Finans Ekonomi ve Sosyal Araştırmalar Dergisi, Cilt.8 Sayı.3, Eylül 2023
Research of Financial Economic and Social Studies, Vol.8 No.3, September 2023
ISSN : 2602 – 2486

BANKA MÜŞTERİLERİNİN SERGİLEDİKLERİ DAVRANIŞSAL EĞİLİMLERİN BULANIK AHP YÖNTEMİ İLE ANALİZİ[1]

ANALYZING THE BEHAVIORAL BIASES OF BANK CUSTOMERS WITH THE FUZZY AHP METHOD

Yusuf GÜNEYSU * *Salih AYDIN* **

Araştırma Makalesi / *Geliş Tarihi: 20.06.2023*
Kabul Tarihi: 30.09.2023

Öz

Çalışmanın amacı, Türkiye'deki ticari banka ve katılım bankası müşterilerinin sergiledikleri davranışsal eğilimleri önem sırasına göre ağırlıklandırmak ve farklı banka müşterilerinin davranışsal eğilimlerinde önem sırasına göre farklılık olup olmadığını ortaya koymaktır. Bu kapsamda hazırlanan anket formu bireylere ulaştırılmış ve elde edilen veriler bulanık Analitik Hiyerarşi Prosesi (AHP) yöntemi ile değerlendirilmiştir. Çalışma sonucunda ticari banka müşterileri için en etkili üç ana kriterin aşırı güven eğilimi, temsiliyet eğilimi ve sürü eğiliminin olduğu sonucuna ulaşılmıştır. Katılım bankası müşterileri açısından en önemli eğilimlerin muhafazakârlık eğilimi, aşırı güven eğilimi ve temsiliyet eğilimi olduğu tespit edilmiştir. Bankacılık işlemlerinde hem ticari bankaları hem de katılım bankalarını tercih eden müşteriler için ise aşırı güven eğilimi, muhafazakârlık eğilimi ve temsiliyet eğilimi önem arz etmektedir. Elde edilen sonuçlara göre farklı bankacılık türlerinde işlem yapan bireylerin sergiledikleri eğilimler arasında önem bakımından farklılıklar olduğu söylenebilir.

Anahtar Kelimeler: Davranışsal Finans, Yatırımcı Eğilimleri, Yatırım Davranışı, Bulanık AHP.

JEL Sınıflaması: C44, G20, G41.

Abstract

The aim of the study was to weigh the behavioral biases of commercial bank and participation bank customers in Turkey in order of significance and to reveal whether there is a difference in behavioral biases of individuals. The questionnaire form prepared in this context was delivered to the individuals and the data obtained were evaluated using the fuzzy Analytical Hierarchy Process (AHP) method. As a result of the study, it was found that the three most effective main criteria for commercial bank customers are overconfidence, representation, and herding biases. The most important biases for the participation bank customers were determined as conservatism, overconfidence, and representation biases. Overconfidence, conservatism, and representation biases were determined as important for customers who prefer both commercial and participation banks in banking transactions. The results show that there are differences between the biases exhibited by individuals who transacted in different types of banking.

Keywords: Behavioral Finance, Bank Customer, Investor Bias, Investment Behavior, Fuzzy AHP.

JEL Classification: C44, G20, G41.

[1] **Bibliyografik Bilgi (APA):** FESA Dergisi, 2023; 8(3) ,759 - 773 / DOI: 10.29106/fesa.1317366

* Dr.Öğr. Üyesi, Trabzon Üniversitesi İİSBF, yusuf.guneysu@hotmail.com, *Trabzon – Türkiye*, ORCID: 0000-0002-6809-1995
** Dr. Öğr. Üyesi, Artvin Çoruh Üniversitesi, salihaydın@artvin.edu.tr, *Artvin - Türkiye*, ORCID: 0000-0002-3817-1169

1. Introduction

Conventional finance assumes that investors and markets experience a completely rational process. According to conventional finance, individuals act by interpreting all the information available to them in investment transactions (Kishor, 2020; Kumar & Goyal, 2015). However, it is seen that individuals do not act rationally upon taking investment decisions due to their psychological and behavioral aspects. There are various psychological biases that prevent investors from taking rational decisions (Quddoos et al., 2020; Rubaltelli et al., 2010). Behavioral finance, which explains such biases, has brought innovation to the world of finance.

Behavioral finance has evolved since 1980, challenging the assumptions of conventional finance. According to behavioral finance, individuals may not always act rationally in their investment decisions being under the influence of various psychological factors (Jain et al., 2021). Chandra (2017) mentioned the emerging biases in behavioral finance. In this study, overconfidence, herding, conservatism, self-attribution, and representation biases are used, which are among the biases mentioned by Chandra (2017), are used. The study examines whether a difference in order of significance in these five biases exhibited by individual investors transacting in both commercial and participation banks. In this part, brief information regarding the biases is given.

Overconfidence is the bias of individuals to believe more in their own knowledge and act accordingly, underestimating uncertainties about the future (DeBont & Thaler, 1995). Overconfidence tendency causes individuals to think that the obtained information would be utilized quite well since they believe that they have an accurate and appropriate analysis (Syarkani & Alghifari, 2022). Overconfidence bias provides individuals with further self-confidence at the point of controlling the future (Ackert & Deaves, 2009). This bias causes individuals not to consider the impact of risks that may be encountered upon choosing the type of transaction (Armansyah, 2021). There are various studies in the literature (Aydın & Güneysu, 2022; Barber & Odean, 2000; Fachrudin et al., 2017; Kartini & Nahda, 2021; Osman et al., 2015; Statman et al., 2006) proving that individuals act with overconfidence bias. These studies are mentioned in the literature review part.

Herding bias is described by researchers interested in behavioral finance from various aspects (Ahmad & Wu, 2022). Patterson and Sharma (2007) defined the herding bias as a group of investors acting together on the same side of the market with the same securities within the same time frame. Chen (2013) described the herding bias as an investment strategy in which individuals follow the actions of financial experts. Vieira and Pereira (2015), on the other hand, defined the herding bias as the behavior of imitating the decisions of other investors by ignoring their own knowledge and beliefs.

Conservatism bias arises due to the inadequate response of individuals to new information emerging in the markets (Barberis et al., 1998). Individuals with conservatism bias to act more slowly than other individuals upon forming their new knowledge, experiences, and beliefs (Luo, 2013). Due to this bias, individuals act according to their previous knowledge in their investments in the markets (Jain & Kesari, 2019). As a result, the conservatism bias emerges when individuals oppose the new and wish to act along with the existing (Sansar, 2016).

Self-attribution bias emerges as individuals overestimate their own skills and underestimate the risk in their investments (Naveed & Taib, 2021). Due to this bias, individuals do not attribute their losses or failures to themselves and perceive external factors as the reasons for them. Nevertheless, this situation causes individuals not to learn from their mistakes (Kansal & Singh, 2018). Although investment decisions have no impact on positive results, individuals convince themselves that these successes occur thanks to the strategies they follow (Koo & Yang, 2018). Self-attribution bias causes individuals to become overconfident instead of making a correct self-evaluation (Mishra & Metilda, 2015).

The representation bias is that individuals act according to the past performance of investments rather than information that would yield future returns (Jain et al., 2022a). The representation bias causes individuals to become overconfident in their past (Shefrin, 2005). Representation bias is described as the habit of individuals categorizing thoughts, events, and emotions based on past events (Kishor, 2020).

In the literature, there are various studies (Javed et al., 2017; Kengatharan & Kengatharan, 2014; Waweru et al., 2014) to determine the behavioral biases of investors. Otherwise, a limited number of studies (Jain et al., 2020; Jain et al., 2022b) are found to claim that these behavioral biases are more important. To the best of our knowledge, there is no study conducted in Turkey to determine the behavioral biases of individual customers of both commercial and participation banks according to their order of significance. In this context, the study contributes to the literature in two aspects. Firstly, it expands the literature on determining the order significance of behavioral biases. Secondly, it presents findings regarding the evaluation of behavioral biases of individual customers in Turkey, which is an emerging market. In this context, the study examines whether or not there is a difference in the behavioral biases of the customers of participation and commercial banks in Turkey.

The following parts of the study are organized as follows. In the second part, investor biases and studies on determining the significance weights of these biases are examined. In the third part, the dataset and methodology of the study are introduced. In the fourth part, the findings are presented. Lastly, conclusions and recommendations are given.

2. Literature Review

It is seen that the number of academic studies on behavioral finance has increased in recent years. Nonetheless, it is noteworthy that there are few studies in the literature that ranked individuals' investor biases in order of significance. In this part, firstly, the studies on investor biases are briefly mentioned, and then the studies conducted to determine the order of significance of these biases are discussed. Studies in the literature on overconfidence, herding, conservatism, self-attribution, and representation biases, respectively, are reviewed.

Barber and Odean (2000), Grinblatt and Keloharju (2000), Statman et al. (2006), Sekkat and Veganzones-Varoudakis (2007), and Osman et al. (2015) examined whether the overconfidence bias differed by gender and found that the overconfidence bias level of males was higher than females. Bashir et al. (2013), Aziz and Khan (2016), Fachrudin et al. (2017), Rizwan et al. (2018), Cherono et al. (2019), Hunguru et al. (2020), Kartini and Nahda (2021), and Aydın and Güneysu (2022) examined the impact of overconfidence bias on investment decisions and found significant relationships between overconfidence bias and investment decisions.

According to Patel et al. (1991), Cipriani and Guarino (2008), and Messis and Zapranis (2014), the herding bias involves following the decisions made by the majority in order to minimize the loss, uncertainty, and regret that may be experienced afterward in the volatile market conditions. According to Kim and Wei (2002), Lee et al. (2004), and Goodfellow et al. (2009), individual investors exhibit a higher level of herding bias than institutional investors. Caparrelli et al. (2004) found that investors were more prone to herding bias in volatile market conditions. Batmunkh et al. (2020) proved the existence of the herding bias in all market periods.

Conservatism has been defined and studied in a variety of contexts, including decision science, investment, and economics (Soper, 2020). Ahsan and Malik (2016) stated that the low reaction situations in the markets were caused by the conservatism bias. Jost et al. (2003) and Moradi et al. (2013) found a relationship between two personality traits, such as intuition and perception, and conservatism bias. Hirsh et al. (2010) stated that not allowing change is the main component of conservatism. According to Doukas and McKnight (2005), investors with a conservatism bias cause the markets to rise too little.

Mittal (2010) and Mahina et al. (2018) state that self-attribution bias forces investors to overreact, resulting in an increase in transaction volume. According to Homburg and Nasev (2008) and Koo and Yang (2018), self-attribution bias causes aggressive investment strategies and enables investors to act with these strategies. According to Ben-David et al. (2008), following the positive results, investors manage to attribute success to themselves, even if they are independent of their decisions. Gervais and Odean (2001) state that the self-attribution bias leads individuals to assume a higher level of risk.

Grether (1992) and Chen et al. (2007) stated that the representation bias is higher in investors who lack financial information than in other investors. According to Andreassen and Kraus (1990), DeBondt (1993), and Lakonishok et al. (1994), investors indicated that past returns could be used to predict future earnings. Investors who rely on the past are more likely to believe that the past would represent the future and act accordingly. According to Ricciardi and Simon (2000) and Kahneman and Frederick (2002), an individual attempts to fit that event or thought into pre-made classifications whenever a new event or thought occurs.

The studies in the literature related to the 5 biases discussed within the scope of the study are mentioned above. The limited number of studies conducted on the ranking of these biases in order of significance for individuals are mentioned below.

Jain et al. (2020), in their study on individual investors in the Indian state of Punjab, listed the biases that affected the investment decisions of individual investors. They used overconfidence, representation, anchoring, availability, regret aversion, loss aversion, mental accounting, and herding biases. As a result of the study, the three most effective criteria were determined as herding, loss aversion, and overconfidence biases.

In another study, Jain et al. (2022b) investigated the factors affecting the stock selection process of institutional investors in the Indian stock market. They analyzed the data collected from 168 institutional investors using the fuzzy AHP method. The study considered, accounting knowledge, ownership structure, business-specific attributes, business image, stock fundamentals, trading opportunities, and behavioral factors. As a result of the study, the most important factors affecting stock selection were determined as behavioral factors, trading opportunities, and accounting knowledge.

The limited number of studies conducted on determining the significance of investor biases for individuals is the basis of this study. In this regard, this study aims to determine the order of significance of the behavioral biases of the customers who prefer either commercial or participation banks and reveal whether a difference exists in the behavioral biases of different bank customers according to the order of significance. In this context, the hypotheses of the study were formed as follows.

H_1: There is a difference according to the level of importance between the behavioral biases of commercial bank customers and participation bank customers.

H_2: There is a difference according to the level of importance between the behavioral biases of commercial bank customers and customers operating in both types of banks.

H_3: There is a difference according to the level of importance between the behavioral biases of participation bank customers and customers operating in both types of banks.

3. Dataset and Methodology

In this study, it is aimed to weigh the behavioral biases of commercial bank customers and the participation bank customers in Turkey. In this framework, data are obtained from the individual customers of the banks through a questionnaire prepared as a pairwise comparison, and the data obtained from 60 participants are evaluated by using the fuzzy Analytical Hierarchy Process (AHP) method. In this context, firstly, the fuzzy logic and fuzzy AHP methods are explained.

3.1. Fuzzy Logic and Fuzzy Numbers

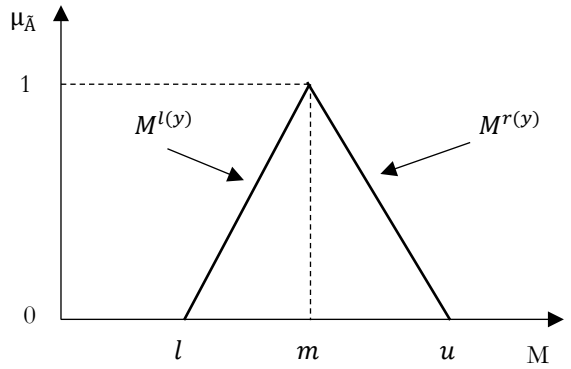
The fuzzy set concept was first coined in 1965 by Lotfi A. Zadeh in a study called “Fuzzy Sets”. A fuzzy set represents a class of objects with membership degrees, and each object’s set membership is associated with a real number between 0 and 1 (Zadeh, 1965). Fuzzy logic based on fuzzy sets provides modeling of uncertain and imprecise information such as individuals’ reasoning in order to make rational decisions (Zadeh, 1988).

Triangular fuzzy numbers are commonly used to perform operations on fuzzy sets. Triangular fuzzy numbers (Ã) are denoted by three real numbers (l, m, u). The membership function of triangular fuzzy numbers is shown as follows (Chang, 1996):

$$\mu_{\tilde{A}}(x) = \begin{cases} (x-l)/(m-l), & l \le x \le m \\ (u-x)/(u-m), & m \le x \le u \\ 0, & otherwise \end{cases} \quad (1)$$

Here, l and u denote the lower and upper limit values, respectively, whereas m denotes the most probable value (modal value). The membership function of triangular fuzzy numbers is illustrated in Figure 1 (Kahraman et al., 2003).

Figure 1. Membership Function of Triangular Fuzzy Numbers



Source: Kahraman et al., 2003.

3.2. Fuzzy AHP

The Analytical Hierarchy Process (AHP) method is one of the multiple criteria decision making (MCDM) methods proposed by Saaty and is widely used in solving complex decision-making issues in various fields (Güneysu et al., 2015). This method provides the evaluation of both quantitative and qualitative data. Although the AHP method is easy to apply, it cannot fully reflect the individuals’ way of thinking since it requires precise judgments. Because

of the complexity and uncertainty of decision problems, decision-makers may need fuzzy evaluations rather than precise comparisons. Therefore, the fuzzy AHP method, which is an extension of the conventional AHP method, has been developed to solve hierarchical decision-making problems in uncertain situations (Kahraman et al., 2003; Wang et al., 2008).

The fuzzy AHP method is similar to the conventional AHP technique in terms of application. Accordingly, in the classical AHP method, orders of significance ranging from 1 to 9 developed by Saaty (2008) are used in the evaluation of criteria pertinent to any issue or purpose. In the fuzzy AHP method, triangular fuzzy numbers are used in pairwise comparisons of the criteria. This comparison scale is presented in Table 1.

Table 1. Fuzzy Evaluation Scale

Order of Significance	Explanation of the Order of Significance	Triangular Fuzzy Scale	The inverse of Triangular Fuzzy Scale
1	Equally Important	(1, 1, 1)	(1/1, 1/1, 1/1)
3	Slightly Important	(2, 3, 4)	(1/4, 1/3, 1/2)
5	Quite Important	(4, 5, 6)	(1/6, 1/5, 1/4)
7	Very Important	(6, 7, 8)	(1/8, 1/7, 1/6)
9	Extremely Important	(9, 9, 9)	(1/9, 1/9, 1/9)
2	Intermediate Values	(1, 2, 3)	(1/3, 1/2, 1/1)
4		(3, 4, 5)	(1/5, 1/4, 1/3)
6		(5, 6, 7)	(1/7, 1/6, 1/5)
8		(7, 8, 9)	(1/9, 1/8, 1/7)

Source: Jain et al., 2020; Saaty, 2008.

In the study, in the evaluation of behavioral biases of bank customers with the fuzzy AHP method, utilizing the findings of Jain et al. (2020) and Jain et al. (2022b), the following phases are followed.

Phase 1. Determining the main and sub-criteria regarding the behavioral biases of individual customers,

At this phase, the main and sub-factors that may affect the behavioral biases of both commercial and participation bank customers are determined. The study of Gündoğdu (2022) are used to determine these factors. The main and sub-criteria pertinent to behavioral biases are presented in Table 2. Accordingly, there are a total of 20 criteria, including 5 main criteria regarding the behavioral biases of individual customers and 3 sub-criteria for each main criterion.

Table 2. Main and Sub-Criteria

Behavioral Biases	Overconfidence Bias (O)	The information I have regarding banking transactions is more valuable than the information of other bank customers (O1)
		I have full confidence in myself that I make the right and healthy decisions (O2)
		I conduct banking transactions at the lowest cost (O3)
	Herding Bias (H)	I prefer the bank preferred by my acquaintances (H1)
		I prefer the bank preferred by the majority in society (H2)
		My religious belief has an impact on my bank preferences (H3)

Conservatism Bias (C)	I do not easily change the bank I work with (C1)
	I do not like to research an alternative for the bank I work with (C2)
	I do not easily believe in advertisements that indicate that other banks are more profitable than the bank I work with (C3)
Self-Attribution Bias (S)	I think that I chose the most suitable bank since I examined every detail in banking transactions (S1)
	If I incur a loss in banking transactions, it is because of the market conditions, not only me but the majority encounter such consequences (S2)
	My banking transaction costs are more convenient than those of other customers, as I research campaigns and details well in banking transactions (S3)
Representation Bias (R)	I keep positive information about a bank or bank product in my mind and use this information upon deciding on my next transactions (R1)
	I think that banks that have yielded well in the past will also yield well in the future (R2)
	I assume that the lower the costs of the bank I work with, the higher the return on deposits will be (R3)

Source: Gündoğdu, 2022.

Phase 2. Evaluation of the main and sub-criteria by the participants through the pairwise comparison scale,

At this phase, firstly, a Google-based online questionnaire, which includes the demographic characteristics of the participants and makes pairwise comparisons about the behavioral bias criteria, is generated. Afterward, it is ensured that the questionnaire is delivered to the participants employing different data collection techniques. The convenience sampling method is preferred in determining the participants. Moreover, explanations and examples are included to help participants better comprehend the concepts and questions. In this context, 60 participants are reached over the period November 2022 – January 2023. The responses obtained from the participants are intact and valid.

Phase 3. Establishing normal pairwise comparison and fuzzy pairwise comparison matrixes,

$$A=(a_{ij})_{nxn}=\begin{bmatrix} 1 & a_{ij} & \cdots & a_{in} \\ 1/a_{ij} & 1 & \cdots & \cdots \\ \vdots & \vdots & \ddots & \vdots \\ 1/a_{in} & \cdots & \cdots & 1 \end{bmatrix} \quad (2)$$

$$\tilde{A}=(\tilde{a}_{ij})_{nxn}=\begin{bmatrix} (1,1,1) & (l_{12}m_{12}u_{12}) & \cdots & (l_{1n}m_{1n}u_{1n}) \\ (l_{21}m_{21}u_{21}) & (1,1,1) & & (l_{2n}m_{2n}u_{2n}) \\ \vdots & \vdots & \ddots & \vdots \\ (l_{n1}m_{n1}u_{n1}) & (l_{n2}m_{n2}u_{n2}) & \cdots & (1,1,1) \end{bmatrix} \quad (3)$$

Phase 4. Taking the average of the evaluations of the participants,

$$\tilde{A}_{ij}=\frac{\sum_{k=1}^{k} A_{ij}^{k}}{K} \quad (4)$$

Phase 5. Calculating the geometric mean of main and sub-criteria,

$$\tilde{r}_i=(l_1 * l_2 * l_3)^{1/n}, (m_1 * m_2 * m_3)^{1/n}, (u_1 * u_2 * u_3)^{1/n} \quad (5)$$

*Phase 6***.** Calculating the fuzzy weights of main and sub-criteria,

$$\widetilde{w_i}=\tilde{r}_i \otimes (\tilde{r}_1 \oplus \tilde{r}_2 \oplus \ldots \oplus \tilde{r}_n)^{-1} \quad (6)$$

Phase 7. Calculating triangular fuzzy numbers,

$$w_i = \frac{l_{\widetilde{w_i}} + m_{\widetilde{w_i}} + u_{\widetilde{w_i}}}{3} \quad (7)$$

Phase 8. Conducting the normalizing process,

$$N_{w_i} = \frac{w_i}{\sum w_i} \quad (8)$$

4. Findings

In this study, besides evaluating the behavioral biases of commercial and participation bank customers, demographic information such as gender, age, education, and frequency of banking transactions are also inquired. Accordingly, it is determined that 92% of the participants are male and 8% are female. In addition, the majority of the participants belong to the age group of 25-44 and they acquire either undergraduate or graduate degrees. Moreover, it is seen that most of the participants are employed in the public or private sector and their monthly incomes of more than 12.000 TL. Nevertheless, although a significant portion of the participants stated that they did not attend any courses or training programs in banking and finance, the majority of them state that they have been monitoring the markets. On the other hand, service quality and religious reasons loom large as the reasons why the participants prefer both types of banks. It is determined that the participants conduct transactions at least once or several times a week depending on their banking transaction status. Information regarding the demographic characteristics of the participants is presented in Table 3.

Table 3. Descriptive Statistics

Variables	Group	Occurrence	Frequency (%)
Gender	Female	5	8.3
	Male	55	91.7
Age	25 years of age and under	4	6.7
	25-34 years of age	16	26.7
	35-44 years of age	24	40.0
	45-54 years of age	11	18.3
	55 years of age and over	5	8.3
Educational Status	High School and lower	5	8.3
	Associate Degree	8	13.3
	Undergraduate Degree	31	51.7
	Graduate Degree	16	26.7
Marital Status	Married	49	81.7
	Single	11	18.3
Income Level	5.500 TL and lower	4	6.7
	5.500 TL-9.000 TL	8	13.3
	9.001 TL-12.000 TL	6	10.0
	12.001 TL-15.000 TL	15	25.0

	15.001 TL and higher	27	45.0
	Public sector	22	36.7
	Private sector	18	30.0
Employment Status	Retired	3	5.0
	Unemployed	3	5.0
	Self-employed	11	18.3
	Student	3	5.0
Status of Attending Courses/Training in Banking and Finance	Yes	17	28.3
	No	43	71.7
Monitoring the Developments in Banking and Finance	Yes	56	93.3
	No	4	6.7
Type of Banking Customers	Commercial bank	25	41.7
	Contribution bank	12	20.0
	Both	23	38.3
Frequency of Conducting Banking Transactions	Everyday	22	36.7
	Several times a week	29	48.3
	Once a week	2	3.3
	Several times a month	5	8.3
	Once a month	1	1.7
	Occasionally	1	1.7
The Reason for Preferring the Bank whose Services are Mostly Utilized	Being the profitable	3	5.0
	Having good service quality	27	45.0
	My close relationship with its employees	1	1.7
	Religious perspective	18	30.0
	Ownership status of the bank (public-private)	11	18.3

The respondents evaluated the main and sub-criteria regarding behavioral biases as pairwise comparisons by grading a point between 1 - 9 (included in Table 1). With the data obtained in this regard, firstly, normal pairwise comparison matrixes (Equation 2) are established separately for each participant. Then, these matrixes are transformed into fuzzy pairwise comparison matrixes (Equation 3). By taking the average of the fuzzy pairwise comparison matrixes for each participant (Equation 4), fuzzy pairwise comparison matrixes regarding the main and sub-criteria are established. Table 4 presents the fuzzy pairwise comparison matrix established for the main criteria.

Table 4. Fuzzy Pairwise Comparison Matrixes of the Main Criteria

	O	**H**	**C**	**S**	**R**
	(*l, m, u*)	(*l, m, u*)	(*l, m, u*)	(*l, m, u*)	(*l, m, u*)
O	(1.00, 1.00. 1.00)	(4.41, 4.97, 5.54)	(3.29, 3.63, 3.99)	(4.80, 5.40, 6.00)	(3.34, 3.78, 4.23)
H	(1.44, 1.71, 2.00)	(1.00, 1.00, 1.00)	(1.90, 2.17, 2.46)	(2.19, 2.54, 2.91)	(1.69, 2.01, 2.36)
C	(3.02, 3.37, 3.71)	(4.00, 4.47, 4.95)	(1.00, 1.00, 1.00)	(3.30, 3.74, 4.21)	(2.67, 3.01, 3.36)
S	(1.05, 1.26, 1.49)	(3.24, 3.73, 4.21)	(2.30, 2.63, 2.96)	(1.00, 1.00, 1.00)	(1.92, 2.19, 2.49)
R	(2.33, 2.73, 3.13)	(3.62, 4.17, 4.76)	(2.77, 3.25, 3.73)	(3.55, 4.07, 4.61)	(1.00, 1.00, 1.00)

After the fuzzy pairwise comparison matrixes are established, the geometric means (Equation 5) and fuzzy weights (Equation 6) are calculated regarding the main and sub-criteria for commercial bank customers, participation bank customers, customers who prefer both types of banks, and all customers. Lastly, the fuzzy mean weights (Equation 7) and normalized weights (Equation 8) are determined. Thus, behavioral biases are ranked by their orders of significance. In this regard, the fuzzy mean weights (MW) for the main and sub-criteria in terms of customer types are presented in Table 5.

Table 5. Evaluation of the Main Criteria

Main Criteria/Sub-criteria	**Commercial Bank Customers**	**Contribution Bank Customers**	**Both Bank Customers**	**All Customers**
	MW (Order)	MW (Order)	MW (Order)	MW (Order)
Overconfidence Bias (O)	**0.243 (1)**	**0.287 (2)**	**0.282 (1)**	**0.264 (1)**
The information I have regarding banking transactions is more valuable than the information of other bank customers (O1)	0.294 (11)	0.221 (10)	0.289 (11)	0.278 (13)
I have full confidence in myself that I make the right and healthy decisions (O2)	0.327 (8)	0.413 (6)	0.405 (4)	0.375 (5)
I conduct banking transactions at the lowest cost (O3)	0.388 (4)	0.371 (7)	0.315 (8)	0.355 (6)
Herding Bias (H)	**0.213 (3)**	**0.087 (5)**	**0.099 (5)**	**0.146 (5)**
I prefer the bank preferred by my acquaintances (H1)	0.354 (6)	0.150 (14)	0.229 (14)	0.290 (11)
I prefer the bank preferred by the majority in society (H2)	0.432 (3)	0.105 (15)	0.260 (13)	0.304 (9)
My religious belief has an impact on my bank preferences (H3)	0.223 (14)	0.745 (1)	0.515 (2)	0.411 (3)
Conservatism Bias (C)	**0.158 (5)**	**0.324 (1)**	**0.250 (2)**	**0.226 (2)**

I do not easily change the bank I work with (C1)	0.456 (2)	0.504 (2)	0.409 (3)	0.441 (2)
I do not like to research an alternative for the bank I work with (C2)	0.259 (13)	0.348 (8)	0.315 (9)	0.296 (10)
I do not easily believe in advertisements that indicate that other banks are more profitable than the bank I work with (C3)	0.298 (9)	0.152 (13)	0.285 (12)	0.272 (14)
Self-Attribution Bias (S)	**0.182 (4)**	**0.115 (4)**	**0.146 (4)**	**0.157 (4)**
I think that I chose the most suitable bank since I examined every detail in banking transactions (S1)	0.350 (7)	0.465 (3)	0.375 (5)	0.381 (4)
If I incur a loss in banking transactions, it is because of the market conditions, not only me but the majority encounter such consequences (S2)	0.295 (10)	0.207 (11)	0.311 (10)	0.287 (12)
My banking transaction costs are more convenient than those of other customers, as I research campaigns and details well in banking transactions (S3)	0.370 (5)	0.339 (9)	0.325 (6)	0.345 (7)
Representation Bias (R)	**0.224 (2)**	**0.194 (3)**	**0.236 (3)**	**0.221 (3)**
I keep positive information about a bank or bank product in my mind and use this information upon deciding on my next transactions (R1)	0.566 (1)	0.419 (4)	0.554 (1)	0.525 (1)
I think that banks that have yielded well in the past will also yield well in the future (R2)	0.283 (12)	0.414 (5)	0.324 (7)	0.325 (8)
I assume that the lower the costs of the bank I work with, the higher the return on deposits will be (R3)	0.171 (15)	0.187 (12)	0.134 (15)	0.165 (15)

Table 5 show that the overconfidence bias (0.566) ranks first in terms of behavioral biases of customers who prefer commercial banks, followed by the representation (0.224), and the herding (0.213) biases. On the other hand, the fact that the positive opinions of commercial bank customers regarding the bank or the banking products are effective in the decision-making process (0.566), that they do not change the bank they work with easily (0.456), and the majority of the society prefer the bank they prefer (0.432) are among the top three in terms of the order of significance. Upon evaluating the main criteria for customers of participation banks in terms of the order of significance, it is determined that the conservatism bias (0.324) ranks first, the overconfidence bias (0.243) ranks second, and the representation bias (0.194) ranks third. Nonetheless, upon considering the order of significance of the sub-criteria, religious belief (0.745) is the most significant factor in the bank preferences of the participation bank customers, followed by not wishing to change the bank they work with (0.504) and the notion that they prefer the most suitable bank (0.465), respectively. It is revealed that the overconfidence bias (0.282), the conservatism bias (0.250), and the representation bias (0.221) are crucial for customers who prefer both types of banks in banking transactions, respectively. On the other hand, upon examining these main behavioral biases in terms of the sub-criteria, a positive impression of the bank or the product offered by the bank being effective in the next decision process ranks first (0.554), religion and belief being effective in the bank preference rank second (0.515), and not giving up on the bank easily ranks third (0.409). Upon making an overall evaluation in terms of all customers, it is seen that results similar to the evaluations of customers who prefer both banks are obtained. In this context, overconfidence (0.264), conservatism (0.226), and representation (0.221) biases rank first, second, and third, respectively. Similarly, in terms of sub-criteria, the effectiveness of positive thoughts in decisions regarding bank

transactions (0.525), not giving up on the bank with which transactions are made (0.441), and bank preference by religious belief (0.411) are found to be more significant than the other factors.

5. Conclusion

In this study, it is examined which of the behavioral biases are more significant in the decision-making process of the bank type (commercial bank or participation bank) in banking transactions of individual customers. Behavioral biases are categorized into 5 main criteria as overconfidence, herding, conservatism, self-attribution, and representation, and 3 sub-criteria for each main criterion. In this context, behavioral biases of commercial bank and participation bank customers are revealed according to the order of significance using the fuzzy AHP method.

It is concluded that the three most effective main criteria for commercial bank customers are overconfidence bias (O), representation bias (R), and herding bias (H). It is determined that the most important biases for participation bank customers are conservatism (C), overconfidence (O), and representation (R). For customers who prefer both commercial and participation banks in banking transactions, overconfidence (O), conservatism (C) and representativeness (R) biases are significant. Accordingly, it can be said that there are differences in the behavioral biases of different bank customers in order of importance and three hypotheses (H_1, H_2, and H_3) are accepted. Upon overall evaluation, it is determined that overconfidence (O), conservatism (C), and representation biases (R) are the most important factors in the bank type preference of individual customers. Jain et al. (2020) evaluated the behavioral biases of individual investors trading in the Indian stock market in order of significance and determined the three most important criteria such as herding, loss aversion, and overconfidence biases. On the other hand, Jain et al. (2022b) listed the factors affecting stock selection in order of significance and found that behavioral factors were among the most significant preference factors. Accordingly, the findings of this study comply with the results of Jain et al. (2020) and Jain et al. (2022b).

According to the sub-criteria, utilizing positive information regarding a bank or bank's product in the decision-making process pertaining to banking transactions (R1), not easily giving up on the bank that one works with (C1), and preferring the bank that the majority of the society deals with (H2) are more significant for commercial bank customers. As expected for participation bank customers, religious belief (H3) is determined as the most significant factor in bank preference. The other two most significant factors for participation bank customers are not easily giving up on the bank that one works with (C1) and the notion that they prefer the most suitable bank (S1). In the decision-making processes of customers who prefer both banks in banking transactions, positive thoughts about the bank or the bank's product (R1), religious belief (H3), and the fact that they do not easily change the bank (C1) loom large. Upon examining the evaluations of all participants, the order of significance of R1, C1, and H3 factors are determined to be similarly high.

This study is crucial in terms of evaluating behavioral biases using the fuzzy AHP method, which is one of the MCDM methods. However, there are some limitations of the study. Accordingly, different behavioral biases (regret aversion, loss aversion, framing, optimism, etc.) may be used in customers' preference of bank type. Besides, 60 individuals were able to respond to the evaluation of behavioral biases that affect bank type preference. Therefore, evaluations can be made by reaching more participants and including different behavioral biases in future studies. Furthermore, with the fuzzy AHP method, analyses can be conducted by employing different MCDM techniques.

References

ACKERT, L., & DEAVES, R. (2009). *Behavioral Finance: Psychology, Decision-Making, and Markets*. Cengage Learning.

AHMAD, M., & WU, Q. (2022). Does Herding Behavior Matter in Investment Management and Perceived Market Efficiency? Evidence from an Emerging Market. *Management Decision*, *60*(8), 2148-2173.

AHSAN, S. M., & MALIK, H. (2016). Moderating Role of Conservatism Bias in Personality Traits and Investment Management. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2812604.

ANDREASSEN, P.B, & KRAUS, S.J. (1990). Judgmental Extrapolation and the Salience of Change. *Journal of Forecasting*, *9*(4), 347-372.

ARMANSYAH, R. F. (2021). Overconfidence, Mental Accounting, and Loss Aversion in Investment Decision. *Journal of Auditing, Finance, and Forensic Accounting*, *9*(1), 44-53.

AYDIN, S. & GÜNEYSU, Y. (2022). The Intermediation Role of Risk Bias Between Overconfidence and Investment Performance: A Research in Borsa Istanbul. *International Journal of Economic and Administrative Studies*, (37), 157-172.

AZIZ, B., & KHAN, M. A. (2016). Behavioral Factors Influencing Individual Investor's Investment Decision and

Performance, Evidence from Pakistan Stock Exchange. *International Journal of Research in Finance and Marketing (IJRFM)*, *6*(7), 74-86.

BARBER, B.M., & ODEAN, T. (2000). Trading Is Hazardous to Your Wealth: The Common Stock Investment Performance of Individual Investors. *The Journal of Finance*, *55* (2), 773-806.

BARBERIS, N., SHLEIFER, A., &VISHNY, R., A (1998). Model of Investor Sentiment. *Journal of Financial Economics*, *49*, 307–343.

BASHIR, T., AAQIBA, J., USMAN, A., USMAN ILYAS, M., & MUBASHAR, M. N. (2013). Empirical Testing of Heuristics Interrupting the Investor's Rational Decision Making. *European Scientific Journal, 9*(28), 185–191.

BATMUNKH, M. U., CHOIJIL, E., VIEITO, J. P., ESPINOSA-MÉNDEZ, C., & WONG, W. K. (2020). Does Herding Behavior Exist in the Mongolian Stock Market?. *Pacific-Basin Finance Journal*, *62*, 101352.

BEN-DAVID, I., J. R. GRAHAM, AND C. R. HARVEY. (2008). Managerial Overconfidence and Corporate Policies. *NBER Working Paper, 13711*, Retrieved from https://www.nber.org/system/files/working_papers/w13711/w13711.pdf.

CAPARRELLI, F., D'ARCANGELIS, A.M., & CASSUTO, A. (2004). Herding in the Italian Stock Market: A Case of Behavioral Finance. *Journal of Behavioral Finance*, *5*(4), 222-230.

CHANDRA, P. (2017). *Behavioural Finance* (1st Ed.), Mcgraw Hill Education.

CHANG, D. Y. (1996). Applications of the Extent Analysis Method on Fuzzy AHP. *European Journal of Operational Research*, *95*(3), 649-655.

CHEN, G., KIM, K.A., NOFSINGER, J.R., & RUI, O.M. (2007). Trading Performance, Disposition Effect, Overconfidence, Representativeness Bias, and Experience of Emerging Market Investors. *Journal of Behavioral Decision Making*, *451*, 425-451.

CHEN, T. (2013). Do Investors Herd in Global Stock Markets?. *Journal of Behavioral Finance*, *14*(3), 230-239.

CHERONO, I., OLWENY, T., & NASIEKU, T. (2019). Investor Behavior Biases and Stock Market Reaction in Kenya. *Journal of Applied Finance and Banking*, *9*(1), 147-180.

CIPRIANI, M., & GUARINO, A. (2008). Herd Behavior and Contagion in Financial Markets. The B.E. *Journal of Theoretical Economics.* 8(1), 1-54.

DE BONDT, W. (1993). Betting on Trends: Intuitive Forecasts of Financial Risk and Return. *International Journal of Forecasting, 9*, 355-371.

DE BONDT, W. & THALER, R.H. (1995). *Financial Decision-Making in Markets and Firms: A Behavioral Perspective*, in Jarrow, R.A., Maksimovic, V. and Ziemba, W.T. (Eds), Handbooks in Operations Research and Management Science, (9), North Holland, Amsterdam, 385-410.

DOUKAS, J.A., & MCKNIGHT, P.J. (2005). European Momentum Strategies, Information Diffusion, and Investor Conservatism. *European Financial Management*, *11*(3), 313–338.

FACHRUDIN, K. R., LUMBANRAJA, P., SADALIA, I., & LUBIS, A. N. (2017). Analysis of Heuristic Behavior on Investment Decision. *International Journal of Economic Research*, *14*(20), 297–309.

GERVAIS, S., & ODEAN, T. (2001). Learning to Be Overconfident. *Review of Financial Studies*, *14*(1), 1-27.

GOODFELLOW, C., BOHL, M.T., & GEBKA, B. (2009). Together We Invest? Individual and Institutional Investors' Trading Behaviour in Poland. *International Review of Financial Analysis*, 18(4), 212-221.

GRETHER, D.M. (1992). Testing Bayes Rule and the Representativeness Heuristic: Some Experimental Evidence. *Journal of Economic Behavior and Organization*, *17*(1), 31-57.

GRINBLATT, M., & KELOHARJU, M. (2000). The Investment Behaviour and Performance of Various Investor Types: A Study of Finland's Unique Data Set. *Journal of Financial Economics*, *55*, 43-67.

GÜNDOĞDU, E. (2022). *View of the Banking Sector from A Behavioral Finance Perspective* (Unpublished Master's Thesis). Ankara Hacı Bayram Veli University, Turkey.

GÜNEYSU, Y., ER, B., & AR, İ. (2015). Analysing Performance of Commercial Banks in Turkey with AHP and GRA Method. *Karadeniz Technical University Institute of Social Sciences Journal of Social Sciences*, *5*(9), 71-93.

HIRSH, J. B., DEYOUNG, C. G., XU, X., & PETERSON, J. B. (2010). Compassionate Liberals and Polite

Conservatives: Associations of Agreeableness with Political Ideology and Moral Values. *Personality and Social Psychology Bulletin*, 36(5), 655-664.

HOMBURG, C., & J. NASEV. (2008). How Timely Are Earnings When Costs Are Sticky? Implication for Link Between Conditional Conservatism and Cost Stickiness. *Management Accounting Section (MAS) Meeting Paper,* Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1187082.

HUNGURU, P., SIBANDA, V., & TADU, R. (2020). Determinants of Investment Decisions: A Study of Individual Investors on the Zimbabwe Stock Exchange. *Applied Economics and Finance*, *7*(5), 38-53.

JAIN, N., & KESARI, B. (2019). Effect of Conservatism Bias and Self-Attribution Bias on Financial Risk Tolerance of Investors. *Gap Gyan-An International Peer-Reviewed Open Access Journal of Social Sciences*, *2*(1), 83-87.

JAIN, J., WALIA, N., & GUPTA, S. (2020). Evaluation of Behavioral Biases Affecting Investment Decision Making of Individual Equity Investors by Fuzzy Analytic Hierarchy Process. *Review of Behavioral Finance*, *12*(3), 297-314.

JAIN, J., WALIA, N., SINGH, S., & JAIN, E. (2021). Mapping the Field of Behavioural Biases: A Literature Review Using Bibliometric Analysis. *Management Review Quarterly*, *72*, 823–855.

JAIN, J., WALIA, N., KAUR, M., & SINGH, S. (2022a). Behavioural Biases Affecting Investors' Decision-Making Process: A Scale Development Approach. *Management Research Review*, *45*(8), 1079-1098.

JAIN, J., WALIA, N., GUPTA, S., AGGARWAL, K., & SINGH, S. (2022b). A Fuzzy Analytical Hierarchy Process Framework for Stock Selection in the Indian Stock Market. *Journal of Public Affairs*, *22*(4), e2710.

JAVED, H., BAGH, T., & RAZZAQ, S. (2017). Herding Effects, Overconfidence, Availability Bias and Representativeness as Behavioral Determinants of Perceived Investment Performance: An Empirical Evidence from Pakistan Stock Exchange (PSX). *Journal of Global Economics*, 6(1), 1-13.

JOST, J. T., GLASER, J., KRUGLANSKI, A. W., & SULLOWAY, F. J. (2003). Political Conservatism as Motivated Social Cognition. *Psychological Bulletin*, *129*(3), 339-375.

KAHNEMAN, D., & FREDERICK, S. (2002). *Representativeness Revisited: Attribute Substitution in Intuitive Judgment*, in Gilovich, T., Griffin, D. and Kahneman, D. (Eds), Heuristics and Biases: The Psychology of Intuitive Judgment, Cambridge University Press, New York, NY, 49-81.

KAHRAMAN, C., CEBECI, U., & ULUKAN, Z. (2003). Multi-Criteria Supplier Selection Using Fuzzy AHP. *Logistics Information Management*, *16*(6), 382-394.

KANSAL, P., & SINGH, S. (2018). Determinants of Overconfidence Bias in Indian Stock Market. *Qualitative Research in Financial Markets*, 10(4), 381–394.

KARTINI, K., & NAHDA, K. (2021). Behavioral Biases on Investment Decision: A Case Study in Indonesia. *Journal of Asian Finance, Economics and Business*, 8(3), 1231–1240.

KENGATHARAN, L., & KENGATHARAN, N. (2014), The Influence of Behavioral Factors in Making Investment Decisions and Performance: Study on Investors of Colombo Stock Exchange, Sri Lanka. *Asian Journal of Finance & Accounting*, *6*(1), 1-23.

KIM, W., & WEI, S.J. (2002), Foreign Portfolio Investors Before and During a Crisis. *Journal of International Economics*, *56*(1), 77-96.

KISHOR, N. (2020). Development and Validation of Behavioral Biases Scale: A SEM Approach. *Review of Behavioral Finance*, *14*(2), 237-259.

KOO, J. H., & YANG, D. (2018). Managerial Overconfidence, Self-Attribution Bias, and Downwardly Sticky Investment: Evidence from Korea. *Emerging Markets Finance and Trade*, *54*(1), 144-161.

KUMAR, S., & GOYAL, N. (2015). Behavioural Biases in Investment Decision Making–A Systematic Literature Review. *Qualitative Research in Financial Markets*, *7*(1), 88-108.

LAKONISHOK, J., SHLEIFER, A., & VISNHY, R.W. (1994). Contrarian Investment, Extrapolation, and Risk. *The Journal of Finance*, *49*(5), 1541-1578.

LEE, Y., LIU, Y., & ROLL, R. (2004). Order Imbalances and Market Efficiency: Evidence from the Taiwan Stock Exchange. *Journal of Financial and Quantitative Analysis*, *39*(2), 327-341.

LUO, G. Y. (2013). Conservatism Bias in the Presence of Strategic Interaction. *Quantitative Finance*, *13*(7), 989-

996.

MAHINA, J. N., MUTURI, W., & FLORENCE, M. (2018). Effect of Self-Attribution Bias on Investment in the Rwandan Stock Market. *Global Journal of Management and Business Research*, *18*(2), 54–63.

MESSIS, P., & ZAPRANIS, A. (2014). Herding Behaviour and Volatility in the Athens Stock Exchange. *The Journal of Risk Finance*, *15*(5), 572-590.

MISHRA, K. C., & METILDA, M. J. (2015). A Study on the Impact of Investment Experience, Gender, and Level of Education on Overconfidence and Self-Attribution Bias. *IIMB Management Review*, *27*(4), 228-239.

MITTAL, M. (2010). Study of Differences in Behavioral Biases in Investment Decision Making Between the Salaried and Business Class Investors. *IUP Journal of Behavioral Finance*, 7(4), 20–34.

MORADI, M., MOSTAFAEI, Z., & MESHKI, M. (2013). A Study on Investors' Personality Characteristics and Behavioral Biases: Conservatism Bias and Availability Bias in the Tehran Stock Exchange. *Management Science Letters*, *3*(4), 1191-1196.

NAVEED, F., & TAIB, H. M. (2021). Overconfidence Bias, Self-Attribution Bias and Investor Decisions: Moderating Role of Information Acquisition. *Pakistan Journal of Commerce and Social Sciences (PJCSS)*, *15*(2), 354-377.

OSMAN, M., CHARY, G. R., BALLOLI, S. S., & HAFFIS, S. (2015). Sustainable Land Use Diversification and Investment Potential in Peri-Urban, Semi-Urban and Rural Areas of Telangana State, India. *Indian Journal of Dryland Agricultural Research and Development*, *30*(1), 24-34.

PATEL, J., ZECKHAUSER, R., & HENDRICKS, D. (1991). The Rationality Struggle: Illustrations from Financial Markets. *The American Economic Review*, *81*(2), 232-236.

PATTERSON, D. M., & SHARMA, V. (2007). Did Herding Cause the Stock Market Bubble of 1998-2001. *University of Michigan-Dearborn*, Retrieved from https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=f04d2d5ae95c23b1e4aafa4089c8dac159de2b26.

QUDDOOS, M. U., RAFIQUE, A., KALIM, U., & SHEIKH, M. R. (2020). Impact of Behavioral Biases on Investment Performance in Pakistan: The Moderating Role of Financial Literacy. *Journal of Accounting and Finance in Emerging Economies*, *6*(4), 1199-1205.

RICCIARDI, V., & SIMON, H.K. (2000). What Is Behavioral Finance?, *Business, Education and Technology Journal*, *2*(2), 1-9.

RIZWAN, K., JAVED, M. U., & KHURRAM, S. (2018). Impact of Behavioral Biases on Investment Decision Making with Moderating Role of Financial Literacy. *Jinnah Business Review*, *6*(2), 34–41.

RUBALTELLI, E., PASINI, G., RUMIATI, R., OLSEN, R. A., & SLOVIC, P. (2010). The Influence of Affective Reactions on Investment Decisions. *Journal of Behavioral Finance*, *11*(3), 168-176.

SAATY, T. L. (2008). Decision-Making with the Analytic Hierarchy Process. *International journal of services sciences*, *1*(1), 83-98.

SANSAR, N. G. (2016). Changing Financial Flows: From Rationalism to Behavioral Finance Approach. *Istanbul Gelisim University Journal of Social Sciences*, *3*(2), 135-150.

SEKKAT, K., & VEGANZONES-VAROUDAKIS, M. A. (2007). Openness, Investment Climate, And FDI in Developing Countries. *Review of Development Economics*, *11*(4), 607-620.

SHEFRIN, H. (2005). *A Behavioral Approach to Asset Pricing* (2nd Ed.). Burlington, MA: Elsevier Academic.

SOPER, D. S. (2020). Informational Social Influence, Belief Perseverance, and Conservatism Bias in Web Interface Design Evaluations. *IEEE Access*, *8*, 218765-218776.

STATMAN, M., THORLEY, S., & VORKINK, K. (2006). Investor Overconfidence and Trading Volume. *The Review of Financial Studies, 19*(4), 1531-1565.

SYARKANI, Y., & ALGHIFARI, E. S. (2022). The Influence of Cognitive Biases on Investor Decision-Making: The Moderating Role of Demographic Factors. *Jurnal Siasat Bisnis*, *26*(2), 183-196.

VIEIRA, E. F. S., & PEREIRA, M. S. V. (2015). Herding Behaviour and Sentiment: Evidence in A Small European Market. *Revista de Contabilidad*, *18*(1), 78-86.

WANG, Y. M., LUO, Y., & HUA, Z. (2008). On the Extent Analysis Method for Fuzzy AHP and Its

Applications. *European journal of operational research*, *186*(2), 735-747.

WAWERU, N. M., MWANGI, G. G., & PARKINSON, J. M. (2014). Behavioural Factors Influencing Investment Decisions in the Kenyan Property Market. *Afro-Asian Journal of Finance and Accounting*, *4*(1). 26-49.

ZADEH, L. A. (1965). Fuzzy Sets. *Information and Control*, *8*(3), 338-353.

ZADEH, L. A. (1988). Fuzzy Logic. *Computer*, *21*(4), 83-93.