Journal of Asset Management (2021) 22:573–580
https://doi.org/10.1057/s41260-021-00239-9

ORIGINAL ARTICLE

Quantitative model for impact of behavioral biases on asset allocation decisions: a case study of investors in UAE

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Revised: 19 July 2021 / Accepted: 20 August 2021 / Published online: 8 September 2021

Abstract

Individuals are expected to be rational and follow the approach prescribed under different traditional finance theories while constructing portfolios. In reality, studies from different parts of the world show that individuals do not act rationally due to cognitive limitations and influence of emotions and feelings. Additionally, in quite a few countries, religion plays an important role in decision-making. As a result, individuals make suboptimal decisions, like holding poorly diversified portfolios, excessive or minimal trading, and taking excessive or too little risk with their portfolios. The analysis of impact of behavioral biases and religiosity has not been done in the context of individual investors living in UAE, which this paper addresses. A survey questionnaire was administered to Arab nationals living in UAE. Data of 129 individuals were analyzed. The findings showed that these investors were influenced by emotional and cognitive biases, had good knowledge of religiosity, & placed them as important. This behavior is consistent with investor behavior observed in the rest of the world. Subsequent to these empirical findings, the paper has developed a quantitative model to predict the impact of behavioral biases and religiosity on asset allocation decisions. The research approach used for developing the quantitative model can be replicated by researchers from across the world tailored to their own regions.

Keywords Behavioral biases · Asset allocation · Portfolio management · Regression aAnalysis · Emerging markets · Investment decision making

Introduction

Traditional finance theories[1] explain how rational thinking individuals should behave while making investment decisions. According to Shiller (2003) around 1970's, different anomalies in individual and market behavior were observed, which could not be explained by traditional finance theories. Gradually, academia and industry practitioners started recognizing the role of emotions and feelings in investment decision-making and the field of behavioral finance emerged. More recently, Heukelom (2014) has complemented Shiller's work by providing a detailed description of how the field of behavioral finance has evolved and describes how it impacts decision making at a personal level. Empirical studies from different geographies have shown that actual decision-making could be explained by two aspects of an individual's psychology—emotional beliefs and cognitive processes, collectively called behavioral biases.

Additionally, there has been a greater recognition of the fact that religious beliefs also play a role in the types of investments individuals choose. There is ample evidence of differences in investment decisions among people from diverse faiths like Judaism, Islam, and Christianity. According to Alderman et al. (2017), data from 2000 Dutch households between 1995 and 2008 showed that in households where religiosity is high, individuals were more likely to save, and they had a preference to fixed income products over equities. Similar observations were found in other studies, which have found a correlation between religious beliefs and individuals' financial decision-making (Hilary and Hui 2009; Kumar and Dhar 2001). Empirical studies have also discovered an impact of intensity of religious beliefs on the types of investment products an individual chooses. There is also evidence to show that religiosity and level of risk

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[1] Modern Portfolio Theory by Harry Markowitz (1952); Efficient Market Hypothesis by Eugene Fama (1970); Capital Asset Pricing Theory by Fischer Black (1972).

aversion have been positively related (Hillary and Hui 2009; Dohmen et al. 2011; Miller and Hoffmann 1995; Liu et al. 2010) as well as negatively related (Hoffmann 2000; Diaz 2000; Ellison and McFarland 2011). Hence, in countries where degree of religiosity is very high, it is important to include religiosity as a variable when modeling factors affecting decision-making.

There is a distinct gap in knowledge of impact of behavioral biases on decision-making, in context of Arab nationals residing in UAE. This subject is relevant from a managerial perspective, because a greater number of Arab nationals in UAE are becoming affluent. A report published by Statista.com (January 2019) stated that more than 77,000 individuals in UAE have a net-worth of 1 million US$ or above. Another report by Knight Frank (May 2019) stated that the total number of high net-worth individuals in UAE is expected to grow 15% by 2023. Finally, on May 08, 2018, a prominent local newspaper—gulfnews.com, reported that on an average individuals have approximately 99,000 US$ as private wealth. Hence, there is huge scope for wealth management companies to improve their net promoter scores by adopting a blended approach in their interactions with clients.

Primary data collected through a survey have been analyzed to find evidence of behavioral biases & elements of religiosity. Subsequently, regression analysis of data has been done to develop a quantitative model to predict their impact on asset allocation decisions. Stated below are the research questions:

- Is there evidence of cognitive/emotional biases and religiosity among Arab investors in UAE?
- Do behavioral biases and religiosity impact asset allocation decisions?

Theoretical concepts and empirical evidence

The field of behavioral finance which tries to explain the role of emotions and feelings on individual decision-making has been defined by different researchers.[2] Additionally, DeBondt et al. (2008) also presented market phenomenon which couldn't be explained by traditional finance theories.[3]

DeBondt and Thaler (1994) listed areas of investment decision-making that are impacted by behavioral biases. Individuals

a. hold poorly diversified portfolios and have improper asset allocation;
b. trade excessively;
c. mis-specify expected returns/risks of securities;
d. disregard opportunities by neglecting new information; &
e. mis-specify risk tolerance.

These behaviors have been validated by Baker and Nofsinger (2002) where they have highlighted some empirical evidence of decisions influenced by behavioral biases.

Representativeness Bias[4]—analysis of stock buy decisions for 62000 households showed that average returns of these stocks were +1.2%, +2.2% and +7.3% during two weeks, month and three months, respectively, before purchase decisions (Kumar and Dhar 2001).

Familiarity Bias[5]—US investment managers had strong preference for investing in stocks headquartered locally (French and Porteba 1991, Huberman 2001 and Coval & Moskowitz 1999).

Overconfidence Bias[6]—online investors show illusion of control due to active involvement in gathering excessive information (Barber and Odean 2002).

Anchoring Bias[7]—analysis of 50,000 employees from seven corporations showed that probability of exercising stock options doubled when current stock price was higher than highest price during recent 52 weeks (Heath, Huddart and Lang 1999).

Apart from these, there is ample evidence of influence of cognitive dissonance bias,[8] status quo bias,[9] endowment bias[10] and disposition effect/loss aversion bias.[11]

[2] Refer to definitions given by Richard Thaler (1993), Shefrin and Shefrin (2000), Statman (1999), Barber and Odean (1999), Ricciardi and Simon (2000), Ritter (2003), Fuller (1998).

[3] Price volatility not linked to market news (Cutler et al. 1991); Excess volatility in markets (Shiller 1981); Price Momentum (Jegadeesh and Titman 1993, 2001); Earnings Momentum (Bernard and Thomas 1989, 1990); Equity Premium (Mehra and Prescott 1985); and literature on Size and calendar effects.

[4] When confronted with new information, individuals classify that information which is consistent with their pre conceived classifications.

[5] Individuals place undue faith in stocks which have presence in their country/region, and perceive them as less risky.

[6] Individuals place unwarranted faith in their intuitive reasoning, judgement and cognitive abilities due to "illusion of knowledge" and "illusion of control".

[7] When individuals are asked to estimate value of something unknown, they start with a default figure, which acts as reference point/anchor. This is periodically adjusted up or down to incorporate subsequent information.

[8] When presented with information conflicting with existing beliefs, individuals experience mental discomfort and either seek information which confirms their existing beliefs, or ignore information which conflicts with them.

[9] When individuals are faced with choices, they have a tendency to do nothing and hold on to their existing portfolios and either delay or take no action.

[10] Individuals tend to value an asset more when they own it. They demand more when selling an asset they own while pay less for same asset when they are buying.

[11] Individuals have a stronger impulse to avoid losses rather than seek gains. They feel greater pain for a similar loss than the amount of happiness felt for a similar gain.

Empirical evidence of role of religion in investment decision-making

As mentioned earlier, in quite a few countries, empirical evidence has shown that religion plays an important role in decision-making. Noussair et al. (2012) observed positive correlation between level of risk aversion and religiosity. In another paper, Renneboog and Spaenjers (2011) have highlighted influence of religiosity on bequest motive of individuals. Both these studies have focused on investors in Europe where people are predominantly Christians. Hassan et al. (2015) have presented some findings among investors who are Muslims by religion.

Research design

The epistemological stance adopted is deductive, to verify existence of behavioral biases & religiosity, followed by developing a quantitative model to predict their impact on asset allocation decisions. The research has used primary data collected through a survey of individual Arab investors selected by simple random sampling. The raw data were analyzed by using software to perform regression analysis and develop the mathematical model.

(a) Primary Data collection

Primary data were collected by using Qualtrics.com and face to face surveys. 500 individuals were requested to take part. 161 responses were received, out of which 129 were completed fully, and used for data analysis.

The survey questions collected the following information:

- Demographics—age, gender, education, employment, and nationality;
- Risk tolerance, return expectation, time horizon and asset allocations of portfolios.
- Evidence of cognitive & emotional biases.
- Level of knowledge & importance for important elements of Sharia.

(b) Secondary Data Collection

To compare actual with optimal asset allocation of portfolios, we narrowed down to those models which had cash, bonds, equities and real estate as investible asset classes, as these are most popular investments in UAE. Models from Barclays, Morningstar and Lazard, were used as benchmark for optimal asset allocation.

(c) Methodology used to perform Regression Analysis for the research

Methodologies used for computing values of variables for regression are given below.

Optimal Asset Allocation: average weights from the 3 models for different assets were calculated.

	Conservative	Moderate	Aggressive	Highly aggressive
Cash	23	16	7	1
Fixed Income	35	23	16	7
Equities	32	47	61	77
Real estate	10	14	16	15
	100	100	100	100

Weighted average deviation in portfolio was used as **dependent variable**. Provided here are calculations for an actual respondent who was moderate in risk tolerance:

(a) Actual allocation to cash was 20%, and optimal allocation was 16%. Hence, the difference was $20 - 16 = 4\%$.
(b) This was multiplied with 16% (optimal weight) to get weighted deviation of 0.64%.
(c) Weighted deviations for other asset classes were calculated, and their average was calculated as $\{0.64 - 2.99 - 12.69 + 5.04\}/4 = -2.5\%$

Since weighted average deviations of all observations were evenly spread as positive/negative, we considered absolute values. For example above, figure used in regression was 2.5%.

Evidence of emotional biases: Presence of emotional biases[12] was used as **independent variable.** Emotional biases tested were – overconfidence, self-control, loss aversion, herding and status quo.

Evidence of cognitive biases: Presence of cognitive biases[12] was used as **independent variable**. Cognitive biases tested were anchoring, recency, mental accounting, conservatism and confirmation biases.

[12] An individual having two or more emotional/cognitive biases was assigned value of one, representing presence of biases, while score of zero or one emotional/cognitive biases was assigned value of zero, representing absence of biases.

Knowledge of Sharia principles: Presence of knowledge of religiosity[13] was used as **independent variable**. Knowledge of Sharia compliance, riba, gharar and maysir was tested.

Importance to principles of Sharia: Importance given to religiosity[14] was used as **independent variable**. Importance given to prohibition of riba, doubtful transactions, principles of moderation and ethical behavior was tested.

Risk tolerance: Risk tolerance was measured by potential losses individual was willing to accept. Conservative investor was assigned 1, moderate 2, aggressive investor 3 and highly aggressive 4. Product of value assigned on risk tolerance and number of emotional & cognitive biases were used as **two different independent variables**. An example—for an aggressive investor, having 3 emotional and 2 cognitive biases, these two product factors were nine (3 × 3) and six (3 × 2), respectively.

d. Description of variables for regression analysis

Dependent variable

Y_0 = Weighted average deviation of asset classes in portfolio.

Independent Variables

X_1 = Presence of emotional biases, with a value of 0 or 1.

X_2 = Presence of cognitive biases, with a value of 0 or 1.

X_3 = Knowledge of elements of religiosity, with a value of 0 or 1.

X_4 = Level of importance given to religiosity, with a value of 0 or 1.

X_5 = Product of value assigned on risk tolerance and number of emotional biases.

X_6 = Product of value assigned on risk tolerance and number of cognitive biases.

Null and alternative hypothesis for all independent variables is stated below, and tests were done to check statistical significance of their regression coefficients.

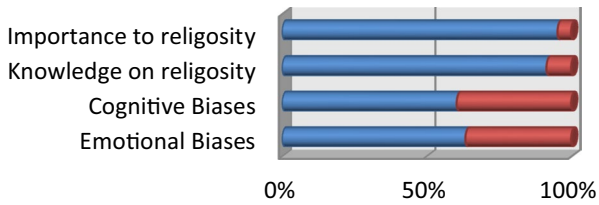
H_o = There is no impact of either of variables X_1, X_2, X_3, X_4, X_5 and X_6 on decision-making.

H_a = There is an of either of variables X_1, X_2, X_3, X_4, X_5 and X_6 on decision-making.

To check if an independent variable was statistically significant at 95% confidence level, 'p' value was analyzed. For "p" value less than 0.05, null hypothesis was rejected. Further analysis of descriptive statistics was done to evaluate the explanatory power of regression model and check if assumptions of linear regression—normal distribution of residuals, absence of auto correlation, heteroscedasticity and multicollinearity were true.

Research findings

We first start by presenting findings on evidence of emotional and cognitive biases, knowledge and level of importance given to different elements of religiosity.



	Emotional Biases	Cognitive Biases	Knowledge on religosity	Importance to religosity
Yes	63.50%	60.50%	91.50%	95.30%
No	36.50%	39.50%	8.50%	4.70%

As seen from figure above, there is evidence of the presence of emotional biases among 63.5% and cognitive biases among 60.5% of respondents. Additionally, 91.5% of respondents have good knowledge of religiosity, and 95.3% considered those aspects as important. Further, major emotional biases observed were—status quo, loss aversion, and herding bias; major cognitive biases observed were anchoring, mental accounting and confirmation biases. Thus, investors in UAE have similar behavioral influences compared to the rest of the world.

(a) Regression Analysis

Regression analysis is done to derive an equation for the line of best fit:

$Y = b_0 + b_1X_1 + b_2X_2 + \ldots\ldots + \mathcal{E}_0$; Y being dependent variable, X_1, X_2, being independent variables, and $\mathcal{E}_0$ residual term.

[13] Likert scale of 1 to 4 was used. Average score of responses was taken, where figure of 1.5 or above was assigned value of 1 representing knowledge of religiosity, and average of below 1.5 was assigned value of 0 representing no knowledge of religiosity.

[14] Likert scale of 1 to 4 was used. Average of four scores was taken. Average of 1.75 or above was assigned value of 1 representing importance to religiosity, and average of below 1.75 was assigned value of 0 representing no importance to religiosity.

In the field of psychology, Green (1991) has indicated that sample $S \geq 50 + 8n$ is acceptable, 'n' being number of independent variables. Additionally, Van Voorhis and Morghan (2007) have provided a range of 10–30 respondents per variable when there are 6 or more independent variables. Using first methodology, sample of $50 + (8 \times 6) = 98$ is acceptable. Using second methodology, if we take average of 10 and 30, sample of 20 per variable is acceptable. Hence, sample of $6 \times 20 = 120$ is acceptable. Lastly, we looked at sample size calculator from qualtrics.com. The Arab population in UAE is approximately 2.6 million. A sample of 129 is sufficient to draw meaningful conclusions at 95% confidence level and 8.6% margin of error. Thus, sample of 129 can be considered as sufficient to draw conclusions, which can be extrapolated to larger population with reasonable accuracy.

(b) Regression Model

From initial data of 129 individuals, four observations were classified as outliers. They had high risk tolerance, placed high importance to religiosity and were strongly influenced by either emotional/cognitive biases. Final regression was run with 125 observations after removing these outliers. The tables below present software outputs on regression analysis.

Variable	Coefficient	*t* value	*p* value
Constant	1.854	2.584	0.011
Presence of emotional biases	− 0.869	− 2.156	0.033
Presence of cognitive biases	− 0.855	− 2.084	0.039
Knowledge of religiosity	− 0.400	− 0.624	0.534
Importance to religiosity	0.435	0.512	0.609
Product of risk tolerance & no. of emotional biases	0.333	3.483	0.001
Product of risk tolerance & no. of cognitive biases	0.214	2.784	0.006

The regression equation can be written as:

$Y = 1.854 - 0.869X_1 - 0.855X_2 - 0.400X_3 + .435X_4 + 0.333X_5 + 0.214X_6 + \mathcal{E}_0$

Null hypothesis for coefficients of X_1, X_2, X_5 and X_6 and intercept term have been rejected, and it can be concluded that they are different from zero at a statistically significant level, as their respective 'p' values are < 0.05 and 't' values are > 2. The null hypothesis for coefficients of X_3 and X_4 cannot be rejected. It cannot be concluded that they are different from zero as their 'p' values are > 0.05 and 't' values are < 2. Hence, at a statistically significant level, asset allocation decisions are influenced by:

- Emotional & cognitive biases.
- Interaction of score on risk tolerance with emotional/cognitive biases.
- Religiosity is not contributing toward asset allocation decision, &
- Intercept term is statistically significant and different from zero.

The findings on evidence of the presence of behavioral biases show that investor behavior in UAE is consistent with investment behavior of individuals from other parts of the world. It is worth noting, however, that there are some differences when empirical evidence of impact of religion on investment decision making is compared with other countries. Ahmad Sabir et al. (2021) found that religiosity had a positive influence on investor's intention to invest in stocks, and their attitude toward risk. In yet another study, Nurasyikin Jamaluddin (2013) found empirical evidence of influence of religiosity on the types of investments individuals chose. Both these studies were done in the context of Muslim investors who were followers of Islamic religion. The profile of investors on the level of education in both these studies showed that majority of individuals had graduate or higher qualifications. This was comparable to the investor profile in UAE. However, when we compare the average incomes of individuals, we find that average annual income of individuals in UAE is approx 80K US$, while in Pakistan, it is 7 K US$ and 6.5 K US$ per year in Malaysia. This gives an impression that the differences in impact of religiosity on investment decision making could be attributed to the difference in income levels. When we look at other religions, there is empirical evidence of impact of religiosity on decision making as well. Rupali Mishra et al. (2019) found that in India, where the majority of individuals follow Hinduism, religiosity had a positive influence on intuitive and cognitive abilities of individuals which in turn increased the efficacy of investment decision making among individuals.

ANOVA

Model	Sum of squares	*df*	Mean square	*F*	Sig.
Regression	126.450	6	21.075	7.983	0.000
Residual	311.502	118	2.640		
Total	437.952	124			

The observed F (6,118) statistic from ANOVA table is 7.983. It is greater than critical value F_c from F table. Therefore, at least one of the independent variables is making a statistically significant contribution toward variation of the dependent variable.

Model summary

Model	*R*	*R* square	Adjusted *R* square	Std. error of the estimate
	0.537	0.289	0.253	1.62476

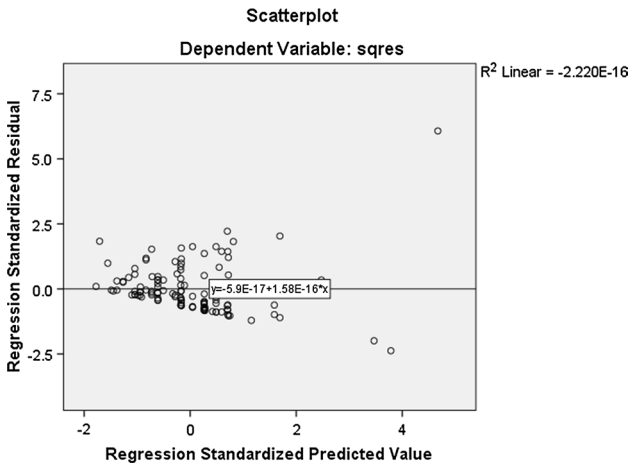
Observed value of adjusted R_a^2 is 0.253 implying that the model explains 25.3% of variation in the dependent variable. Unlike studies conducted in physical sciences, researchers in human behavior or psychology face difficulty in generating models with high R_a^2 as human behavior is very complex, diverse and difficult to predict. Hence, it is acceptable to have R_a^2 less than 0.5. According to Ferenc Moksony (1999), low R^2 of a model just means that there may be factors other than those considered in regression analysis which could explain the variation of dependent variable. Peterson K Ozili (2016) also mentioned that R_a^2 as low as 0.10 is acceptable in human behavior and social sciences. Lastly, Kenshi Itaoka (2012) mentioned that R_a^2 of 0.09 is considered respectable in social sciences. Observed R_a^2 is within acceptable value for explanatory power.

(c) Tests for assumptions of linear regression

Tests of normality

	Kolmogorov–Smirnov			Shapiro–Wilk		
	Statistic	*df*	Sig.	Statistic	*df*	Sig.
Standardized residual	0.068	125	0.200	0.989	125	0.403

Observed '*p*' value for Shapiro–Wilk test is 0.403, and 0.2000 for Kolmogorov–Smirnov test. Since both these values are greater than 0.05, it can be concluded that residuals are following a normal distribution.



Analysis of scatter plot for standardized residuals against predicted values, shows barring three data points on extreme right, all other residuals are within a range and their variance is constant, implying the absence of heteroscedasticity. Observed Durbin–Watson statistic was 2.1, which is close to the desired value of 2, implying residuals are not autocorrelated. The VIF value was 2.6 or below for all variables which was within desired value of less than 3 to conclude absence of multicollinearity.

To sum up, the regression model has an explanatory power of 25.3% and satisfies all assumptions of linear regression increasing confidence in the predictive power of the model.

Conclusions and scope for further research

There is strong evidence of the presence of both emotional and cognitive biases among Arab investors in UAE. Regression analysis shows they are contributing significantly toward asset allocation decisions. These decisions are suboptimal and can impact ability of portfolios to generate desired returns in the long term. Investment advisors need to have a blended approach to tackle impact of behavioral biases. They can moderate the impact of biases and help clients bring their portfolios closer to optimal portfolios prescribed under traditional finance. Else they can adapt and accept their presence and allow for smaller deviations from optimal portfolios to bring about a discipline in their investment patterns. Researchers from other parts of the world can develop similar quantitative models which can find a quantitative link between behavioral biases and decisions made by individuals. This can be done by administering a survey of a representative sample of investors to test them for emotional & cognitive biases, and relevant portfolio related information like risk tolerance, asset allocations and types of securities held in the portfolio. With the use of software, a regression model can be generated to predict the impact of behavioral biases on investment decision making at a statistically significant level. This will help investment advisors help manage their client portfolios more effectively. As a final point—there is ample scope for further research to look beyond elements of behavioral finance and look toward analyzing how societal norms and ideologies are going to affect financial decision making. This field of study termed as "social finance" by Hirshleifer (2014), looks at studying how social interactions and processes are influencing financial decision making, and will be the focus in the field of behavioral finance in future.

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