Past-Oriented Behavioural Bias: A study on SandP and TEPIX Indexes

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ARTICLE INFO	ABSTRACT
	Behavioral finance had been becoming a fast-growing field of study in the past few years and because of the importance of investors' behavior in market performance, it's extremely noteworthy. By studying biases from their orientation perspective, we can divide them into two major groups, past-oriented, and current-oriented biases. In this research, a model had been developed for the past-oriented behavioral bias, which is closely related to the random walk theory. The research sample included the daily price information of 9 different industry indices in the Tehran Exchange Price Index (TEPIX), the index of 50 Top Companies in the Tehran Stock Exchange, and the SandP index in the New York Stock Exchange from 2011/25/03 to 2019/19/03. The results of the ARIMA model based on Markov switching models were measured for the degree of rigidity of these indexes by random walk theory, and then the effect of past-oriented behavioral bias was calculated in each of these 12 indexes by developing a new model. The results indicate that the cement index had the highest past-oriented behavioral bias (57%), followed by the top 50 companies index (46%), chemicals (41%), and oil product index (12%). However, the SandP index had no past-oriented behavioral bias.

1 Introduction

As concepts develop, all of them eventually going to expand multidisciplinary, and finance isn't an exception in this regard. The combination of finance with psychology and sociology in some layers because of its use both in business and the academic area is nowadays one of the most notable fields of study which called behavioral finance. behavioral finance is investors' struggle to find a way to taking and giving risks and gain Jaiswal and Kamil [29]. First studies about behavioral finance had been taken by two famed psychologists Tversky and Kahneman in 1974. Behavioral finance studies investors' deviations and anomalies from traditional finance assumptions during the decision-making process, it can be about portfolios, asset pricing, and market efficiency directly or indirectly. As Graham et al. [20]

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said this field of study focus on psychological factors which leads to a common pattern in investment practitioners. Investor's anomalies come from various types of biases Sharma and Dibrugarh [50], Hirshleifer [25] and Shiller [52]. Nowadays experimental methods had been became a practical way for assessing these deviations and gives us a better understanding of behavioral finance Duxbury [14]. Theories like prospect theory Kahneman and Tversky [34], overconfidence Matsumoto et al. [38], Michailova et al. [40] anchoring Chandra [10], Sadi et al. [48], mental accounting Thaler [62], and other studied biases Aren et al. [3], Bogan et al. [7], Hackbarth[23], Howard[26], Lacalle[36], Zhou and Pham[69]. Moreover being aware of behavioral biases will lead investors to perform more professionally Suresh [58] and eventually more efficient market. However, overcome to these biases isn't such a straightforward approach to do but fortunately, some studies making light in solving this dilemma.

In this research, behavioral biases were introduced past-oriented. Then, by developing a model for the past-oriented behavioral bias, 12 indicators, including Tehran exchange price index (TEPIX), top 50 companies index, and 9 indices of different industries, including bank, cement, oil products, machinery, chemicals, automobiles, sugar, food but sugar, metal minerals in Tehran Stock Exchange, and SandP index in New York Stock Exchange were measured from 2011/25/03 to2019 /19/03. Past-oriented behavioral bias, which is closely related to the theory of Random Walk, reflects the impact of past information on prices. Regarding the goal of this research, namely, modelling the past-oriented behavioral bias, the behavioral bias that constitutes the past-oriented behavioral bias is generally divided into two general strategies of momentum or contrarian. In both of these two strategies, attempts have been made to make predictive performance and additional returns using the past performance. In general, the momentum strategy means the continuation of the current trend found in the ARIMA model with a positive coefficient. The contrarian strategy means the opposite of the current trend, which is equivalent to the negative ARIMA coefficient. The second section of the article is devoted to the theoretical and experimental foundations. In the third section, we introduce the research methodology and modelling of a new model to study the adherence of Tehran Stock Exchange indices to the Random Walk method and hence the effect of past-oriented behavioral bias. In the fourth section, the experimental findings of the research are presented. In the final section, the results are summarized.

2 Literature Review

Traditional finance dominated investors' decision-making assumptions for many years. One of the most important obligations in traditional finance is investors practice rationally and prices in the market reflect all accessible information. Rational investors never disarrange by cognitive errors, are self-controlled, and risk-averse. Later on, neoclassical finance appeared and concepts like CAPM, EMH, and arbitrage-based option pricing theories got the appeal. Concerning rational players, the market will perform under the EMH assumption. An efficient market is distinguished as a market that reacts to the new information instantly and all the information is reflected in prices so there is no way for prediction of prices Fama et al. [16], therefore research about the efficient market was based on the random walk hypothesis generally. In this regard, Fama [17] introduced the efficient market theory which claims market players can be confident about reflecting all accessible information about securities on their prices and the prices have equilibrium with their risk. But observing facts like the financial crisis, market fluctuations and seasonal effects questioned standard finance assumptions. Fama [17], Samuelson [49] and Roberts [47] proposed three-level of information efficiency in the capital market: Weak-form efficiency applies to the market in which prices are totally adjusted with past information. Semi-strong efficiency refers to the market that not only past information doesn't make any superiority in investment

decisions but also all public information will not make any advantages for investors. Strong-form efficiency: in this market, any kind of information like past, current and confidential are reflected in prices so there would be no advantages in the decision-making process of investment. Bernstein [5] Showed investors in the face of uncertainty have irrationality, inconsistency, and incompetence patterns. Thus traditional finance assumption has been denied by Daniel Kahneman and Amos Tversky, two outstanding psychologists, who had the very beneficial theoretical and experimental work for the transition of finance to a new phase during the 1980s named behavioral finance Nofsinger [41]. Behavioral finance developed on the "Bounded Rationality" assumption Uzar and Akkaya [66]. This concept refers to rational decision making which considers cognitive restrictions, and knowledge and computational dimensions. These limitations come from human nature like being emotional and limitation of knowledge. In complicated and risky situations because investors' tendency to predilections decisions is more predictable and non-optimal, behavioral biases are defined as systematic errors Chen et al. [11]. Researchers have defined some biases as psychological specifications which have notable relevance with the decision-making process Shehzad et al. [53].

In standard finance investors' decision-making should follow the risk and probability principles, but in fact, there are various biases that we'll discuss pursuantly. Shiller argued about the facility of random movement in the stock market by questioning strong market efficiency by behavioral biases Shiller [52]. Bondt and Thaler [12] Asserted that people overreact to the sudden and notable news. And winner-loser effect shows that the occurred gain and loss cannot be explained by CAPM beta and it has a reversal pattern with overreaction Bondt and Thaler [9]. The law of chance says a small sample of the total population can have a highly representative means to people and it plays a critical role in intuitive assessment by investors Kahneman and Tversky [31- 32- 33]. The anchoring effect means when the assessment of information is set initially, an anchor occurs and other information or analysis may not have enough effect on investor decision making Tversky and Kahneman [64]. The framing effect also influences investors' decisions and it refers that the same problem can have different interpretations in people's minds Tversky and Kahneman [65]. Transparency and framing effect have tight accommodation of bounded rationality Tversky and Kahneman [63]. Thaler [63] Pointed out another bias named "Mental Accounting" which represents people divers their money based on varying criteria into different accounts and treat them differently. Generally, investors think they are smarter and more informative than they are Shefrin [51]. Surprisingly experienced investors make more behavioral biases than others Chen et al. [11]. The stock split effect is shown, although there should be no difference in companies' growth after stock splitting, the evidence says the probability of price raising is more Desai and Jain[13], and Ikenberry et al. [28], The dividend yield effect designates if a stock has a high dividend it will perform better than an average of the market Litzenberger and Ramaswamy [37] and Keim [35]. The insider transaction effect signifies that if anyone has specific information about the company, besides gaining more profit, can predict stock price movements Finnerty [18]. The Country effect refers to any of the calendar and non-calendar effects that can show the distinctive effects related to the economic system that governs it Gultekin and Gultekin [22]. Hence Tajdini et al. [57] can be a strong proof of this claim. The Neglected firm's effect means firms that got underestimated by institutional investors usually have a better outcome Arbel and Strebel [2]. Another interesting effect is mean aversion over the long run which means everything will drift back into long-run mean ultimately. Particularly biggest loser investors will become the biggest beneficial investors in 3 to 5 years De Bondt andThaler [9]. The market overreaction effect alludes to situations when investors overreact to recent news such as future earnings announcements Kahneman and Tversky [64]. On the other hand, Market under-reaction effect refers to a situation that activists are less reactionary to recent news Abarbanel and Bernard [1]. And

reacting to news is related to priority and importance of them, it means if there is already bad news about a company good news won't affect the prices that much Hasani et al. [24]. By stepping back and looking generally we can have 2 major segmentations about biases, past-oriented, and current-oriented behavioral biases. There are numerous studies about the proximity of past-oriented behavioral biases with random walk theory in different stock exchanges over the world such as Huber [27], Grieb and Reyes [21], Zhu [69], Chakradhara and Narasimhan [8], Nwidobie and Barine Michael [43], Pandey and Samanta [44], Bilal Nawaz et al. [6], Tehrani et al. [60], Nourbakhsh et al. [42], Tas and Guleroglu Atac [58]. Although [30] found out behavioral biases has significant and revers effect on stock return, but behavioral finance isn't dedicated to the stock market, there are also studies about customer behavior and bank funding stability in the banking industry Tehrani and et al. [59], or Tajdini and et al [57] argued about the fluctuation in the exchange rate is affected by economic-behavioral component and [39] biases has more effect in currency market than stock market.

The autoregressive integrated moving average (ARIMA) model has been successfully used as a popular linear model for economic time series forecasting Wang et al. [67]. They applied a hybrid model, which is distinctive in integrating the advantages of ARIMA and ANNs (artificial neural networks) in modeling the linear and nonlinear behaviors in the data set. In addition, some studies are related to other aspects of behavioral economics by using the ARIMA model. For instance, Porto et al. [45] worked on the effects of price discounts on revenues received from services. They studied the commercial cycle from the viewpoint of operant behavioral economics. Many other econometric, statistic models and academic researchers can be used in behavioral economics and behavioral finance. A time series that consists of two components: the major component that follows an autoregressive integrated moving average (ARIMA) process and the noise component is very difficult to estimate. To solve the problem, Wong and Miller [68] adopted and developed the theory of repeated time series. So, they developed the theory of the ARIMA with noise (ARIMAN) model. In addition, they relax the normality assumption that both major and noise components can follow any distribution, not necessarily follow a normal distribution. They derived some properties for the ARIMAN model on the identification, estimation, and forecasting for each component. They also used their proposed model for real data. The limitations of the model developed by Wong and Miller [68] include: The variances of both components are constants, and the number of repetitions cannot be changed. To overcome the limitations in Wong and Miller [68] apply the Kalman filter technique to improve the theory to relax both conditions in (i) and (ii). They develop the ML estimation to estimate the ARIMAN model for each component and they suggest an approach to conduct forecasting.

In another study, Siami-Namini et al. [54] studied a comparative analysis of forecasting financial time series using ARIMA, LSTM, and BiLSTM. The results of their study show that additional training of data and thus BiLSTM-based modeling offers better predictions than regular LSTM-based models. More specifically, it was observed that BiLSTM models provide better predictions compared to ARIMA and LSTM models. It was also observed that BiLSTM models reach the equilibrium much slower than LSTM-based models. Also, Assous et al. [4] worked on how international Market Indices Estimate TASI's Movements by ARIMA Model. This study investigates the effectiveness of six of the key international indices in estimating the Saudi financial market (TADAWUL) index (TASI) movement. Moreover, we can find some studies in the banking system. For instance, Eti et al. [15] worked on predicting the role of Islamic banking on sustainable economic development by the ARIMA Model. There are more researches in this area such as A hybrid statistical approach for stock market forecasting based on artificial neural network and ARIMA time series models Rathnayaka and Seneviratna [46], or a comparative analysis of forecasting financial time series using Arima, lstm, bilstm

Siami et al. [54], and can International Market Indices Estimate TASI's Movements? The ARIMA Model Assous [4], and predicting the role of Islamic banking on sustainable economic development: An analysis for Turkey with ARIMA model.

3 Methodology

Data were collected through the library method by referring to the libraries and stock exchange database. The data collection instruments were a computer, internet, and content analysis, i.e., study and analysis of the content of the books and studies carried out by others in this regard, which could be useful in this research. Finally, two basic and important principles were taken into account in the preparation of statistics and data. In terms of time, the trend of the stock exchange during seven years, from 2011/25/03 to 2019/19/03, was considered, and its efficiency and inefficiency in the two mentioned indices were studied. Regarding the place, this study analyzed the activity of Tehran and New York Stock Exchanges and companies listed in these markets. Statistical society: The statistical society of this study comprised of the companies listed in the Tehran and New York Stock Exchanges. Statistics and information were obtained from the top 50 companies listed in Tehran Stock Exchange and the SandP index on New York Stock Exchange. The statistics and data about these two indices were calculated daily, during which 2511 pieces of data were collected.

3.1 The Weak-Form Efficiency

A capital market is said to be weakly Efficient, or to satisfy weak form efficiency if it fully incorporates the information in past stock prices. Thus, the preceding strategy would not be able to generate profits if weak form efficiency holds. Often, weak-form efficiency is represented mathematically as:

$$P_t = P_{t-1} + Expected\ return + Random\ error_t \tag{1}$$

Equation 1 states that the price today is equal to the sum of the last observed price plus the expected return on the stock plus a random component occurring over the interval. The last observed price could have occurred yesterday, last week, or last month, depending on the sampling interval. The expected return is a function of a security's risk and would be based on the models of risk and return in previous chapters. The random component is due to new information about the stock. It could be either positive or negative and expects zero. The random component in any period is unrelated to the random component in any past period. Hence, this component is not predictable from past prices. If stock prices follow Equation 1, they are said to follow a random walk. The market efficiency was determined by Box-Jenkins methodology, as follows:

$$Y_t = \varphi_0 + \varphi_1 Y_{t-1} + \varphi_2 Y_{t-2} + ... + \varphi_p Y_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - ... - \theta_q \varepsilon_{t-q} \tag{2}$$

Autoregressive: this method is used to determine the presence of a non-zero significant relationship between existing efficiency series and efficiency of former periods. A zero-significant relationship shows the predictability of stock efficiency from the previous efficiencies. yt is today's price, yt-p is previous days' price, εt is today's random error value, which has to be white noise based on efficient market hypothesis, and εt-q is a disturbance of previous periods. Where Φi and θj are autocorrelation coefficients and moving to mean with prices of previous periods, respectively, which should not be significant based on the efficient market hypothesis in any of the previous periods. P and q are the duration of autocorrelation and moving mean lags. These values can be determined by testing the hypothesis. Also, by using information criteria, the best state for p and q and optimal model, i.e., fitting

and simplicity of the model, can be determined. Three methods can be used to analyze whether the disturbance is white noise in EViews:

Since the parameters of econometric models typically have major changes over the period under study, to determine market efficiency in weak form based on Markov switching models and the Box Jenkins model under both low fluctuating and high fluctuating regimes by the autoregressive method. To test the existence of a non-zero significant relationship between the series of current returns and the values of returns in previous periods, the significant difference of zero indicates the ability to predict stock returns from past returns. In Equation 3, yt is today's price, yt-1 is the price of the day before, and εt is the random error value today which, according to the efficient market hypothesis, must be white noise, where φ1 and φ2 are the autoregressive coefficients in both regimes one and two, respectively. Which, according to the efficient market hypothesis, should not be significant in any of the preceding periods.

$$y_t = \begin{cases} \phi_1 y_{t-1} + \varepsilon_t & if \ , S_t = 1 \\ \phi_2 y_{t-1} + \varepsilon_t & if \ , S_t = 2 \end{cases} \quad (3)$$

3.2 Research Modelling

Past-Oriented Behavioral Bias (POBB): Behavioral bias in two general terms is the momentum strategy, the continuation of the current trend found in the Arima model with a positive coefficient. And the contrarian strategy means the opposite of the current trend, which is equivalent to the negative Arima coefficient.
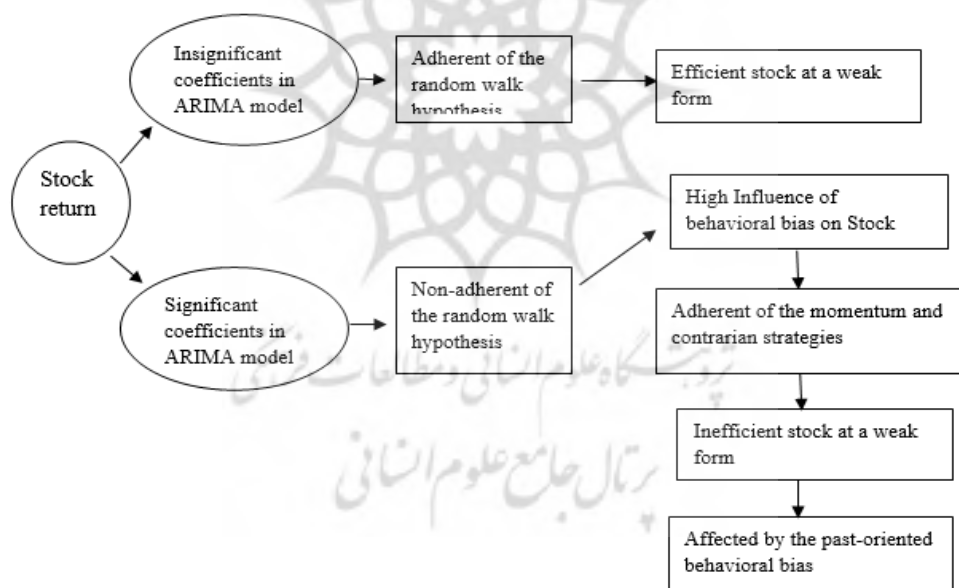

Fig. 1: Past-Oriented Behavioral Bias (POBB) Model

In this study, we modelled the effects of Past-oriented behavioral bias in the stock market as below as shown in Equation 4, given. The exponential function was used to more accurately assess behavioral biases. The logic of using the exponential function is to increase the effect of behavioral biases incrementally. Considering the attribute of the exponential function of the effect of behavioral biases in higher coefficients, AR (1) is higher than the time when the AR (1) coefficients are shorter.

$$POBB = \left[EXP \left(|Coefficient \ AR \ (1)| \right) - 1 \right] \% * (CDR1 + CDR2) \quad (4)$$

Where AR (1) is autoregressive coefficients in OLS Model, CDR1 is the constant duration of regime 1 in the condition of disobedience of the random walk in the Markov switching model, CDR2 is the constant duration of regime 2 in the condition of disobedience of the random walk in the Markov switching model and POBB is past oriented behavioral bias.

4 Findings

Analyzing the data of daily price information of 9 different industry indices of the bank, cement, oil products, machinery, chemicals, automobiles, sugar, food except sugar, metal minerals, index of 50 Top Companies and price index (TEPIX) in Tehran Stock Exchange and SandP index in the New York Stock Exchange for the period from 2011/25/03 to2019 /19/03. By performing three criteria including (1) Durbin-Watson statistics (2) simple auto-correlation hypothesis, and (3) Lagrange Multiplier test of serial correlation, and following findings were obtained considering the structural failures.Based on Durbin-Watson statistics and inconsistency of the random walk hypothesis, there should be no consecutive correlation between residuals or disruption components. As a result, the value of this statistic in Durbin-Watson statistics must be close to 2 concerning column 1 of Table 1. The spacing of this column's numbers with 2 -except for the SandP index of the New York Stock Exchange (2.01) and the oil products index of Tehran Stock Exchange (1.76), so it can be concluded that the disruption component of the other ten indicators is not white noise.

Table 1: Durbin-Watson Statistics, Simple Auto-correlation Hypothesis, And Lagrange Coefficient Test of Serial Correlation

Index Name	Durbin-Watson Statistics	Prob of Correlogram of Residuals	Prob of Serial Correlation Lagrange Multiplier Test
Banks	1.48	zero	zero
Cement	1.107	zero	zero
Oil Products	1.76	zero	zero
Machinery	1.53	zero	zero
Chemicals	1.35	zero	zero
Automobiles	1.47	zero	zero
Sugar	1.44	zero	zero
Food Except For Sugar	1.36	zero	zero
Metal Minerals	1.38	zero	zero
50 Top Companies	1.23	zero	zero
Price Index (TEPIX)	1.31	zero	zero
SandP Index	2.01	0.82	0.11

Simple auto-correlation hypothesis test that says there shouldn't be any jags out of a 95% confidence interval, i.e., the auto-correlation is not significant, According to column 2 of Table 1, the significance level is close to zero in the 11 different Tehran Stock Exchange indices, and only in the SandP index of the New York Stock Exchange with a value of 0.82 is well far from zero, which indicates the ideal condition for the white noise disturbance component of the SandP index in the New York Stock Exchange. Results of Lagrange Multiplier test series correlation also confirm the two other hypothesis tests. P-Value for Lagrange coefficient test of series correlation According to column 4 of Table 1, the significance level is close to zero in the 11 different Tehran Stock Exchange indices, and only in the SandP index of the New York Stock Exchange which is well far from zero with a value of 0.11, which

indicates the ideal condition for the white noise disturbance component of the SandP index of the New York Stock Exchange.

Table 2: ARIMA Model Using Simple Regression (OLS Regression)

Index Name	Coefficient AR (1)	T-Statistic	F-Statistic	Prob F-Statistic
Banks	0.26	11.9	142.2	0.0000
Cement	0.45	22.15	490.6	0.0000
Oil Products	0.12	5.3	28.7	0.0000
Machinery	0.32	15.2	232.7	0.0000
Chemicals	0.35	16.4	270	0.0000
Automobiles	0.26	12.2	148	0.0000
Sugar	0.33	15.8	248.9	0.0000
Food Except For Sugar	0.32	15	225	0.0000
Metal Minerals	0.31	14.5	210	0.0000
50 Top Companies	0.38	18.3	336.2	0.0000
Price Index (TEPIX)	0.34	16.3	267	0.0000
SandP Index	Insignificant	-0.23	0.05	0.82

Table 3: ARIMA Model Using Markov Switching Model

Index Name	Type Of Regime	Coefficient AR (1)	LOG(SIGMA)	Constant Duration Of The Regime
Banks	Low Turbulence	0.31	-6	0.52
	High Turbulence	0.25	-4.1	0.48
Cement	Low Turbulence	0.37	-5.5	0.496
	High Turbulence	0.43	-4.5	0.504
Oil Products	High Turbulence	Insignificant	-2.7	0.06
	Low Turbulence	0.28	-4.4	0.94
Machinery	High Turbulence	0.31	-4.1	0.37
	Low Turbulence	0.3	-5.1	0.63
Chemicals	Low Turbulence	0.22	-5.8	0.55
	High Turbulence	.34	-4.2	0.45
Automobiles	Low Turbulence	0.2	-4.7	0.36
	High Turbulence	0.26	-3.8	0.64
Sugar	Low Turbulence	0.43	-5.1	0.42
	High Turbulence	0.29	-4	0.58
Food Except For Sugar	Low Turbulence	0.31	-5.5	0.56
	High Turbulence	0.31	-4.1	0.44
Metal Minerals	Low Turbulence	0.32	-5.5	0.52
	High Turbulence	0.28	-3.9	0.48
50 Top Companies	Low Turbulence	0.34	-5.7	0.62
	High Turbulence	0.36	-4.4	0.38
Price Index (TEPIX)	Low Turbulence	0.27	-5.9	0.36
	High Turbulence	0.34	-4.5	0.73
SandP Index	Low Turbulence	-0.08	-5.2	0.68
	High Turbulence	Insignificant	-4.2	0.32

In this study according to the research findings, it was shown that the error term in eleven indicators of bank, cement, machinery, and chemicals, other mines, automobiles, sugar, food except for sugar, metal minerals, top 50 companies index, and Tehran Stock Exchange price index (TEPIX) was not white noise. As a result, the ARIMA model was significant for these eleven indicators. After estimating the ARIMA model using OLS regression in the 12 indices studied in this research, as shown in columns 3 and 4 of Table 2, the F-statistic and t-statistic were not significant only in the SandP index of the New York Stock Exchange but were significant in the other 11 indexes of Tehran Stock Exchange. As a visible pattern in the results of this study, there was a direct relationship between the coefficient of AR (1) and the values of T and F statistics.

As shown in columns 3 and 5 of Table 3, after estimating the ARIMA model using Markov Switching Model, the coefficient of AR (1) was only significant for the turbulent regime of the SandP index of the New York Stock Exchange with a constant duration of 32% and the turbulent regime of the oil products index of Tehran Stock Exchange with a constant duration of 6%, of the random walk theory, followed. Using equation 4 in this research, the effect of past-oriented behavioral bias on each index was calculated using the exponential function of coefficient AR (1). The rationale for using the exponential function was to increase the past-oriented behavioral bias incrementally. As shown in columns1 and 4 of Table 4, as the coefficient AR (1) increases, the effect of behavioral biases increases. Column 5 of Table 4 shows the highest rate of retrospective behavioral bias is related to the cement index (57%), followed by the top 50 companies index (46%), chemicals (41%), price index (40%), sugar index (39%), machinery index (38%), food except for sugar (37.7%), metal minerals index (36%), automobiles index (30%), Bank index (30%), and finally oil products (12%). The SandP index of the New York Stock Exchange was without past-oriented behavioral bias.

Table 4: Effect of Each Index of the Past-Oriented Behavioral Bias

Index name	Coefficient AR (1)	POBB	Ranking
Banks	0.259	29.7%	10
Cement	0.45	57%	1
Oil Products	0.12	12%	11
Machinery	0.324	38%	6
Chemicals	0.35	41%	3
Automobiles	0.264	30%	9
Sugar	0.33	39%	5
Food Except For Sugar	0.32	37.7%	7
Metal Minerals	0.31	36%	8
50 Top Companies	0.38	46%	2
Price Index (TEPIX)	0.34	40%	4
SandP Index	Insignificant	Zero	12

For example, to calculate a Past-oriented behavioral bias of the bank index

$$POBB = \left[EXP(|Coefficient\ AR\ (1)|) - 1 \right]\% * (CDR1 + CDR2) = [EXP(0.26) - 1] * (0.52 + 0.48) = 0.297$$

Also, the Past-oriented behavioral bias of the cement index was calculated as follows.

$$POBB = \left[EXP(|Coefficient\ AR\ (1)|) - 1 \right]\% * (CDR1 + CDR2) = [EXP(0.45) - 1] * (0.496 + 0.504) = 0.57$$

Also, the Past-oriented behavioral bias of the oil products index was calculated as follows.

$$POBB = \left[EXP(|Coefficient\ AR\ (1)|) - 1 \right]\% * (CDR1 + CDR2) = [EXP(0.12) - 1] * (0 + 0.94) = 0.12$$

And Past-oriented behavioral bias of the SandP index was calculated as follows.

$$POBB = \left[EXP\left(\left|Coefficient\ AR\ (1)\right|\right) - 1\right]\% * (CDR1 + CDR2) = [EXP(0) - 1] * (0.68 + 0.32) = 0$$

5 Conclusions and Suggestions

The purpose of this study was to introduce the past-oriented behavioral bias, which is related to the past information that influences investor behavior and has a lot to do with the random walk theory. The next step in this research was to design an appropriate model for past-oriented behavioral bias, which is closely related to random walk theory. To this end, the trend of changes in 9 different industries, including bank, cement, oil products, machinery, chemicals, automobiles, sugar, food except for sugar, metal minerals, index of 50 Top Companies and in Tehran Stock Exchange Price Index (TEPIX) and the SandP index of the New York Stock Exchange was investigated from 2011/25/03 to 2019/19/03 using Markov switching model. Given the close relationship of retrospective behavioral bias with random walk theory, first, the degree of adherence of these 02 indices to the random walk theory was evaluated using three measures of the rate of the stickiness of price returns, including Durbin-Watson statistics, simple auto-correlation coefficients hypothesis, and Lagrange Multiplier test of serial correlation using the simple OLS regression model.

The findings showed that the disturbance component was not white noise for 11 indices except for the SandP index of the New York Stock Exchange, so the prices in these indices did not follow a random walk. It should be noted that lack of adherence of price returns to the random walk hypothesis and bias or behavioral sourcing of real and legal investors are due to lack of trust in information dissemination mechanism as well as psychological and sociological factors, each of which should be explored in future research. This study, as Tehrani et al. [61], showed non-following to a random walk in the Tehran Stock Exchange. On the other hand, the advantage of this paper was the development of a new model for measuring past-oriented behavioral bias based on random walk theory. Also, as we concluded, Tajdini et al. [56- 57] showed that Tehran Stock Exchange and Tehran foreign exchange rate market are affected by behavioral biases. In general, behavioral biases make sense in two general forms of acceleration theory, including the continuation of the current trend in the ARIMA model with a positive coefficient and the opposite theory, i.e., the opposite of the current trend that has a negative ARIMA coefficient. Moreover, the results obtained using Markov Switching and ARIMA models showed that the ARIMA model was not significant in the turbulent regime of the SandP index of the New York Stock Exchange with 32% shelf life and the oil products index from among the 11 indices of Tehran Stock Exchange with 6% shelf life. It was significant, however, in all other indices.

Hence, by comparing the performance of the SandP index of New York Stock Exchange and the Index of Petroleum Products, the results of this study showed the SandP index of the New York Stock Exchange adhered to the random walk theory more than 5 times greater than the oil products index of the Tehran Stock Exchange Furthermore, using the past-oriented behavioral bias model, it was found that the cement index had the highest rate (57%) of the past-oriented behavioral bias, followed by the top 50 companies index (46%), chemicals (41%), oil products index (12%), and the SandP index of the New York Stock Exchange without the past-oriented behavioral bias. We suggest that other industries will check the Tehran Stock Exchange and compare their indexes with foreign stock markets. In addition, we suggest this model will develop for current-oriented behavioral bias.

References

[1] Abarbanell, J.S., Bernard, V.L., *Tests of Analysts' Overreaction/ Underreaction to Earnings Information as an Explanation of Anomalous Stock Price Behavior*, Journal of Finance, 1992, **47**, P.1181-1207. Doi:10.2307/2328982

[2] Arbel, A., Strebel, P. J., *Pay Attention to Neglected Firms*, Journal of Portfolio Management, winter 1983, **9**, P. 37-42. Doi:10.3905/jpm.1983.408901

[3] Aren, S., Aydemir, S.D., and Şehitoğlu, Y., *Behavioral biases on institutional investors: a literature review*, Kybernetes, 2016, 45(**10**), P. 1668-1684. Doi:10.1108/K-08-2015-0203

[4] Assous, H. F., Al-Rousan, N., Al-Najjar, D., and Al-Najjar, H., *Can International Market Indices Estimate TASI's Movements? The ARIMA Model*, Journal of Open Innovation: Technology, Market, and Complexity, 2020, **6**(2), P.27. Doi:10.3390/joitmc6020027

[5] Bernstein, P. L. *Against the Gods: The remarkable Story of Risk*. USA: John Wiley and Sons, 1998.

[6] Nawaz, B., Sarfraz, A., Hussain, H., Altaf, M., *An empirical investigation on the existence of weak-form efficiency: The case of Karachi stock exchange*, Management Science Letters, 2013, **3**, P.65–72. Doi: 10.5267/j.msl.2012.10.025

[7] Bogan, V., Just, D., and Dev, C., *Team Gender Diversity and Investment Decision Making Behavior*, Review of Behavioral Finance, 2013, **5**, P.134-152. Doi:10.2139/ssrn.1638971

[8] Panda, C., Narasimhan, V., *Predicting Stock Returns: An Experiment of the Artificial Neural Network in Indian Stock Market*, South Asia Economic Journal, 2006, **5**(3), P.33. Doi:10.1177/139156140600700203

[9] Bondt, W. F., and Thaler, R., *Further Evidence on Investor Overreaction and Stock Market Seasonality*, The Journal of Finance, 1987, **42**(3), P.557-581. Doi:10.2307/2328371

[10] Chandra, A., *Decision making in the stock market: Incorporating psychology with finance National Conference: FFMI 2008 IIT Kharagpur*, 2008, https://mpra.ub.uni-muenchen.de/21288/1/Decision_Making_in_the_Stock_Market.pdf

[11] Chen, G., Kim, K.A., Nofsinger, J., Rui, O.M., Chang, C., Cici, G., Fitzgerald, V., Li, W., Lin, B., Seasholes, M.S., and Warnock, F.E, *Behavior and performance of emerging market investors: Evidence from China*, 2004, Doi:10.1002/bdm.561

[12] De Bondt, W., and Thaler, R., *Does the stock market overreact*? Journal of Finance, 1985, 40(**30**), P. 793-805. Doi:10.2307/2327804

[13] Desai, H., Jain, P., *Long-run common stock returns following splits and reverse splits*, Journal of Business, 1997, **70**, P.409-433. Doi:10.1086/209724

[14] Duxbury, D., *Behavioral finance: insights from experiments II: biases, moods, and emotions*, Review of Behavioral Finance, 2015, **7**(2), P.151 – 175. Doi:10.1108/RBF-09-2015-0037

[15] Eti, S., Kalkavan, H., Dinçer, H., and Yüksel, S., *Predicting the Role of Islamic Banking on Sustainable Economic Development: An Analysis for Turkey with ARIMA Model,* In U. Akkucuk (Ed.), Handbook of Research on Creating Sustainable Value in the Global Economy, 2020, P.146-164, IGI Global. Doi:10.4018/978-1-7998-1196-1.ch009

[16] Fama, E. F., Fisher, L., Jensen, M. C., and Roll, R., *The Adjustment of Stock Prices to New Information*, International Economic Review, 1969, **10**(1), P.1–21. Doi:10.2307/2525569

[17] Fama, E. F., *Efficient Capital Markets: A Review of Theory and Empirical Work*, The Journal of Finance, 1970, **25**(2), P.383–417. Doi:10.2307/2325486

[18] Finnerty, J. E., *and Market Efficiency,* The Journal of Finance, 1976, **31**(4), P.1141–1148. Doi:10.2307/2326279

[19] Forbes, W.P., *picking winners? a survey of the mean reversion and overreaction of stock prices literature*. Journal of Economic Surveys, 1996, **10**, P.123-158. Doi:10.1111/j.1467-6419.1996.tb00007.x

[20] Graham, J.F., Stendardi, E.J., Myers, J.K., and Graham, M.J., *Gender differences in investment strategies: an information processing perspective*, International Journal of Bank Marketing, 2002, 20(**1**), P. 17-26. Doi:10.1108/02652320210415953

[21] Grieb, T., and Reyes, M.G., *random walk tests for latin american equity indexes and individual firms*, Journal of Financial Research, 1999, **22**, P.371-383. Doi:10.1111/j.1475-6803.1999.tb00701.x

[22] Gultekin, M., and Gultekin, N.B., *Stock market seasonality: International Evidence*, Journal of Financial Economics, 1983, **12**, P.469-481. Doi:10.1016/0304-405X(83)90044-2

[23] Hackbarth, D., *Managerial traits and capital structure decisions*, Journal of Financial and Quantitative Analysis, 2008, **43**(4), P.843–881. Doi:10.1017/S002210900001437X

[24] Hasani, M., gharkaz, M., maetoofi, A., Didehkhani, H., *Investors' Behavioral Biases in Tehran Stock Exchange by emphasizing the Role of Significant Weaknesses in Internal Control*, Advances in Mathematical Finance and Applications, 2021. Doi:10.22034/amfa.2021.1921343.1552

[25] Hirshleifer, D., *Behavioral Finance*, Annual Review of Financial Economics, 2015, **7**(1), P.133–159. Doi:10.1146/annurev-financial-092214-043752.

[26] Howard, C. T., *Behavioral portfolio management*, Journal of Behavioral Finance and Economics, 2014, P.1–37. Doi:10.2139/ssrn.2210032

[27] Huber, P., *Stock market returns in thin markets: evidence from the Vienna stock exchange*, Applied Financial Economics, 1997, **7**, P. 493-518. Doi:10.1080/096031097333358

[28] Ikenberry, D., Rankine, G., and Stice, E., *What do stock splits signal?* Journal of Financial and Quantitative Analysis, 1996, **31**(3), P.357-374. Doi:10.2307/2331396

[29] Jaiswal, Bimal, and Kamil Naela., *Gender, Behavioral Finance, and the Investment Decision*, IBA Business Review 7.**2**, 2012: 8-22. Business Source Complete.

[30] Jokar, H., Shamsaddini, K., Daneshi, V., *Investigating the Effect of Investors' Behavior and Management on the Stock Returns: Evidence from Iran*, Advances in Mathematical Finance and Applications,2018, **3**(3), P.41-52. Doi:10.22034/amfa.2018.544948

[31] Kahneman, D., and Tversky, A*., Belief in Law of Small Numbers*, Psychological Bulletin, 1971, **76**(2), P.105-110. Doi:10.1037/h0031322

[32] Kanehman, D., and Tversky, A., *Subjective Probability: A Judgment of Representatives*, Cognitive Psychology, 1972, **3**(3), P.430-454. Doi:10.1016/0010-0285(72)90016-3

[33] Kahneman, D., Tversky, A., *On the psychology of prediction*, Psychological Review, 1973, **80**(4), P.237–251.

[34] Kahneman, D., and Tversky, A., *Prospect Theory: An Analysis of Decision under Risk*, Econometrica, 1979, **47**(2), P.263-292. Doi:10.1037/h0034747

[35] Keim, D.B., *Dividend yields and stock returns: Implications of abnormal January returns*, Journal of Financial Economics, 1985, **14**, P.473-489. Doi:10.1016/0304-405X(85)90009-1

[36] Lacalle, D., *Are the effects of unconventional monetary policy on financial markets causing bubbles?* Journal of Business Accounting and Finance Perspectives, 2018, **1**(1), P.95–117. Doi:10.26870/jbafp.2018.01.003

 [37] Litzenberger, R., and Ramaswamy, K., *The Effects of Dividends on Common Stock Prices: Tax Effects or Information Effects?* Journal of Finance, 1982, **37**, P.429-443.Doi:10.2307/2327346

[38] Matsumoto, A. S., Fernandes, J. L., Chagas, P. C., and Oliveira, N. A., *Overconfidence in individual and group investment decisions*, Journal of International Finance and Economics, 2013, **13**(1), P.109–114. Doi:10.18374/JIFE-13-1.11.

[39] Mehrara, M., Tajdini, S., *Comparison of profitability of speculation in the foreign exchange market and investment in Tehran Stock Exchange during Iran's currency crisis using conditional Sharpe ratio*, Advances in Mathematical Finance and Applications, **5**(3), P.271-284. Doi:10.22034/amfa.2020.1881227.1317

[40] Michailova, J., Mačiulis, A., and Tvaronavičienė, M., *Overconfidence, risk aversion and individual financial decisions in experimental asset markets, 2017*, Economic Research, **30**(1), P.1119–1131. Doi:10.1080/1331677X.2017.1311234.

[41] Nofsinger, J. R., *Investment Madness: How Psychology Affect Your Investing and What to Do About It*. USA: Pearson Education.

[42] Nourbakhsh, A., Asgari, Gh., Nasiri, R., *Efficiency in the developing markets: empirical evidence from Tehran Stock Exchange,* Quarterly of Accounting and Auditing Review, 2010, **17** (62), P.103-116. (in Persian)

[43] Nwidobie and Barine Michael., *The Random Walk Theory: An Empirical Test in The Nigerian Capital Market*, Asian Economic and Financial Review, 2014, **4**(12), P.1840-1848.

[44] Pandey, S., Samanta, A., *Weak-Form Efficiency in Indian Stock Market Index; Ijmrr*, 2016, **6**(7), P.904-913.

[45] Porto, R. B., *The commercial cycle from the viewpoint of operant behavioral economics: effects of price discounts on revenues received from services*, Revista de Administração(São Paulo), 2016, **51**(3), P.310-322.

Doi: 10.1016/j.rausp.2016.06.005

[46] Rathnayaka, R., Seneviratna, D., Wei, J., and Arumawadu, H., *A hybrid statistical approach for stock market forecasting based on Artificial Neural Network and ARIMA time series models*International Conference on Behavioral, Economic and Socio-cultural Computing (BESC), 2015, P.54-60. Doi:10.1109/BESC.2015.7365958

[47] Roberts, H., *Statistical versus clinical prediction of the stock market*, Unpublished manuscript, Center for Research in Security Prices, University of Chicago 1967.

[48] Sadi, R., Asl, H. G., Rostami, M. R., Gholipour, A., and Gholipour, F., *Behavioral finance: The explanation of investors' personality and perceptual biases effects on financial decisions*, International Journal of Economics and Finance, 2011, **3**(5), P.234–241. Doi:10.5539/ijef.v3n5p234

[49] Samuelson, P., *Proof that Properly Anticipated Prices Fluctuate Randomly*, Industrial Management Review, 1965, **6**, P.41-49. Doi:10.1142/9789814566926_0002

[50] Sharma, A. J., Dibrugarh, A. I., *Understanding Cognitive Dissonance-The Behavioural Finance Principle*, International Journal of Commerce, Business and Management, 2014, **3**(1), P.18–27.

[51] Shefrin, H., Statman, M., *The Disposition to Sell Winners Too Early and Ride Losers Too Long: Theory and Evidence*, In: The Journal of Finance, 1985, **40**(3). Doi:10.2307/2327802

[52] Shiller, R. J., *From efficient markets theory to behavioral finance*, Journal of economic perspectives, 2003, **17**(1), P.83-104. Doi:10.1257/089533003321164967

[53] Shehzad, S. J., Ali, P., Saleem, F., Ali, S., and Akram, S., *Stock Market Efficiency: Behavioural or Traditional Paradigm? Evidence from Karachi Stock Exchange (KSE) and Investors Community of Pakistan*, 2013.

[54] Siami-Namini, S., Tavakoli, N., Namin, A. S., *A comparative analysis of forecasting financial time series using Arima, lstm, and bilstm*, 2019, arXiv preprint arXiv,1911.09512.

[55] Suresh, A., *Understanding behavioral finance through biases and traits of trader vis-à-vis investor*, Journal of Finance, Accounting and Management, 2013, **4**(2), P.11–25.

[56] Tajdini, S., Jafari, F., Lotfi Ghahroud, M., *Unusual behavior: Reversed Leverage Effect Bias*, Journal of Mathematics and Modeling in Finance, 2020, **1**(1), P. 15. Doi:10.22054/JMMF.2020.54928.1016

[57] Tajdini, S., Mehrara, M., and Taiebnia, A., *Investigating the fluctuations of exchange rate based on monetary-behavior approach*, International Journal of Finance and Economics, 2021, **10**(3),19. Doi:10.1002/ijfe.2473

[58] Tas, O., Guleroglu Atac, C., *Testing Random Walk Hypothesis for Istanbul Stock Exchange*, 5th Global Business Research Congress, 2019, **9**, P.48-53. Doi:10.17261/Pressacademia.2019.1063

[59] Tehrani, R., Mirlohi, S. M., Mehrara, M., and Ghahroud, M. L., *The effect of contractual rewards on non-maturing deposits and bank funding stability (Case Study: Bank Mellat)*, Asset Management and Financing, 2019, **7**(1), 45-62. Doi:10.22108/amf.2018.111350.1262

[60] Tehrani Reza Ansari, H., Saran, A., *Analysis of return to mean phenomenon in Tehran Stock Exchange using variance ratio test*, Accounting and Auditing Review, 2008, **15**(54). (In Persian)

[61] Tehrani, R., Tajdini, S., Abbasian, E., Mirlohi, M., *Measure the level of adherence to the random walk Theory in Various Industry Indices Using the Markov Switching Model*, Financial Management Strategy, 2021, **9**(1), -. Doi:10.22051/jfm.2019.19604.1626

[62] Thaler, R., *Toward a positive theory of consumer choice*, Journal of Economic Behavior and Organisation, 1980, **1**(1), P.39–60. Doi:10.1016/0167-2681(80)90051-7

[63] Thaler, R. H., *From cashews to nudges: The evolution of behavioral economics*, American Economic Review, 2018, **108**(6), P.1265-87. Doi:10.1257/aer.108.6.1265

[64] Tversky, A., Kahneman, D., *Judgment under uncertainty: Heuristics and biases*, 1974, Science. **185** (4157), Doi:10.1126/science.185.4157.1124

[65] Tversky, A., Kahneman, D., *The framing of decisions and the psychology of choice,* Science. 1981 Jan 30., **211**(4481), P.453-8. Doi:10.1126/science.7455683.

[66] Uzar, C., and Akkaya, G. C., *The Mental and Behavioural Mistakes Investors Make*, International Journal of Business and Management Studies, 2013, **5**(1), P.120-128.

[67] Wang, L., Zou, H., Su, J., Li, L., and Chaudhry, S., *An ARIMA -ANN hybrid model for time series forecasting*, Systems Research and Behavioral Science, 2013, **30**(3), P.244-259. Doi:10.1002/sres.2179

[68] Wong, W. K., *Review on behavioral economics and behavioral finance*, Studies in Economics and Finance, 2020, **6**(2), P.32. Doi:10.1108/SEF-10-2019-0393

[69] Zhu, Z., *The random walk of stock prices: evidence from a panel of G7 countries*, Applied Economics Letters, 1998, **5**, P. 411-3. Doi:10.1080/135048598354528

[70] Zhou, R., and Pham, M. T., Journal of consumer research. Serials Review, 1984, **10**(2), 34. Doi:10.1016/0098-7913(84)90029-7