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Analysis of Engineers' Investment Decisions with a Behavioral Finance Approach

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Abstract

The classical theory of financial behavior assumes that investors would always act rationally. Nonetheless, investors do not always act rationally. This situation has been leading to the emergence of behavioral finance. As a result of the education they received, engineers who have been thought to exhibit rational behaviors instead of prejudices in their investments were chosen as the target group in this study. The sample size capable of representing the main population was determined and a structured questionnaire was applied to the addresses determined by the internet. In this context, 113 engineers from 7 different disciplines participated in the study. By performing explanatory factor analysis in the evaluation of the data, the effective components in the behavioral finance decisions of the engineers were determined. It was also investigated whether or not demographic and some other characteristics had an impact on behavioral finance decisions. Accordingly; gender, marital status, and investment review time were not found effective on behavioral finance decisions. In general, it was concluded that engineers also acted in accordance with behavioral finance theory in their investments.

Keywords: *Behavioral Finance; Factor Analysis; Engineer*

1. Introduction

Behavioral finance (BF) concentrates on the impacts of these factors on investment decisions by considering the impacts of psychological factors on the financial behavior of investors. The financial decision process has a complex structure that combines various variables. Cognitive biases, emotions, and cognitive intelligence are crucial factors that determine the economic decisions of individuals. Emotional aspects and cognitive biases have always contributed to decision-making, which is considered irrational behavior (Antony, 2020). From this point of view, BF examines the relationship between financial sciences and behavioral sciences.

BF helps us comprehend the extent to which individual investors trade, perform, choose their portfolios, and why returns differ across securities for reasons besides risk (Wagdi, 2017). It examines the consequences of rationality as well as the impacts of often non-quantitative decisions on markets (Sewell, 2010). BF examines individuals' responses to two important economic decisions; namely, saving and spending.

Conventional theories asserted the efficiency of markets, rationality of all investors, and coherence of profit maximization as a vision. Although these theories focused on market conditions, conventional finance theories have been insufficient to define the accurate vision of the market (Fogaat et al., 2022). BF models do not adhere to conventional rationality and risk aversion assumptions, but also explore the extent to which behavioral bias and irrationality affect our decisions (Hon et al., 2021). Individually made financial decisions constitute the onset of BF. Unlike classical economics, it prioritizes human psychology. Therefore, it argues that individuals may make mistakes in their financial decisions depending on the psychological infrastructure.

Researchers have categorized irrational behavior into two theories; cognitive dissonance theory (Festinger, 1957), and prospect theory (Kahneman & Tversky, 1979). According to the cognitive dissonance theory, an individual's behavior is determined by one's own mind, meaning, self-perception and contemplation determine both behaviors and emotions (Beck, 2011). However, prospect theory explains the extent to which investors perceive profit and loss (Antony, 2020).

BF urges to find answers to the behavior patterns of investors upon investing. Every investor has a different target and time horizon for their investments. Investors may wish to grow or maintain capital, invest in equities or investment instruments, and make these decisions in the long- or short-run (Kumari and Sar, 2016). All these financial behaviors are based on individuals' cognitive abilities and risk definitions. From this point of view, it can be claimed that the essential factor underlying BF is individual differences.

In this study, besides the individual differences that affect investment behaviors, professional differences are also taken into account. Engineers with high cognitive ability levels who were thought to be able to exhibit rational behaviors participated in the study, and it was investigated whether they acted rationally or according to cognitive biases (overconfidence, self-attribution, anchoring, herd behavior, and confirmation) in their investment decisions. Kansal and Singh (2015), in their empirical study, stated that engineers would have been much more inclined towards rationalist thoughts, and therefore, would have had more logical decision-making power, and they specifically examined the investment behavior of engineers (Kansal & Singh, 2015).

1.1. Overconfidence

It has been a widely debated issue in psychology since the 1960s (Habib & Hossain, 2013). The term was first coined by Oskamp (1965) (Busenitz & Barney, 1997). It is a circumstance in which individuals are quite optimistic about the trading results and think that the information they gather is sufficient for them to make healthy investment decisions (Zahera & Bansal, 2017). Research studies conducted on overconfidence have led to an understanding of accounting and management policies, as well as decisions regarding financial choices (Habib & Hossain, 2013).

1.2. Self-Attribution Bias

Self-attribution bias means that individuals are likely to attribute their success stories to their personal abilities, whereas their failures to other people's decisions or external factors such as bad fortune (Miller & Ross, 1975). Traders with recent success attributed this to their trading abilities, although they were more inclined to attribute it to unpredictable random processes after failure. If this trend is stable

over time, it renders market participants more confident in their individual skills and to trade more speculatively and aggressively (Zaleskiewicz, 2015).

1.3. Anchoring

Investors make their decisions based on the initial knowledge they have, and then make their next decisions based on historical information. Successive decisions are fixed around some previous knowledge (Tversky & Kahneman, 1981). In the decision-making process, the anchoring process is utilized by an individual to solve complex problems by choosing an initial reference point and gradually adjusting it to reach a final judgment. A past event or trend would be exemplified as one of the most commonly used anchors. The marketer, upon attempting to plan the sales of a product for a consecutive year, usually begins by considering the sales volumes of the past years (Ricciardi, 2008).

1.4. Herd Behaviour

It is the tendency of a person to perform either the irrational or rational actions of a larger group. Such herd mentality is the outcome of two reasons. Firstly, there may be social conformity pressure. Most individuals do not wish to be excluded from the group to which they belong. Secondly, a common sense that a large group is less likely to be wrong exists. Buying securities on the basis of price momentum upon omitting the fundamental economic principles of demand and supply is called herd behavior in BF and causes erroneous decisions (Chaudhary, 2013).

1.5. Confirmation

Confirmation bias refers to a kind of selective perception emphasizing ideas that can confirm individual beliefs whereas downplaying anything that contradicts them (Costa et al., 2017). It means the tendency to evaluate new knowledge in a manner that is in line with one's pre-existing beliefs in psychology, economics, and scientific applications (Allahverdyan & Galstyan, 2014). It is generally defined as seeking evidence or interpreting existing beliefs in partial ways (Nickerson, 1998).

2. Literature Review

Raza (2014) distinguished hard-to-beat markets from rational markets in the debate of BF regarding the efficient market separation that blurred in standard finance and examined why so many investors thought that beating the market was simple. Chira et al. (2008) found that BF stemmed from the branch of psychology claiming that human psychology played a crucial role in decision-making and that the individual made confusing decisions. Hon et al. (2021) stated that, unlike the standard finance paradigm, BF did not support the traditional assumption that individuals were fully rational, but they acknowledged that cognitive bias might have limited rationality.

Thaler (2015) stated that BF models integrated opinions of cognitive psychology into financial and economic models, and explored the extent to which behavioral bias affected the decisions of market agents that were not fully rational in financial markets. Also, Thaler (1980) stated in another study that investors often made decisions under the effect of behavioral biases that led to non-optimal decisions. Shiller (2003) commented on many weaknesses and doubts regarding the efficient market hypothesis and claimed that the relationship between various social sciences and finance could be called BF.

Glaser and Weber (2007), in their study where they evaluated the overconfidence of a group of online broker investors in many dimensions such as better-than-average impact, volatility estimates, and miscalibration, stated that overconfidence measures were significantly associated with the trading volumes of investors. Ricciardi and Simon (2001) stated that anchoring should have been used as a

reference point for future decisions and to explain the substantial tendency that one has to get attached to a notion that might or might not be true. Shiller (2000) considered herd behavior in the stock market as investors' tendency to follow other investors' decisions. Besides, the author stated that investors trusted their collective information rather than private information.

Cipriano and Gruca (2014), in their study of traders in the US stock market, stated that market prices did not accurately reflect information regarding the new value when traders were subject to confirmation bias. Costa et al. (2017) stated that cognitive biases affected managerial and financial decision-making processes. Alsabban and Alarfaj (2019), in their study on the Saudi stock market, revealed that investors tended to trade higher volumes once they achieved positive returns in the last period, meaning when they exhibited a tendency to be overconfident.

Matsumoto et al. (2013), in their study confirming the presence of emotional and cognitive biases in personal financial decision-making, concluded that financial information partially alleviated anchoring bias in individuals' investment decisions. Satar et al. (2020) stated in their study that within the framework of BF, the decision maker had varying behaviors such as heuristics and expectation behaviors and that BF contributed to the investment decision-making process. Epley and Gilovich (2001) asserted that different mechanisms accounted for the formation of anchoring impacts. Murithi (2014) reported that anchoring would have occurred whenever investors relied on past experiences or prices, ignored novice knowledge in the market, fixed prices prior to selling and purchasing securities, and measured the most appropriate moment for trading securities.

Kumari and Sar (2016) concentrated on establishing a broad comprehension of the development of BF, the shortcomings of traditional finance, and the biases involved in decision-making. The authors reported that herd bias, overconfidence, and risk tolerance biases were drivers of investment decisions. Ahmed et al. (2011), in their research on investors in the Lahore Stock Exchange, stated that the statements made by BF reflected the truth and that the investors in the Lahore Stock Exchange did not follow the rationality principles upon making investment decisions. Birau (2012) stated that BF was not a perfect substitute for the classical finance paradigm, however an alternative remedy to the hardship experienced by conventional theory in explaining some financial circumstances.

3. Material and Methodology

3.1. Material

In this study, engineers residing in Trabzon province were selected as material. Engineering disciplines within the population of the study consisted of mechanical, construction-map, computer, electrical-electronic-software, environment-mining, industrial, and food-agricultural engineering. As of 2021, there are 618,796 registered member engineers in the Chamber of Engineers in Turkey (URL-1, 2022). The number of samples for Trabzon was calculated approximately with Equation 1 as follows (Arıkan, 2011):

$$n = [Nt^2pq]/[d^2(N-1) + t^2pq] \quad \text{(Equation 1)}$$

In Equation 1; n denotes sample size; N is the population size (618,796 registered member engineers in Turkey); t represents the theoretical value found according to the t table at a certain significance level (1.96); p denotes the probability of occurrence of the investigated event (assumed as 0.9); q stands for the probability of non-occurrence of the investigated event (taken as 0.1), and d denotes the margin of error (0.05). Accordingly, n was calculated as 138. Based on the sample calculated for Turkey, in general, this study was conducted with 113 engineers from different disciplines residing and working in Trabzon province. Besides, there are different approaches to determining the sample size in

factor analysis (Aksu et al., 2017). Hatcher (1994) recommended that the sample size would have exceeded 100 or that the number of scale items would have been 5 times higher (Hatcher 1994, cited by Aksu et al., 2017). According to this approach, it can be claimed that the sample size of this study is sufficient.

3.2. Methodology

3.2.1. Data Collection

The survey method was used as a data collection tool in the research study, the survey questionnaires were sent to the participants online, and their participation was ensured. Previous studies (Hamurcu and Aslanoğlu, 2016; Küçük, 2014; Sahi et al., 2013), anchoring, herd behavior, overconfidence, confirmation, and self-attribution scales were used in the preparation of the survey questions. The survey questionnaire consisted of (i) 10 optional questions about the demographic structures of the participants, and (ii) 20 statements prepared on a five-point Likert-type scale. Participants rated the extent to which they agreed or disagreed with the statements presented to them by anchoring, overconfidence, familiarity, confirmation, herd behavior, and self-attribution. The rating was designed as 1 “strongly agree”, 2 “agree”, 3 “undecided”, 4 “disagree”, and 5 “strongly disagree”. The survey questionnaire was applied according to the simple random sampling method.

4. Findings

Demographic and some other characteristics of the participants were obtained as seen in Table 1. Since there is no missing data in the dataset, the total frequency for the entire characteristic is 113. According to the table, 1/3 of the participants are women. 50% of the participants belong to the 40-49 age group. In the table, it is seen that similar engineering disciplines are combined and the largest proportion of them is comprised of 25 participants from each of the mechanical and industrial engineering disciplines. 69.9% of the participants have work experience of 10 years and over. The vast majority of investors review their investments on a weekly basis. Merely 11.5% of them declared that they do this on a daily basis. 42.5% of investors consider securities as investment tools.

Table 1. Demographic and some other characteristics of the participants

		Frequency	**%**
Gender	Female	35	31.0
	Male	78	69.0
	Total	113	100.0
Age	29 and under	13	11.5
	30-39	36	31.9
	40-49	57	50.4
	50-59	5	4.4
	60 and over	2	1.8
Marital Status	Married	96	85.0
	Single	17	15.0
Engineering disciplines	Mechanical	25	22.1
	Construction-Mapping	22	19.5
	Computer Science	8	7.1
	Electrical-Electronics-Software	6	5.3
	Environmental-Mining	10	8.8
	Industrial	25	22.1

	Food-Agriculture	17	15.0
Duration of employment	Less than 5 years	13	11.5
	6-10 years	21	18.6
	11-15 years	42	37.2
	16-20 years	12	10.6
	Over 21 years	25	22.1
Duration of investment reviews	Once a day	13	11.5
	Once a week	53	46.9
	Once a month	47	41.6
Investment preference method	Analysis methods	36	31.9
	Brokerage house referrals	6	5.3
	Acquaintance referrals	11	9.7
	Foreign exchange rates	49	43.4
	Personal intuitions	11	9.7
Investment instrument price prediction	I do it myself	65	57.5
	I do not do it myself	48	42.5
Risk-taking status	Yes, I like it.	57	50.4
	No, I do not like it.	56	49.6
Used investment tool	Gold	19	16.8
	Foreign Exchange	19	16.8
	Securities	48	42.5
	Real Estate	27	23.9

It was investigated whether the survey questionnaire questions were consistent within themselves and whether the mean values exhibited a normal distribution. To this end, reliability and normal distribution conformity tests were performed. In the reliability test, Cronbach's Alpha value was found to be 0.804. The decision of conformity to normal distribution was given since it did not exhibit normal distribution according to the Kolmogorov-Smirnov test result ($p<0.05$). Therefore, non-parametric tests were performed in the data analysis.

20 items of the BF scale of engineers were subjected to principal component analysis using a computer software. Prior to the performance of the principal component analysis, the suitability of the dataset for factor analysis was investigated. Numerous coefficients of 0.3 and higher were observed in the correlation matrix. The Kaise-Meyer-Olkin value was found to be 0.68 (Kaiser 1970) and the Bartlett Test result ($p<0.05$) was statistically significant. The values in the common variance values table are required to be close to 1. In this study, the value of a single item was 0.45. The values of the remaining items were close to 1. These obtained values mean that the dataset is suitable for analysis.

Principal component analysis revealed the existence of components with eigenvalues above 1.Oblimin rotation, which is one of the oblique rotation methods, was chosen to help interpret these components. It is accepted that a relationship exists among the factors in oblique rotation (Aksu et al., 2017). As a result of the analysis made according to this method, 6 factors were obtained. Nonetheless, since some of the items had overlapping factors and the difference between the overlapping factors was lower than 0.10, they were excluded from the analysis. Due to the exclusion of the overlapping variables/expressions, 5 components (factors) were obtained. These components explain 34.5%, 13.8%, 9.7%, 8.9%, and 7.3% of the variance, respectively. The 5-component solution explains a total of 74.4%

of the variance. This result is presented in Table 2. In Table 2, it is seen that the factor loads of 3 variables/expressions are distributed over two variables, however, since the difference between them exceeds 0.10, they are considered in the variable with the larger factor load.

In the rotated solution, it is seen that most of the variables load on a single component. Only 3 variables loaded on 2 components at the same time, but since the difference between the loadings on the two components exceeded 0.1, the component with the higher load was considered. It was observed that confirmation, which is one of the BF types, loads on component 1; overconfidence loads on component 2; anchoring loads on component 3; self-attribution loads on component 4; and herd behavior loads on component 5.

Table 2. Variables obtained as a result of the analysis.

Components (Factors)	Items	Distribution of loads over items				
		1	2	3	4	5
Confirmation	If someone recommends me a particular investment option, I check on two or three persons before investing.	0.901				
	Before making an investment decision, I search for information that supports my decision.	0.862				
	If someone recommends something, I check this recommendation with others and if it is good I go ahead and invest.	0.800				
	I follow the tactics of successful people in investment.	0.631				-0.466
Overconfidence	The more I manage my investments myself, the more likely I earn.		0.902			
	I have full confidence in myself that I make the right and healthy decisions.		0.880			
	I believe that success in investment decisions stems from my personal abilities.		0.807			
Anchoring	When an asset in which I invest loses its value, I do not sell it before it reaches the purchase price.			0.900		
	I would not hesitate to invest in products offered by a good brand.			0.671	0.341	
	When I invest, I always set the selling price and do not sell until the value of the investment reaches this price.	0.314		0.630		
Self-Attribution	I believe that failure in investment decisions is mostly external or due to bad fortune.				0.871	
	I am influenced by my religious beliefs upon making investment decisions.				-0.592	
Herd Behavior	I think that acting in accordance with expert comments reduces the risk in investment decisions.					-0.926
	Indicators that support my thoughts regarding an investment enhance my motivation to invest.					-0.783
	I would hesitate to invest in a bearish asset.					-0.485

The Mann-Whitney U test was performed to investigate the relationship between demographic characteristics in Table 3 and BF characteristics since they do not exhibit a normal distribution. In Table 3, which presents the results of the Mann-Whitney U test, which is performed to investigate the impacts of demographic characteristics on financial behavior, only the difference between gender and herd

behavior, which is one of the BF factors, is found to be significant ($p_{0.001}<0.05$). The difference between gender and other BF factors was not statistically significant (overconfidence, $p_{0.832}>0.05$; self-attribution, $p_{0.903}>0.05$; anchoring, $p_{0.107}>0.05$; confirmation, $p_{0.764}>0.05$). The relationship between marital status and financial behavior factors was significant merely in self-attribution ($p_{0.042}<0.05$). The difference between marital status and other financial behavior factors was not determined to be statistically significant. The difference between risk-taking and financial behavior factors was significant in overconfidence ($p_{0.006}<0.05$), anchoring ($p_{0.001}<0.05$), and herd behavior ($p_{0.044}<0.05$). The difference between whether the investors make the future price predictions of investment instruments themselves and overconfidence ($p_{0.026}<0.05$) and anchoring ($p_{0.018}<0.05$), which are among the factors of financial behavior, was found to be significant.

Table 3. Investigation of the impacts of investor demographics on BF characteristics with the Mann-Whitney U Test

		Overconfidence	Self-Attribution	Anchoring	Herd	Confirmation
Gender	Mann-Whitney U	1331	1345.5	1110.5	828	1317.5
	Wilcoxon W	4412	4426.5	4191.5	3909	4398.5
	Z	-0.212	-0.122	-1.612	-3.371	-0.3
	Asymp. Sig. (2-tailed)	0.832	0.903	0.107	0.001	0.764
Marital Status	Mann-Whitney U	782	565	709	764.5	713.5
	Wilcoxon W	5438	5221	862	5420.5	866.5
	Z	-0.274	-2.032	-0.876	-0.418	-0.838
	Asymp. Sig. (2-tailed)	0.784	0.042	0.381	0.676	0.402
Risk-taking status	Mann-Whitney U	1117	1485	959.5	1249.5	1293
	Wilcoxon W	2713	3081	2555.5	2902.5	2946
	Z	-2.763	-0.643	-3.728	-2.012	-1.771
	Asymp. Sig. (2-tailed)	0.006	0.521	0.001	0.044	0.077
Investment tool price prediction	Mann-Whitney U	1177.5	1361.5	1160	1297.5	1445
	Wilcoxon W	2353.5	2537.5	2336	2473.5	2621
	Z	-2.231	-1.162	-2.369	-1.542	-0.68
	Asymp. Sig. (2-tailed)	0.026	0.245	0.018	0.123	0.497

In Table 4, the Kruskal-Wallis Test was performed to investigate the relationship between demographic and other characteristics with 3 or more categories and BF factors. According to the test results, significant differences existed between age groups and overconfidence ($p_{0.001}<0.05$), self-attribution ($p_{0.003}<0.05$), and herd behavior ($p_{0.008}<0.05$). Significant differences were found between engineering disciplines and overconfidence ($p_{0.001}<0.05$), and anchoring behaviors ($p_{0.018}<0.05$). Although no difference was found between duration of employment and overconfidence behavior ($p>0.05$), the difference was found with other types of financial behavior (self-attribution, $p_{0.002}<0.05$; anchoring, $p_{0.001}<0.05$; herd behavior, $p_{0.002}<0.05$; and confirmation $p_{0.024}<0.05$). The differences between the duration of investment reviews and financial behavior ($p>0.05$ for the overall financial behavior factor) were not found to be significant. The difference between investment preference methods and financial behavior factors such as overconfidence ($p_{0.009}<0.05$); self-attribution ($p_{0.033}<0.05$); and herd behavior ($p_{0.011}<0.05$) was found to be statistically significant. All the differences between the used investment instrument and the financial behavior factors were found to be significant ($p<0.05$).

Table 4. Investigation of the impacts of some other investor characteristics on BF characteristics with the Kruskal-Wallis Test

		Overconfidence	Self-Attribution	Anchoring	Herd	Confirmation
Age group	Chi-Square	27.619	16.277	1.556	13.903	5.470
	df	4	4	4	4	4
	Asymp. Sig.	0.001	0.003	0.817	0.008	0.242
Engineering disciplines	Chi-Square	28.523	16.671	15.247	9.759	4.420
	df	6	6	6	6	6
	Asymp. Sig.	0.001	0.011	0.018	0.135	0.620
Duration of employment	Chi-Square	6.845	16.492	25.853	17.153	11.233
	df	4	4	4	4	4
	Asymp. Sig.	0.144	0.002	0.001	0.002	0.024
Duration of investment reviews	Chi-Square	4.500	3.560	2.440	0.535	0.407
	df	2	2	2	2	2
	Asymp. Sig.	0.105	0.169	0.295	0.765	0.816
Investment preference method	Chi-Square	13.598	10.452	4.664	13.125	3.841
	df	4	4	4	4	4
	Asymp. Sig.	0.009	0.033	0.324	0.011	0.428
Used investment instrument	Chi-Square	14.297	17.401	9.395	23.423	16.287
	df	3	3	3	3	3
	Asymp. Sig.	0.003	0.001	0.024	0.001	0.001

Although the Kruskal-Wallis Test states whether or not the differences between categorical variables and financial behavior factors are significant, it does not specify which ones. Therefore, it is recommended to perform the Mann-Whitney U Test with Bonferroni Correction to investigate the groups between which the difference occurs (Bursal, 2017). Tables 5, 6, and 7 indicate the subgroups between which the differences are found significant in Table 3.

In the survey questionnaire through which the study data were obtained, engineering disciplines were categorized into seven groups such as mechanical (1); construction-map (2); computer (3); electrical-electronic-software (4); environment-mining (5); industry (6); and food-agriculture (7). According to Table 5, statistically significant differences were found between mechanical and computer engineering ($p_{0.001}$<0.002); between mechanical and environmental-mining engineering ($p_{0.001}$<0.002); between environmental-mining and food-agricultural engineering ($p_{0.002}$ <0.002) in the overconfidence variable. The significance value was evaluated according to the value of 0.002 calculated by Bonferroni Correction.

Table 5. Differences among BF types according to engineering disciplines

Groups		Overconfidence	Self-Attribution	Anchoring
Engineering disciplines 1-3	Mann-Whitney U	22.500	40.500	43.000
	Wilcoxon W	347.500	365.500	368.000
	Z	-3.293	-2.560	-2.437
	Asymp. Sig. (2-tailed)	0.001	0.010	0.015
	Exact Sig. [2*(1-tailed Sig.)]	0.000[b]	0.010[b]	0.015[b]
Engineering disciplines 1-5	Mann-Whitney U	36.500	78.000	121.000
	Wilcoxon W	361.500	403.000	446.000
	Z	-3.279	-1.758	-0.156
	Asymp. Sig. (2-tailed)	0.001	0.079	0.876
	Exact Sig. [2*(1-tailed Sig.)]	0.001[b]	0.090[b]	0.900[b]
Engineering disciplines 5-7	Mann-Whitney U	26.000	63.500	75.000
	Wilcoxon W	179.000	118.500	228.000
	Z	-3.086	-1.113	-0.534
	Asymp. Sig. (2-tailed)	0.002	0.266	0.594
	Exact Sig. [2*(1-tailed Sig.)]	0.002[b]	0.286[b]	0.639[b]

The methods used in the choice of investment instruments are categorized into five groups: analysis (1), brokerage house referrals (2), acquaintance referrals (3), exchange rates (4), and personal intuitions (5). Factors affecting the methods employed by the participants in their investment decisions were estimated as self-attribution, herd behavior, and overconfidence. Table 6 presents statistically significant differences between the analysis method and exchange rates ($p_{0.002}<0.005$) in the overconfidence variable; between brokerage house referrals and exchange rates ($p_{0.003}<0.005$) in the herd behavior variable, and between brokerage house referrals and personal intuitions ($p_{0.005}<0.005$) in acquaintance referrals and personal intuitions ($p_{0.005}<0.005$) ($p_{0.002}<0.005$) in both herd behavior and self-attribution variables. The significance value was evaluated according to the value of 0.005 calculated by Bonferroni Correction.

Table 6. Differences among BF types according to investment preference methods

Groups		Self-Attribution	Herd	Overconfidence
Investment preference method 1-4	Mann-Whitney U	613.500	844.500	541.000
	Wilcoxon W	1838.500	2069.500	1766.000
	Z	-2.411	-0.338	-3.047
	Asymp. Sig. (2-tailed)	0.016	0.736	0.002
Investment preference method 2-4	Mann-Whitney U	91.000	38.000	67.000
	Wilcoxon W	1316.000	1263.000	1292.000
	Z	-1.539	-3.014	-2.179
	Asymp. Sig. (2-tailed)	0.124	0.003	0.029
	Exact Sig. [2*(1-tailed Sig.)]	0.137[b]	0.002[b]	0.029[b]
Investment preference method 2-5	Mann-Whitney U	8.000	6.000	19.000
	Wilcoxon W	74.000	72.000	85.000
	Z	-2.585	-2.814	-1.433
	Asymp. Sig. (2-tailed)	0.010	0.005	0.152
	Exact Sig. [2*(1-tailed Sig.)]	0.010[b]	0.005[b]	0.180[b]
Investment preference method 3-5	Mann-Whitney U	19.500	15.000	42.000
	Wilcoxon W	85.500	81.000	108.000
	Z	-2.805	-3.075	-1.259
	Asymp. Sig. (2-tailed)	0.005	0.002	0.208
	Exact Sig. [2*(1-tailed Sig.)]	0.005[b]	0.002[b]	0.243[b]

The investment instruments used are categorized into five groups: gold (1), foreign currency (2), securities (3), and real estate (4). Factors affecting the participants' investment instrument decisions were estimated as self-attribution, herd behavior, overconfidence, anchoring, and confirmation. In Table 7, statistically significant differences were found between gold and foreign currency ($p_{0.003}$<0.0084) in herd behavior variable; between gold and securities ($p_{0.001}$<0.0084) ($p_{0.002}$<0.0084) ($p_{0.001}$<0.0084) ($p_{0.001}$<0.0084) in self-attribution, herd behavior, overconfidence, and confirmation variables; between foreign currency and securities ($p_{0.007}$<0.0084) in anchoring variable; between foreign currency and real estate ($p_{0.001}$<0.0084) in herd behavior variable; and between securities and real estate $p_{0.004}$<0.0084) ($p_{0.001}$<0.0084) ($p_{0.004}$<0.0084) ($p_{0.004}$<0.0084) in self-attribution, herd behavior, overconfidence, and validation variables. The significance value was evaluated according to the value of 0.0084 calculated by Bonferroni Correction.

Table 7. Differences among BF types according to used investment instrument methods.

Groups		Self-Attribution	Herd	Overconfidence	Anchoring	Confirmation
Used investment instruments 1-2	Mann-Whitney U	100.500	79.000	110.500	146.500	101.500
	Wilcoxon W	290.500	269.000	300.500	336.500	291.500
	Z	-2.419	-3.007	-2.084	-1.027	-2.369
	Asymp. Sig. (2-tailed)	0.016	0.003	0.037	0.304	0.018
Used investment instruments 1-3	Mann-Whitney U	197.500	243.500	229.500	328.000	214.500
	Wilcoxon W	387.500	433.500	419.500	518.000	404.500
	Z	-3.639	-3.026	-3.180	-1.848	-3.418
	Asymp. Sig. (2-tailed)	0.000	0.002	0.001	0.065	0.001
Used investment instruments 2-3	Mann-Whitney U	414.500	379.500	373.500	265.500	416.000
	Wilcoxon W	604.500	1555.500	563.500	455.500	606.000
	Z	-0.583	-1.083	-1.156	-2.703	-0.570
	Asymp. Sig. (2-tailed)	0.560	0.279	0.248	0.007	0.568
Used investment instruments 2-4	Mann-Whitney U	151.500	113.000	198.000	250.500	170.500
	Wilcoxon W	529.500	491.000	576.000	440.500	548.500
	Z	-2.369	-3.238	-1.316	-.138	-1.971
	Asymp. Sig. (2-tailed)	0.018	0.001	0.188	0.890	0.049
Used investment instruments 3-4	Mann-Whitney U	391.500	309.500	386.000	467.000	391.000
	Wilcoxon W	769.500	687.500	764.000	845.000	769.000
	Z	-2.863	-3.778	-2.912	-2.032	-2.900
	Asymp. Sig. (2-tailed)	0.004	0.000	0.004	0.042	0.004

Correlation analysis was applied for the relationship between 5 components obtained as a result of factor analysis. Since the component means did not exhibit a normal distribution, Spearman's rho test results were taken into account and the result was found as shown in Table 8. Upon examining the table, it is seen that a statistically positive and significant relationship exists between all the variables. The

variables with the highest correlation levels were calculated as herd behavior (r= 0.806) (p<0.005) with self-attribution; herd behavior (r= 0.680) (p<0.005) with confirmation; and self-attribution (r=0.679) (p<0.005) with confirmation.

Table 8. Correlations between factors/variables

			Overconfidence	Self-Attribution	Anchoring	Herd	Confirmation
Spearman's rho	Overconfidence	Correlation Coefficient	1.000	0.498**	0.356**	0.390**	0.279**
		Sig. (2-tailed)	.	0.001	0.001	0.001	0.003
		N	113	113	113	113	113
	Self-Attribution	Correlation Coefficient	0.498**	1.000	0.604**	0.806**	0.679**
		Sig. (2-tailed)	0.001	.	0.001	0.001	0.001
		N	113	113	113	113	113
	Anchoring	Correlation Coefficient	0.356**	0.604**	1.000	0.440**	0.497**
		Sig. (2-tailed)	0.001	0.001	.	0.001	0.001
		N	113	113	113	113	113
	Herd	Correlation Coefficient	0.390**	0.806**	0.440**	1.000	0.680**
		Sig. (2-tailed)	0.001	0.001	0.001	.	0.001
		N	113	113	113	113	113
	Confirmation	Correlation Coefficient	0.279**	0.679**	0.497**	0.680**	1.000
		Sig. (2-tailed)	0.003	0.001	0.001	0.001	.
		N	113	113	113	113	113

5. Discussion and Conclusion

The basic building block of the financial system involves people. Individuals are affected by various psychological factors throughout their lives and make decisions based on these factors. Although conventional theories claim that markets are efficient and that all investors act rationally, the concept of psychology has neutralized these claims over time. BF includes a number of concepts on classical economics, all financial concepts, and human psychology. BF offered a new perspective to conventional finance theories by putting forward the theory that people make mistakes upon making financial decisions (Fogaat et al., 2022). In the study, engineers, who are expected to act rationally in financial investment decisions as a professional group, are considered within the scope of BF. In this context, the impacts of BF factors such as overconfidence, self-attribution, anchoring, confirmation, and herd behavior on engineers' investment decisions are examined.

Studies on the behavioral biases of investors mentioned the importance of demographic variables. Studies indicated that the most important demographic variables were gender, age, occupation, and investment experience (Baker et al., 2018). Seven different engineering groups were discussed in the study. The impacts of the demographic characteristics of engineers on BF dimensions were examined. In the analysis results, a significant difference was found between gender and herd behavior; between marital status and self-attribution; between risk-taking and overconfidence, anchoring, and herd behavior; between price estimation of the investment instrument and overconfidence and anchoring dimensions. All

of the engineering disciplines that constituted the basis of the study exhibited a significant difference in terms of overconfidence, self-attribution, and anchoring dimensions.

Similar BF dimensions were observed between mechanical engineering and computer engineering, environmental-mining engineering, environmental-mining engineering, and food-agricultural engineering at the point of identifying similarities in investment decisions across data groups. In terms of the methods used by the engineers upon choosing investment instruments, similar BF dimensions were obtained between the analysis method and exchange rates; between brokerage firm referrals and exchange rates as well as personal intuitions; and between acquaintance referrals and personal intuitions. In the choice of used investment instruments, similarities were obtained between self-attribution, anchoring, confirmation, overconfidence, and herd behavior between gold and foreign currency, gold and securities, foreign currency and securities, and securities and real estate.

In general, the dimensions of self-attribution, anchoring, confirmation, overconfidence, and herd behavior, which we call psychological factors, are effective on the investment decisions of engineers. In particular, based on the obtained data, it is seen that engineers usually shape their investment decisions at the point of self-attribution. As a result, it can be assumed that investors in the field of engineering, where cognitive abilities are used at a high rate, can make rational investment decisions. Although the engineering profession group makes use of cognitive intelligence as much as possible within the framework of their field of work, psychological factors also come into play for engineers when it comes to economics and investment.

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