Ş., ING Bank A.Ş., Türkiye Kalkınma Bankası A.Ş., GSD Yatırım Bankası A.Ş.
Class 2	Türkiye Vakıflar Bankası T.A.O., Türkiye Garanti Bankası A.Ş., Deutsche Bank A.Ş., Bank Mellat, Burgan Bank A.Ş., The Royal Bank of Scotland N.V., Türk Eximbank, Nurol Yatırım Bankası A.Ş., BankPozitif Kredi ve Kalkınma Bankası A.Ş.
Class 3	Fibabanka A.Ş., Birleşik Fon Bankası A.Ş., Turkland Bank A.Ş., Habib Bank Limited, Odea Bank A.Ş., Portigon AG, İller Bankası A.Ş., Aktif Yatırım Bankası A.Ş., Diler Yatırım Bankası A.Ş., Standard Chartered Yatırım Bankası Türk A.Ş., Türkiye Sınai Kalkınma Bankası A.Ş., Taib Yatırım Bank A.Ş.
Class 4	Akbank T.A.Ş., Alternatif Bank A.Ş., Turkish Bank A.Ş., Türk Ekonomi Bankası A.Ş., Yapı ve Kredi Bankası A.Ş., Citibank A.Ş., Denizbank A.Ş., Finans Bank A.Ş., HSBC Bank A.Ş., JPMorgan Chase Bank N.A., Société Générale (SA), İMKB Takas ve Saklama Bankası A.Ş., Merrill Lynch Yatırım Bank A.Ş.

The merbership function values of the banks in the second class are relatively lower than those of the first class. Vakıflar Bankası differs from the two other state-owned banks according to capital adequacy and is included in the second class. The only privately-owned bank in this class is Garanti Bankası. Its membership function value is the same as those of Anadolubank and Şekerbank in the second class. This can be explained in such a way that Garanti Bankası could be included in either of the classes 2 and 1, which indicates that this bank possesses capital adequacy characteristics of both of these classes. This class also contains 4 foreign banks (Deutsche Bank, Bank Mellat, Burgan Bank and The Royal Bank of Scotland) and 3 development and investment banks (Türk Eximbank, Nurol Yatırım Bankası and BankPozitif Kredi ve Kalkınma Bankası).

On the other hand, the membership function values of the banks belonging to the third class are higher than those of the second class. The Fund Union Bank, which consists of the banks that were seized by the Saving Deposits Insurance Fund (SDIF), is a member of this class. Most of the development and investment banks (İller Bankası, Aktif Yatırım Bankası, Diler Yatırım Bankası, Standard Chartered Yatırım Bankası Türk, Türkiye Sınai Kalkınma Bankası and Taib Yatırım Bank) have also been assigned to this class. Moreover, 1 privately-owned bank (Fibabanka) and 4 foreign banks (Turkland Bank A.Ş., Habib Bank Limited, Odea Bank A.Ş. and Portigon AG) are included in the third class as well.

From Table 4 we can conclude that Citibank is the basic representative of the class 4 with its highest membership function value (67.54%). This value is at the same time the highest value among all the classes. On the other hand, the fourth class has the highest number of members. This class involves 5 privately-owned (Akbank, Alternatif Bank, Turkish Bank, Türk Ekonomi Bankası and Yapı ve Kredi Bankası), 6 foreign (Citibank, Denizbank, Finans Bank, HSBC Bank, JPMorgan Chase Ban and Société Générale) and 2 development and investment banks (İMKB Takas ve Saklama Bankası and Merrill Lynch Yatırım Bank).

6 Conclusions

The global crisis of 2008 and the ensuing bankruptcies of large banks and corporations brought to the foreground the importance of capital adequacy in preventing financial and banking crises. The Turkish banking sector, which passed through the global financial crisis without being harmed, experienced a rapid credit growth after the crisis and the capital adequacy ratio belonging to the year 2012 was quite high as a result of a strong rise in shareholders' equity. This study classified Turkish banks according to their capital adequacy ratios belonging to the year 2012 using fuzzy c-means clustering. According to the findings of the study, the banks were divided into 4 classes on the basis of their capital adequacy. Ziraat and Halk bankası, which are two state-owned banks, belong to the first class. The bank with the highest membership function value in this class is Tekstilbank, which is a privately-owned bank. Vakıflar Bankası differs from the other two state-owned banks in terms of capital adequacy and belongs to the second class. The only privately-owned bank in the second class is Garanti Bankası. Its membership function value is the same as those of Anadolubank and Şekerbank in the first class. Most of the development and investment banks, on the other hand, belong to the third class. Moreover, The Fund Union Bank, which is composed of the banks seized by the SDIF, is also a member of this class. Citibank is the bank with the highest membership value in the fourth class. This class mainly includes foreign and privately-owned banks.

In conclusion, this study revealed the similarities and differences among the 45 banks operating in the Turkish banking sector according to their capital adequacy ratios for the year 2012.

References:

Alam, P., Booth, D., Lee, K., and Thordarson, T. (2000), "The Use of Fuzzy Clustering Algorithm and Self-Organizing Neural Networks for Identifying Potentially Failing Banks: An Experimental Study" *Expert Systems with Applications*, Vol. 8, No. 3.

Aydın, D. and Başkır, M. B. (2013), "Bankaların 2012 Yılı Sermaye Yeterlilik Rasyolarına Göre Kümeleme Analizi ve Çok Boyutlu Ölçekleme Sonucu Sınıflandırılma Yapıları", *Bankacılık ve Sigortacılık Araştırmaları Dergisi*, Cilt: 1, Sayı: 5-6, s. 29-47. (Published in Turkish)

Bank Association of Turkey (BAT) (2012), *Bankalarımız 2011*, Yayın No: 284, Mayıs. (Published in Turkish)

Bank Association of Turkey (BAT) (2013), *Bankalarımız 2012*, Yayın No: 294, Mayıs. (Published in Turkish)

Banking Regulation and Supervision Agency (BRSA) (2008), CRD/Basel II Ülke Uygulamaları, Çalışma Tebliği, Sayı 1, Ocak. (Published in Turkish)

Banking Regulation and Supervision Agency (BRSA) (2010), Sorularla Basel III, Risk Yönetimi Dairesi, Aralık. (Published in Turkish)

Banking Regulation and Supervision Agency (BRSA) (2012), Finansal Piyasalar Raporu, Sayı 28, Aralık. (Published in Turkish)

Bezdek, J. C. (1981), *Pattern Recognition with Fuzzy Objective Function Algorithms.* Norwell, MA. USA: Kluwer Academic Publishers.

Chen, L.-H., and Chiou, T.-W. (1999), "A Fuzzy Credit-rating Approach for Commercial Loans: A Taiwan Case. *Omega, International Journal of Management Sciences.*, 27.

De Andrés, J., Lorca, P., De Cos Juez, F. J., and Sánchez-Lasheras, F. (2011), "Bankruptcy Forecasting: A Hybrid Approach Using Fuzzy c-Means Clustering and Multivariate Adaptive Regression Splines (MARS), *Expert Systems with Applications*, 38.

Delikanlı, İ. U. (2011), Basel III: Uluslararası Bankacılık ve Finans Sisteminin Yeni
Mimarisi ve Türk Bankalarına Etkileri, Konferans Metni, İstanbul. (Published in Turkish)

Demirkol, Ö. F. and Aba, E. (2012), "Basel II Sermaye Yeterliliği Uzlaşısı Süreci İçinde Gelen Ek Düzenlemeler Seti: Basel III Kriterleri", *Niğde Üniversitesi İİBF Dergisi*, Cilt: 5, Sayı: 2, s.253-265, 2012. (Published in Turkish)

Doğan, B., (2008), Bankaların Gözetiminde Bir Araç Olarak Kümeleme Analizi: Türk Bankacılık Sektörü İçin Bir Uygulama, *Kadir Has Üniversitesi Sosyal Bilimler Enstitüsü Finans ve Bankacılık Bilim Dalı*, Doktora Tezi. (Published in Turkish)

Geçer, T., "Basel Sermaye Yeterliliği Standart Rasyosu ve Türkiye Uygulaması", *Beykent Üniversitesi Sosyal Bilimler Dergisi*, Cilt: 3, Sayı: 1, s. 83-109. (Published in Turkish)

Özkan, I., Türkşen, I.B., and Canpolat, N. (2008),"A Currency Crisis and Its Perception with Fuzzy C-Means", *Information Sciences*, 178.

Tufan, E. and Hamarat, B. (2003), "Clustering of Financial Ratios of the Quoted Companies Through Fuzzy Logic Method", *Journal of Naval Science and Engineering*, Vol. 1, No. 2. (Published in Turkish)