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Full Length Article

Investor characteristics and the effect of disposition bias on the Tunisian stock market

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Abstract

Drawing evidence from financial theory, which suggests the tendency of investors to sell winning stocks quickly and to hold on to losing ones for a long time, this is the first study to investigate the relevance of the effect of disposition bias on individual investors in the Tunisian equities market. Our analysis is carried out on a sample of 925 Tunisian traders over the period 2009–2014 to find out how gender, age, investor characteristics, portfolio management types, bull or bear market conditions, and external factors are related to the intensity of the disposition effect by separately tracking their trading transaction histories. The findings show mainly robust evidence of disposition bias across different groups of investors. In particular, the study reveals that male and younger Tunisian investors suffer from a strong disposition bias compared with their counterparts, female and mature investors. Furthermore, our results show that other behavioral biases, including market trading volume, the value of a share traded, trading frequency, trading in round numbers, and the investor's overall level of portfolio diversification depend on the disposition effect. Concerning the bull and bear market issue, we divided our data period into bull and bear markets to observe the effect of disposition bias every month of the year, and we found that this effect is even more pronounced in bull markets.

JEL Classification: G11; G14

Keywords: Behavioral finance; Disposition effect; Investor characteristics; Market trends; Tunisian investors; Tunisia's stock market

1. Introduction

Numerous studies on behavioral finance have contributed to the development of financial models based on the bounded rationality hypothesis of investors. They aim to provide plausible explanations for observed anomalies on markets. These situations, which are inexplicable by traditional financial theory, are considered as aberrances and irregularities in investor behavior that affect their performance in a significant way. Many recommendations exist for success on the stock market, among them the rule "cut your losses and let your winners run." Concretely, investors need to be able to control their emotions and follow a pre-established plan that sets limits, beyond which they have to stop their losses or realize their profits. Nevertheless, several observations on stock markets show that, instead of following these recommendations, the majority of investors do the opposite. They recover their winning trades too quickly and hold on to losing positions too long. This behavior, called the disposition effect, undoubtedly attracts a lot of interest.

Indeed, and as defined by Brown, Chappel, Silva, Rosa, and Walter (2002), the disposition effect is aversion by investors to realizing losses more than profits. This trend is seen as the sale of stocks that have made gains and long-term holding of those with losses (Dhar & Zhu, 2006; Odean, 1998; Rau, 2015;

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Shefrin & Statman, 1985). The development of the term "disposition effect" and its influence in several areas of finance has led to a better understanding of the decision-making process. A considerable number of studies has been developed in this stream, such as Shefrin and Statman (1985), which is considered the pioneering study of the disposition effect, and Cheng, Lee, and Lin (2013), Da Costa, Goulart, Cupertino, Macedo, and Da Silva (2013), Dhar and Zhu (2006), Frino, Lepone, and Wright (2015), Odean (1998), and Rau (2014). These researchers have advanced arguments relating to the heterogeneity of investor behavior and have identified the fundamental characteristics of the effect of disposition bias by developing models to explain this behavior. Moreover, recent studies explore the impact of competence approaches, the experience and sophistication of investor on the magnitude of the disposition effect (Da Costa et al., 2013; Dhar & Zhu, 2006; Feng & Seasholes, 2005).

On the heels of these researchers, in this paper we study the disposition effect in the context of the Tunisian stock market. Our goal is to provide a clearer understanding of the disposition effect and trends in it. In this context, we pose the following question: Are Tunisian investors subject to the disposition effect in the same way and to the same degree during all periods? Going further, we show the influence of physical characteristics, such as the age and gender of investors, on the disposition effect. These inherent factors in investor profiles have more influence on the behavior of individuals in stock exchanges than their education, income, or wealth. In addition to internal factors, the study addresses external factors by observing changes in the disposition effect under bear and bull markets. The empirical evidence tests hypotheses on whether Tunisian investors exhibit the disposition effect; females and youth are more subject to the disposition effect; sophistication and experience mitigate this bias; and the disposition effect is more pronounced during bull markets.

The remainder of this paper proceeds as follows. Section 2 presents a literature review and develops the research hypotheses. Section 3 describes the data and presents the methodology. Section 4 presents the descriptive statistics and interprets the empirical results. We test the robustness of our results in Section 5. Finally, Section 6 sets forth our conclusions.

2. Prior literature and hypothesis development

2.1. Literature on the disposition effect

Several explanations of the disposition effect are mentioned in the literature, such as the irrational belief in the return of prices to the average, the search for pride, the refusal to regret, and loss aversion. The irrational belief that prices will return to their average creates a tendency for investors to quickly sell winning securities to avoid the trend reversal and delay the sale of losing securities to take advantage of the trend reversal (Barber, Lee, Liu, & Odean, 2007; Jackson, 2004; Kadous, Tayler, Thayer, & Young, 2014; Shu, Yeh, Chiu, & Chen, 2005). Rau (2015) demonstrates that the disposition effect is caused by a combination of two psychological factors: loss aversion explained by prospect theory (Kahneman & Tversky, 1979) and emotions, such as the feeling of regret (Shefrin & Statman, 1985; Summers & Duxbury, 2012). Summers and Duxbury (2012) also highlight the role of emotional responses in the emergence of the disposition effect. The authors show that investors hold on to stocks with losses to avoid the feeling of regret, while they sell stocks with gains to ensure a feeling of satisfaction (Muermann & Volkman, 2007; Petit, 2010; Rau, 2015; Shefrin & Statman, 1985). They also show that people who regret their choices tend to sell the securities after a price increase (Weber & Camerer, 1998). Another explanation of the disposition effect is the loss aversion associated with the shape of the investor valuation function (the prospect theory), according to which the disposition effect is the result of the different treatment of gains and losses relative to a reference point (Gomes, 2005; Kahneman & Tversky, 1979, 1992; Oehler, Heilmann, Lager, & Oberlander, 2003).

2.2. Hypothesis development

In order to highlight the disposition effect in the Tunisian financial market, we formulate several hypotheses.

First, we test whether Tunisian investors are subject to the disposition effect. Hence we form our first hypothesis, as follows:

Hypothesis 1. *Among Tunisian investors, the proportion of gains realized is less than or equal to the proportion of losses realized.*

Studies of investor behavior stipulate that women are more risk averse (Booth & Nolen, 2012; Sutter & Rützler, 2010) and perform fewer transactions than men, because the latter have high levels of overconfidence (Barber & Odean, 2001, pp. 261–292). Elsewhere, it has been shown that women are more averse to losses than men (Rau, 2014; Rieger, Wang, & Hens, 2011). Hence, we posit our second hypothesis as follows:

Hypothesis 2. *Women are more inclined than men to hold on to stocks with losses and to sell stocks with gains.*

Regarding the second demographic criterion, age, Feng and Seasholes (2005) predict that young investors are less subject to behavioral biases because they are more active and informed about real market situations. Thus, it appears that age has a negative effect on people's ability to make effective investment decisions (Cheng et al., 2013). Nevertheless, theoretical models of portfolio choice (Gomes & Michaelides, 2005) state that the risk associated with a portfolio decreases with the age of investor. In addition, investors learn through the trading process and become less subject to behavioral biases. Then, empirical data found in the literature dealing with individual investment show that older investors hold less-concentrated portfolios (Goetzmann & Kumar, 2008), have a low level of overconfidence (Barber & Odean, 2001, pp.

261–292), and demonstrate a weaker disposition effect (Dhar & Zhu, 2006; Korniotis & Kumar, 2011; Talpsepp, 2010). Hence, we form our third hypothesis.

Hypothesis 3. *Older investors are less subject to disposition effect than young investors.*

In terms of professional portfolio management, the literature shows that fund managers exhibit the disposition effect (Puetz & Ruenzi, 2011) but appear to be less subject than nonprofessionals to this bias (Andreu & Puetz, 2015). Shapira and Venezia (2001) conduct a study on the behavior of clients of a large brokerage firm. The results of their study show that not only are investors who manage their own accounts subject to the disposition effect but professionals are also subject to this effect. The authors explain this by the fact that experience contributes to the decrease in behavioral biases, such as the disposition effect.

Hypothesis 4. *The level of the disposition effect is lower among sophisticated investors than unsophisticated traders.*

Leal, Armada, and Duque (2008) prove that the least-active investors in the financial market are more subject to the disposition effect than more frequent traders. Similarly, Chen, Kim, Nofsinger, and Rui (2007) and Frino et al. (2015) find a negative correlation between the overconfidence bias defined by high trading frequency and the disposition effect. Odean (1998) also proves that the least-active US investors are more inclined to hold on to losing stocks and to quickly sell winning stocks. Hence, we posit our fifth hypothesis.

Hypothesis 5. *The intensity of the disposition effect depends on trading frequency.*

Brown, Chappel, Silva, Rosa, and Walter (2006) and Leal et al. (2008) also show that the most sophisticated investors exhibit a weak disposition effect (the value of transaction is a determining factor of the degree of sophistication). Subdividing investors into groups according to the number of their transactions allows a comparison of the disposition effect based on trading frequency. Otherwise, this grouping does not take into account the transaction volume, which means that realizing a transaction with a single share would have the same significance as trading a thousand shares. In order to take this difference into account, we also examine differences in investor behavior based on the number of shares traded. Leal et al. (2008) and Cheng et al. (2013) assume that sophisticated investors tend to have higher trading volumes and are less inclined to hold on to losing shares.

Hypothesis 6. *The most sophisticated investors exhibit a weak disposition effect.*

Trading in round numbers in financial markets has been proposed as a possible human bias (Easley, López de Prado, & O'Hara, 2012). According to Chen et al. (2007), behavioral biases, such as the disposition effect, are forms of heuristic simplification that stem from the brain's tendency to create mental shortcuts, rather than engaging in more complex analytical processing. Similarly, the theory of heuristic principles developed by Kahneman and Tversky (1974) suggests that individuals opt for reasoning shortcuts that allow them to save time and make acceptable inferences, even though they may seem illogical from the perspective of deductive logic. So, trading in round numbers, that is, a volume that is a multiple of ten, regardless of the optimality of the investment decision, is considered a mental shortcut, and the disposition effect results in part from this heuristic.

Hypothesis 7. *Trading in round numbers is a possible root of the disposition bias.*

Kim and Nofsinger (2002), analyzing the behavior and performance of individual investors in Japan, state that the behavior of subjects varies according to market conditions (bullish or bearish). Thus it seems relevant to test whether the disposition effect is affected by market conditions. Moreover, Leal et al. (2008), Lin (2011), and Cheng et al. (2013) find that the disposition effect is higher during bull markets than during bear markets.

Hypothesis 8. *The disposition effect is associated with a bull markets trend.*

Odean (1998) and Leal et al. (2008) show that the disposition effect is affected by the end-of-the-year effect. They demonstrate that this tendency to hold losing shares disappears on financial markets because of the imposition of taxes. So, if the tax effect persists on the Tunisian market in December (end of the fiscal year), we expect to find that investors prefer to realize more losses than gains at that time, unlike other months of the year. However, for hedonic reasons, we would expect different results. If investors tend to realize gains to end the year with good results and to have a feeling of pride, then the tax effect, if present, would not be large enough to reduce or overwhelm the disposition effect. However, Firth (2015) shows that the end-of-the-year effect is absent in financial markets that do not tax capital gains and dividends, and therefore the disposition effect persists during the month of December. On the basis of these arguments, we test whether the difference in the proportion of gains and losses realized in December differs significantly from those in other months of the year.

Hypothesis 9. *The disposition bias is not affected by the December effect.*

3. Data and methodology

3.1. Sample

The analysis is based on Tunisian individual investors. The main dataset comprises confidential information on certain investor accounts, including account holders' date of birth, name, address, name (from which we obtain demographic information), date of opening an account, type of account management (managed or independent), transactions

performed between January 1, 2009, and September 30, 2014, transaction dates, the securities involved, transaction prices, and related commissions. This database also provides information on the composition of the portfolios between January 1, 2009, and September 30, 2014, reporting the portfolios of different customers as well as average prices for securities purchases. The transactions performed have been merged and sorted in order to retain only those that provide information about the securities and their variations. The database of portfolios as of September 30, 2012, was the disposition effect is higher during bull markets used only to check the composition of portfolios after accounting for changes introduced by buy-and-sell transactions. The database also provided information on the type of account management and indicated whether the account is managed by the investor himself (independent) or by a portfolio manager (managed). This database also contained the different securities held by the individuals who are subjects in this study and the types of transactions conducted, which allowed us to identify whether it was a sale or a purchase and then to study quantitative changes in portfolios. The price, volume, and number of shares traded are mentioned for each transaction realized. Similarly, a database containing opening and closing prices, the highest and lowest price of the day, was transposed to the main database of the study according to securities and date and was used to calculate theoretical gains and losses: PG (paper gain) and PL (paper loss) to calculate PGR (proportion of gains realized) and PLR (proportion of losses realized). Lines containing securities still held by the individual that were not traded on the day when other securities (one or more) were sold by the same investor were added, as well as the highest and lowest prices of the day that corresponded to them in order to calculate the theoretical gains and losses required to calculate the RGP and PLR. Changes in portfolio, whether in terms of the number of shares or the average purchase price were introduced for each share for a given individual to have portfolios updated on a daily basis and thus to calculate the realized gains or the realized losses, to calculate the PGR and PLR, and the difference between them is the disposition effect. The final parameter in this database is the TUNINDEX index, whose temporal evolution reflects the Tunisian market trend: bullish or bearish.

The final sample contains 60,260 transactions, with 38,289 purchases and 21,971 sales performed by 925 individuals (560 men and 365 women, based on their names—about 60% male and 40% female), aged between 18 and 91 at the time of the transactions (age is obtained by comparing the account holders' date of birth and the date of the transaction, which means that the same individual may be captured at five different ages over the study period). In our study, individuals who did not realize transactions that affected the portfolio by either a buy or sell transaction between 2009 and 2014 were not included, nor were individuals under 18 years old because they would distort the analysis that takes into account the gender and age of the person who manages the account. Similarly, traders' investments representing companies or agencies are not included.

3.2. Methodology

In examining the disposition effect in the context of the Tunisian stock market, we were inspired by Odean (1998) [1] approach. Each transaction performed by an investor is associated with different stock prices, mainly the highest price $P_{j,t}^{H}$ and the lowest price $P_{j,t}^{L}$ for the day. After each purchase transaction, we calculate the average purchase price using the weighted average cost (WAC) method.[2] For example, if an investor holds 30 shares of security A at an average purchase price of 20 dinars and buys another 10 shares of A at a price of 15 dinars, his average purchase price decreases from 20 dinars to 18.75 dinars ($18.75 = ((30 \times 20) + (10 \times 15)/(30 + 10))$. The number of securities that each shareholder holds before and after each transaction was previously calculated. We therefore know the value of each security for a given customer at every moment. The measure of the disposition effect takes into consideration not only realized gains and losses but also theoretical (paper) gains and losses, which are accounted only when a sale occurs at a given account. We calculate these figures individually for each investor account and then aggregate all investors and trading days in each month. We use the aggregate figures to form the following proportions:

$$\begin{aligned} &\textit{Proportion of Gains Realized } (PGR) \\ &= \textit{Realized Gains } (RG)/\textit{Realized Gains } (RG) \\ &\quad + \textit{Paper Gains } (PG) \end{aligned}$$

$$\begin{aligned} &\textit{Proportion of Losses Realized } (PLR) \\ &= \textit{Realized Losses } (RL)/\textit{Realized Losses } (RL) \\ &\quad + \textit{Paper Losses } (PL) \end{aligned}$$

Following this categorization, we calculate the realized gain (RG) or loss (RL) on days with a sale recorded for all stocks sold in the portfolio by comparing the weighted average purchase price with the sale price:

$$\frac{Ps_{j,t}}{APP_{j,0}} - 1 \begin{cases} >0, RG = 1 \\ <0, \ RL = 1 \end{cases}$$

where $Ps_{j,t}$ is the sale price of share j on trading date t, and $APP_{j,0}$ is the weighted average purchase price, which is considered a benchmark (point of reference).

[1] Barber and Odean (2000), Barber et al. (2007, 2009), Brown et al. (2006), Dhar and Zhu (2006), Rau (2014,2015) have used the same approach to calculate the disposition effect. Some alternative models have been used to analyze the disposition effect: Grinblatt and Keloharju (2001) use a logit model, Chen et al. (2007), Feng and Seasholes (2005), and Talpsepp (2011) used a survival analysis. Feng and Seasholes (2005) argue that the survival analysis is more reliable and relevant than the analysis of the PGR/PLR ratio since it allows the disposition effect to be tested while controlling for factors that may be correlated to the added value of the transaction. By contrast, Chen et al. (2007), Ormos and Joó (2014), and Talpsepp (2011) find that survival analysis and the difference PGR-PLR lead to the same result. In consequence, we follow a methodology similar to that of Odean (1998).

[2] We calculate the WAC of transactions completed before January 1, 2009.

Paper (unrealized) gains or losses for stocks in the portfolio not sold on the trading date are calculated using the weighted average purchase price and the high and low prices for the day. Following Odean (1998), paper gains (PG) are recorded when the average purchase price is below the low for the day, $P_{j,t}^{L}$, and paper losses (PL) are recorded when the average purchase price is above the high for the day, $P_{j,t}^{H}$:

$$APP_{j,0} < P_{j,t}^{L},\ PG = 1$$

$$APP_{j,0} > P_{j,t}^{H},\ PL = 1$$

On days when the average purchase price is between the high and low prices, or there are no trades in the portfolio, neither a gain nor loss, paper or realized, is recorded. On days when there is no trade in the stock to be examined, we consider it a missing value, and if that is the other stock holding in addition to the actual sale, no realized gain or loss will be included. The reported results are based on this approach.

The disposition effect of investors is the difference between these PLR (ratio of realized losses to all losses) and PGR (ratio of realized gains to all gains): Significant differences between PLR and PGR indicate that investors are, on average, more willing to realize losses than gains. Specifically, the disposition effect is demonstrated when PLR is higher than PGR. Odean (1998) also introduces the notion of standard errors of the t-statistics for the difference between PLR and PGR:

$$\sigma(PLR - PGR) = \sqrt{\frac{PGR(1-PGR)}{N_{RG}+N_{PG}} + \frac{PLR(1-PLR)}{N_{RL}+N_{PL}}}$$

where N_{RG}, N_{PG}, N_{RL}, and N_{PL} are the number of RG, PG, other months of the year RL, and PL.

The t-statistic is calculated as:

$$t = \frac{PLR - PGR}{\sigma(PLR\,|PGR)}$$

The t-statistic shows the overall significance of the differences between PLR and PGR. Indeed, a negative value means that investors are more inclined to hold on to losing shares and to sell winners. In other words, a negative and significant difference constitutes proof of the existence of disposition effect.

We attempt to extend the literature by testing the disposition effect across the variations of different individual investor characteristics and market trends (bullish or bearish). The following ordinary least squares (OLS) regression with White's heteroskedasticity correction of standard errors is used to test the impact of different factors:

$$\begin{aligned} PLR - PGR = {} & \beta_0 + \beta_1 TM_i + \beta_2 Gender_i + \beta_3 Age_i \\ & + \beta_4\, Gender{*}Age_i + \beta_5 Bull/Bear_i \\ & + \beta_6\, Gender{*}Bull/Bear_i + \beta_7 Age{*}Bull/Bear_i \\ & + \beta_8\, TV_i + \beta_9 RS_i + \beta_{10} FT_i + \beta_{11} ANS_i + \varepsilon_i \end{aligned}$$

In our model, the dependent variable $PLR - PGR$ is the difference between PLR and PGR for account i, measuring each investor's disposition effect. The independent variables are as follows: TM_i is the type of management and takes a value of 1 if account i is not managed by the holder and 0 otherwise; Gender_i takes a value of 1 if the account holder is male and 0 otherwise (female); Age_i is the age of the holder of account i in years as at the last day of the sample period; $Gender{*}Age_i$ is an interaction variable that takes different values for each combination; $Bull/Bear_i$ reflects the market trend and takes a value of 1 for bull market conditions and 0 otherwise (bear market); $Gender{*}Bull/Bear_i$ is an interaction variable that takes different values for each combination; $Age{*}Bull/Bear_i$ is an interaction variable that takes different values for each combination; TV_i is the trading volume, meaning the total trade volume of account i over the sample period; RS_i is a dummy variable that takes a value of 1 if account i trades in round numbers (volumes) and 0 otherwise; FT_i is the trading frequency, meaning the total trading amount of account i over the sample period, used as a proxy for investor overconfidence; and ANS_i is the average number of stocks held in account i at the start of each month, which reflects how diversified a portfolio is. Whereas a higher number does not necessarily mean the portfolio is well diversified if all the stocks have the same beta, a portfolio with few stocks is definitely not diversified enough. Finally, ε_i is an error term in the OLS regression.

4. Empirical results

4.1. Descriptive statistics

The summary statistics for our final sample, which was filtered beforehand, are in Table 1. It describes the number of individuals according to gender, age, and type of management. Overall, it informs us about the average number of transactions performed by our sample population as well as the average number of shares for the same individual over the period of the study, which is from January 1, 2009, to September 30, 2014.

Our population is mostly male, with 560 men and 365 women. The average age of the males is higher than that of their female counterparts; the average trading number and the average number of stocks held are also similar. Among age groups, the older traders seem to have a tendency to make more transactions than those who are younger. Finally, and logically, investors who have accounts managed by portfolio managers perform many more transactions than those who manage their own accounts (independent management) and are clearly older than others.

Table 1
Descriptive statistics (N = 925 individuals, 60,260 on-market transactions).

	Gender		Age			Type of management	
	Male	Female	<35	35–65	65<	Managed	Independent
Number	560	365	292	578	55	149	776
Average age	52	43				49	50
Minimum	18	18				18	18
Maximum	89	85				80	89
Average trade number	117	100	90	120	108	172	100
Average stocks	25	23	22	25	24	30	23

4.2. Statistical tests

In order to study the dependence of the disposition effect on individual Tunisian investor characteristics, i.e., age, gender, and type of account management, as well as the market trend (bullish or bearish), we firm perform tests such as the Mann-Whitney *U* test and the means and variances comparison tests.

The Mann-Whitney *U* test (Appendix Table A1) indicates whether sorted populations are independent. We rely on ordered daily values in this test in an increasing way, which allows us to see the risk we are taking, by saying whether the two filtered populations have the same behavior. In all our categories, the *p*-value is always at the 5% confidence interval, which means that the risk of saying that our populations are independent is greater than 5%. On the other hand, in bull or bear markets, we have different behaviors and distinct demonstrations of the disposition effect, as indicated by the risk level of between 20% and 25%, emphasizing the Mann-Whitney independence of these two periods. Similarly but less accentuated for distinguished populations by the type of management and age (under 35 and over 65 years), which have a risk level between 45–50% and 40–45% respectively, distinct behaviors and different demonstrations of the disposition effect. Finally, regarding gender, there is only a 35%–40% risk that males and females are exposed to the disposition effect differently.

Tests of the equality of means and variances (Appendix Table A2) indicate that the dispersion around the average is not the same for males and females (high variance ratio of about 1.703). In terms of means, we have a risk of 10.91% of confirming their dependence. The dispersion around the average is not the same for young people and people over 65 years old. Behavior among the elderly is more similar than is the case among than the young. In terms of means, we have a 3.64% risk of confirming their dependence. Regarding the type of management, the dispersion around the average is not the same for managed accounts and independent accounts (variance ratio of about 1.167). This implies that the accounts are subject to the disposition effect in a more similar way by comparing them to independent accounts with a risk that this is wrong less than 5% of the time. Regarding the means, we have a risk of 45.33% of confirming their dependence. In market trends, two different behaviors exist: one in a bull market and another in a bear market (variance ratio of1.225). The means are independent, with a risk of less than 1%, which shows the importance of market conditions in the determination of the disposition effect.

4.3. Regression analysis

4.3.1. Disposition effect and individual investor characteristics

4.3.1.1. Disposition effect according to age, gender, and type of management. Our results show that Tunisian investors have a preference for selling the winners and holding on to the losing stocks, and they are subject to the disposition effect (Appendix Table A3). The PGR/PLR ratio estimates indicate that Tunisian investors are almost 50% more inclined to sell winning stocks than losing ones. The difference between PLR and PGR (0.141) is higher than that found in similar studies, such as that of Odean (1998). This difference can be explained by the low level of sophistication and professionalism of Tunisian investors. Indeed, in emerging markets such as the Tunisian market, which is characterized by high volatility (Leal et al., 2008), investors are more subject to behavioral biases, and their decisions are influenced by emotions and characterized by a lack of adequate and clear investment strategies. This is in addition to the underlying causes of the disposition effect (the irrational belief that prices will return to the average, the search for pride and refusal of regret, and loss aversion) (Barber et al., 2007; Jackson, 2004; Kadous et al., 2014; Rau, 2015; Shu et al., 2005). Otherwise, results regarding the mean of PGR show that women are more inclined to realize gains than men, while, according to the mean PLR estimates, women have more losses than men. The PLR-PGR differences show that males are slightly more subject to the disposition effect than females. This confirms the results of Feng and Seasholes (2005), Grinblatt and Keloharju (2001), and Talpsepp (2010). This little inherent difference in gender could be explained by men's higher level of overconfidence (Barber & Odean, 2001, pp. 261–292). However, experience increases with age, and it can be seen that the disposition effect decreases with age. Indeed, young investors show the highest disposition effect among the three age groups of investors.

Regarding the type of portfolio management, investors who manage their own portfolios exhibit a greater disposition effect than those who entrust the management of their portfolios to professionals and brokers. Findings confirm the existing literature, which stipulates that even professionals and fund managers are subject to the disposition effect (Da Costa et al., 2013; Puetz & Ruenzi, 2011; Shapira & Venezia, 2001). Combined with gender, the age trend among males indicates that the older we are, especially if we are experienced, the less we are subject to the disposition effect. However, this is reversed for females, which is consistent with Cheng et al. (2013). By combining gender and the type of management, we find that females with independent management are exposed to this bias slightly more than males. By grouping the three characteristics, the most pronounced disposition effect is among young men under 35 years old who manage their own accounts. Globally, managed account holders show the smallest disposition effect.

4.3.1.2. The disposition effect and the type of stock trading. Trading in round numbers has been raised as a possible behavioral bias (Easley et al., 2012). Chen et al. (2007) theorize that the human brain tends to take shortcuts and estimates in order to avoid lengthy analysis. As a result, trading in round numbers, regardless of the optimality of aggregate investment, is considered a mental shortcut and therefore a heuristic bias. Results show that traders who perform transactions in round numbers are more subject to the disposition effect than others (Appendix Table A4). This result is very significant, and it is explained by investors who make

transactions in round numbers are those who avoid doing a thorough analysis and make their decisions based on simplifications and shortcuts in reasoning, rather than on estimates over the long run: according to Frino et al. (2015), this is at the origin of the disposition effect. The disposition effect stems in part from the heuristic in which actors do not really follow forecasts from a statistical calculation but, rather, follow their intuition, feeling, or previous experience. All these elements often lead to the emergence of a disposition effect. They also reflect the role of experience and sophistication in limiting the disposition effect: the fact that investors always trade in round numbers reflects their lack of experience, which in the end makes them more subject to the disposition effect, in accordance with the study by Dhar and Zhu (2006), which highlights the impact of experience on the disposition effect.

4.3.1.3. Disposition effect and frequency trading volume. Our results indicate that Tunisian traders are not very active on the stock market: on average, 0.98 percent of sales or purchases are performed by a customer in a month (Appendix Table A5). Like Odean (1998), we find that less-active traders are the most subject to the disposition effect. Indeed, Odean (1998) compares the first nine deciles together at the 10th decile, and his results are identical to ours, considering the PLR-PGR value of the last decile is −0.090 while that of the total population is −0.0149. The result still holds for the last four deciles by comparing them in particular to the second and third deciles, which present fairly high disposition effect values. The first decile is characterized by high PGR and PLR values, which means that the disposition effect is less pronounced only for the next six deciles, in which the disposition effect greatly increases, with a consistently high PGR but a progressively lower PLR. We also find that the disposition effect does not vary monotonically following the different deciles, which could be explained by overconfidence[3] among some investors who make transactions frequently but not strategically. Finally, on average, the most active investors in the last three deciles are the least subject to the disposition effect, which confirms the negative correlation between overconfidence and the disposition effect (Chen et al., 2007; Frino et al., 2015). If the frequency of trading is considered a sign of experience and sophistication, the negative correlation between the disposition effect and experience proves that those who manage their emotions and acquire experience through practice and making many transactions are less subject to behavioral biases, such as the disposition effect (Chen et al., 2013; Dhar & Zhu, 2006; Frino et al., 2015).

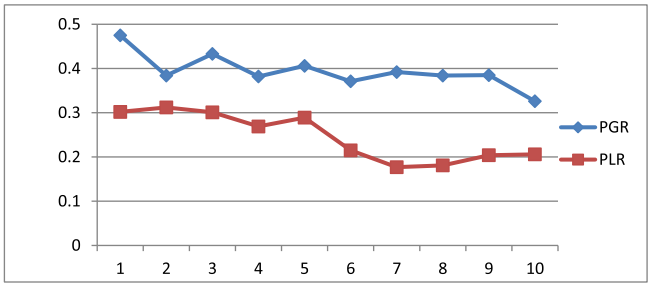
4.3.1.4. Disposition effect and trade volume. Another sign of the degree of sophistication, highlighted in Appendix Table A6, is the trade volume. In this table, the higher the value of transactions is, the less investors tend to realize losses or gains, as is also shown by changes in the PLR and PGR curves in Fig. 1. PLR and PGR are constantly decreasing across the deciles, which shows that decisions on a losing or winning sale become more difficult when the amount involved is high. In the disposition effect, it is important for deciles to be located between 60% and 90%, which means holding losing stocks and selling the winners. After share prices increase, investors tend to realize their gains quickly by not necessarily taking into account the volume but, rather, the feeling of pride and personal satisfaction that it generates. This explains why the PGR curve decreases slightly or is constant.

4.3.1.5. Disposition effect and the number of shares. The first observation we draw from Appendix Table A7 is that the disposition effect exists for all categories of investors classified by the kind of shares held. The number of distinct stocks held by the same investor during the study period provides information on portfolio diversity, reflecting the investor's level of experience and professionalism. This also reflects the degree of investment in the Tunisian stock market and the investor's ability to manage his securities well. The results related to these explanations seem relevant because in the third and fourth quartiles, we find the lowest PLR-PGR values, −0.111 and −0.116, respectively. Investors with the most diversified portfolios tend to realize fewer proportional gains and losses. The first two quartiles are characterized by high exposure to the disposition effect, with values of −0.171 and −0.226 in order. These results are highly significant, which reflects concentration around the averages. As noted by Chuang and Lee (2006), overconfident investors tend to overestimate the risk level and hold under-diversified portfolios: this explains the consequent shift in the disposition effect.

4.3.2. Disposition effect and market external factors

In addition to internal factors, we also focus on external factors, such as temporal variations in the market and their impact on the disposition effect calculated not for different groups of investors but, rather, over time periods related to changes in the market.

4.3.2.1. Disposition effect for each year. Results by year (Appendix Table A8) show that the disposition effect is substantially the same in 2007 and 2012, with a high level compared to other years (−0.235 and −0.218). Like Lin



Notes: Axe x represents the decile groups; Axe y represents PLR and PGR points ratios.

Fig. 1. Ratio of changes in PLR and PGR to trade volume.

[3] Barber and Odean (2001), Chen et al. (2007), and Frino et al. (2015) show that a high trading frequency reflects a high level of overconfidence among investors.

(2011), we find a significant disposition effect, which can be explained by market conditions. In particular, a major event occurred in 2011, the Tunisian revolution, so we see a further decrease in the disposition effect that year compared with 2010 and other years, which follows the market trend (Fig. 2).

4.3.2.2. Disposition effect and market trends. Fig. 3 shows the changes in Tunisian Stock Market Index values during the study period, which allows us to identify three bull markets and two bear markets, which satisfies the conditions by Cheng et al. (2013), who suggest that bull and bear markets last at least three consecutive months. The bull and bear market periods that we have identified are the following:

Bull market periods	Bear market periods
From 01/2009 to 09/2010	From 09/2010 to 12/2010
From 12/2010 to 09/2012	From 10/2012 to 05/2013
From 06/2013 to 09/2014	

Appendix Table A9 shows that during bull markets, the realization of gains is at least 1.5 times greater than the realization of losses, while during bear markets, this ratio decreases to the point that it barely exceeds the threshold of 1. These results can be explained by behavioral biases.

4.3.2.3. Disposition effect for each month. Fig. 4, based on Appendix Table A10, reflects the variation in the PGR/PLR ratio. The tendency to realize gains is greater than that of losses and is sometimes 2.4 times greater.

Like Leal et al. (2008), who study of the Portuguese stock market, we find that the highest PGR/PLR ratio is recorded in

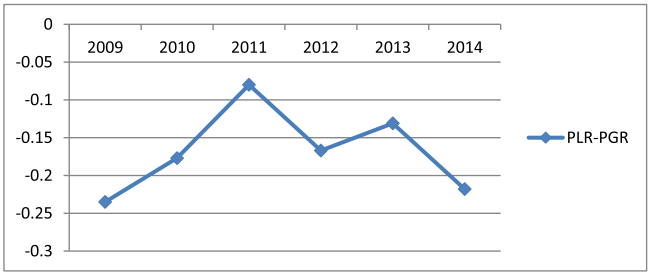
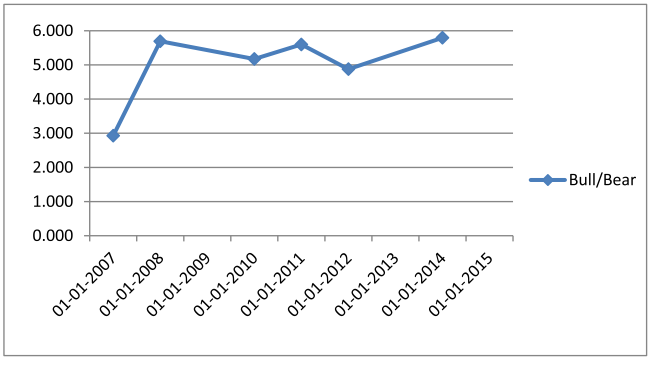
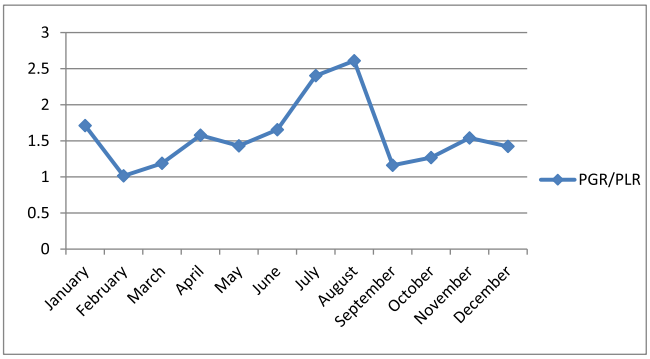


Fig. 2. Annual changes in the disposition effect.



Note: Scale is the 1000 points of unities.

Fig. 3. Ratio of Bull and Bear market periods.



Note: Scale is the points of unities.

Fig. 4. Change in the disposition effect characterized by PGR/PLR by month.

July and August and the lowest in February, March, September, and October. According to several studies, including Brown et al. (2002), Leal et al. (2008), and Odean (1998), the disposition effect in December seems to be related to taxes and the end of the fiscal year. However, until January 1, 2013, we find, by contrast, that this difference is linked to the absence of taxation on the Tunisian market. Rumors starting in October 2012 that a tax would be imposed on the Tunisian Stock Exchange dampened the disposition effect during the first two weeks of December to a PLR-PGR value of −0.028.

4.3.2.4. Disposition effect and the end of the year effect. In accordance with Leal et al. (2008), whose results are contrary to those of Odean (1998) and others, such as Brown et al. (2006), we find that the disposition effect varies only slightly between December and the rest of the year (Appendix Table A11). Nevertheless, the investor preference for selling winning stocks is twice as high as the preference for selling the losers. This proportion is also higher than that found from January to November, which indicates the presence of the disposition effect all year long. Our results are similar to those in Firth (2015) and could be explained by the desire to end the year with good results.

4.3.3. Impact of investor characteristics and market trend on the disposition effect

The impact of investor characteristics and market trends on the disposition effect is estimated using an empirical linear regression of the different variables in our model on the disposition effect variable (PLR-PGR). The variables are related to investor characteristics such as age, gender, type of portfolio management, trading frequency, the average number of stocks held, trading volume, trading in round numbers, market trends (bull/bear market), and interaction variables that take different values for each combination. To this end, we use OLS regressions with White's heteroskedasticity correction of standard errors. A correlation analysis between this set of variables was conducted beforehand. Table 2 shows the results of our correlations and regression estimates.

The correlations inform us about links studied earlier between the variables for individual investor characteristics as well as market trends. With regard to these links, a bullish or bearish

Table 2
Correlations and regression results (with White heteroskedasticity correction of standard errors).

	Correlations between the different variables												OLS regression results
	TM	Gender	Age	Gender* Age	Bull/Bear	Gender* Bull/Bear	Age* Bull/Bear	TV	RS	FT	ANS	PLR-PGR	
TM	1												0.080 (1.526)
Gender	0.100	1											−0.022 (−0.489)
Age	−0.126	0.126	1										0.025 (0.732)
*Gender*Age*	−0.113	0.113	0.172	1									0.041 (1.120)
Bull/Bear	0.000	0.000	0.000	0.000	1								−0.095* (−1.847)
Gender Bull/Bear*	−0.124	0.090	−0.103	0.121	0.000	1							−0.047** (−2.150)
*Age * Bull/Bear*	−0.117	−0.103	0.149	0.216	0.000	0.157	1						−0.062*** (−2.653)
TV	−0.054	0.108	0.372	−0.350	−0.359	−0.368	−0.353	1					0.001** (2.462)
RS	0.118	0.146	−0.136	−0.431	−0.504	−0.450	−0.442	0.440	1				−0.185 (−0.464)
FT	0.541	0.157	−0.258	−0.248	0.020	−0.270	−0.255	0.040	−0.098	1			0.005 (1.116)
ANS	0.586	0.212	−0.137	−0.188	−0.017	−0.211	−0.199	0.070	−0.095	0.959	1		−0.011 (−0.336)
PLR-PGR	0.437	0.091	0.185	−0.055	−0.443	−0.074	−0.067	0.532	0.144	0.541	−0.573	1	
R^2													0.7683

Notes:***, ** and * denote significance at the 1%, 5%, and 10% levels respectively. *T*-statistics are reported in parentheses.
$(PLR - PGR)$ measures each investor's disposition effect; (TM_i) is the type of management and takes a value of 1 if the account i is not managed by the holder and 0 otherwise; $Gender_i$ takes a value of 1 if the account holder is male and 0 otherwise (female); Age_i is the age of the holder of account$i$; $Gender*Age_i$ is an interaction variable that takes different values for each combination; $Bull/Bear_i$ reflects the market trend and takes a value of 1 for bull market conditions and 0 otherwise (bear market); $Gender*Bull/Bear_i$ is an interaction variable that takes different values for each combination; $Age*Bull/Bear_i$ is an interaction variable that takes different values for each combination; TV_i is the trading volume, meaning the total trade volume of account i over the sample period; RS_i is a dummy variable that takes a value of 1 if account i trades in round numbers and 0 otherwise; FT_i is the frequency of trading, meaning the total trade numbers of account i over the sample period and is used as a proxy for investor overconfidence; and ANS_i is the average number of stocks held in account i at the start of each month and that reflects the diversification of a portfolio.

trend does not change the number of traders in the market, or the age distribution or number of independent or managed accounts. Little connection is found between these variables. In other words, for example, men are equally present in bull and bear markets. Nevertheless, investors are more active when the market is bullish, which results in a positive correlation coefficient between the dummy variable bull/bear and trading frequency (0.020). Also, in a bull market, investors who trade only in round numbers tend to have more money. We notice a strong obvious correlation between trading frequency over the sample period and investor portfolio diversification (0.959). A mostly positive correlation exists between being male and all other variables, except the interaction variable of age and a bull market. Otherwise, older and male investors contribute more to the market trading volume, as shown by the positive correlation between these two variables (0.108 and 0.372 respectively). Trading volume is also related to trade in round numbers (0.440). Older investors tend to manage their own accounts, which has an increasing effect on trading.

Results of estimates reflect changes in the disposition effect following changes in investor characteristics and market trends. Our coefficient of determination $R^2$of the model is 76.83%, which is good enough to predict the disposition effect following individual investor characteristics and market conditions. A higher trading volume is estimated to slightly increase the disposition effect, with a coefficient of 0.001 at the 5% confidence level. Decisions on whether to sell losers or winners become more difficult when the amount involved is high, which explain the disposition effect. The volume effect is accentuated after an increase in share prices, that is, investors tend to realize their gains rapidly because of the feeling of pride and personal satisfaction it generates.

In addition, our results suggest that market conditions (whether bullish or bearish) is a major determinant of the intensity of the disposition effect. Indeed, when the market is bullish, the disposition effect decreases by 9.5 percent. This result confirms our initial findings. The tendency to realize gains and retain losing stocks during bull markets is related to mental calculations, loss aversion, and prospect theory, following Cheng et al. (2013) and Leal et al. (2008). The prospect theory states that, during bull markets, it is easier to realize gains, so investors see them as part of their quest for satisfaction linked to a new gain, and this explains the high PGR value. In contrast, losses during bull markets give the impression of bad decisions, which are not easy to accept. Gervais and Odean (2001) suggest that investors are overconfident during bull markets, which means that they only want to feel the euphoria linked to the realization of gains and not the bitterness of a bad decision. In bear markets, investors are also averse to losses, but they assume that their losses were due to external factors, which makes them more acceptable. This is reflected in a very significant increase in PLR during bear markets.

The combination of the market condition variable with gender and age variables yields more interesting results. The terms *age* × *bull/bear* and *gender* × *bull/bear* are found to be negative and statistically significant at the 1% and 5% level respectively and have higher estimated coefficients. This result indicates that each of them is closely related to the disposition effect. The negative coefficient indicates that in a bear market, the older the investors, the less likely they are to exhibit the disposition effect. Indeed, this effect decreased by 6.2 percent. This can be explained by the maturity and experience among older investors with respect to adequate analyses and profitable transactions. Thus, they have learned to invest appropriately over time (Talpsepp, 2010). In addition, during a bear market,

the disposition effect fell by 4.7 percent among stockholders who are male. This can be justified by the men higher level of overconfidence compared to women (Barber & Odean, 2001).

The weakening of psychological biases with investor or market characteristics has not been confirmed in recent research in other areas of analysis, such as sports. Studies suggest that biases including loss aversion, accuracy, and the disposition effect are found to persist even among experienced and competitive professionals and in markets with high stakes. In this line of literature, Pope and Schweitzer (2011) find that golfers are significantly influenced by the reference point of par, and even the best golfers—including Tiger Woods—show evidence of loss aversion. When golfers are playing "under par,"[4] they are significantly less accurate than when they attempt otherwise similar putts at par or are "over par."[5]

Similarly, Anbarci, Arin, Okten, and Zenker (2017) show that, in the high stakes, professionalized context of tennis as well, experienced professionals, especially male players, exhibit strong behavioral biases. Their results provide evidence that Pope and Schweitzer's (2011) findings of loss aversion among male golfers in high-stakes settings extend beyond golf. Specifically, they find that professional male tennis players serve faster when they are behind than when they are ahead. Female players do not change their service speed when they are behind, but they do serve more slowly when they are ahead. Thus, male players' behavior is more consistent with prospect theory, exhibiting more loss aversion and the reflection effect. Anbarci, Arin, Okten, and Zenker (2018) provides additional evidence of the existence of "lossaversion" in the highly competitive context of professional tennis. Interestingly, the impact of lossaversion is visible in different settings. When players'scores are behind, they show that they are more likely to take risks in their speed of service, although the timing of the lossaversion differs between male and female players. They also document that male players are more willing to take risks when the stakes are highest; namely, they take more risks in the final, when in monetary terms as well they have much more to lose. They also document that among lower-ranked male players risk taking is higher as well, and eligibility for the main draw of subsequent competitions is highly dependent on their performance in the previous ones.

Despite these conclusive results, Anbarci et al. (2017, 2018) and Pope and Schweitzer (2011) recognize that their findings are suggestive and not generalizable to other domains, such as financial consulting, real estate, and the public sector.

4.3.4. Additional robustness checks

In this section, we present three treatments that allow us to test the robustness of our results and to see whether Tunisian investors are actually subjects to a behavioral bias (disposition effect). In fact, trading activity on financial markets can be explained by reasons other than behavioral biases, such as reasons for hedging, portfolio rebalancing, liquidity needs, fiscal reasons, or the aim to adjust the return-risk pair. Our goal is to see at what point this might be true, i.e., the tendency to sell winning stocks and to keep losers is due to a behavioral bias which is the effect of disposition.

4.3.4.1. Alpha measure of Weber and Camerer (1998). In order to determine whether investors use prices in a previous period as a reference point, we calculate the disposition effect based on the alpha measure (Weber & Camerer, 1998).[6] A positive value of this index indicates that investors tend to sell securities after a price increase.

The results in Appendix Table A12 show that females have a higher alpha (=0.1929) than males (=0.1735). This means that females are more inclined to sell stocks after a price increase. Similarly, managed accounts tend to sell stocks more than independent accounts after a price increase. However, young people are inclined to sell stocks after a rise in prices, which is consistent with the characteristics of the Tunisian market, for which we cite the need for liquidity and quick gains for young people. Kadous et al. (2014) show that individuals tend to trade stocks as if they expect a return to the average in the short term. After a rise in prices, investors believe that the probability of a price drop over the following days is higher than a price increase, while they expect a lower probability of a price drop than a price decrease in the case of a fall in prices (Shu et al., 2005): this explains the tendency to sell a stock the day after a price increase. According to Weber and Camerer (1998), this phenomenon is consistent with the disposition effect.

4.3.4.2. Portfolio rebalancing. One behavior that is not explained by the disposition effect is that investors try to sell their securities to rebalance their portfolio. Odean (1998) proposes that the effect of portfolio rebalancing can be seen if transactions that do not clear the portfolio are removed. Therefore, he kept only realized gains and losses when the sale allows total liquidation and clears the investor's total stock holdings. He also kept all paper gains and losses related to these sales days. Appendix Table A13 shows that, even after portfolio rebalancing is controlled for, the disposition effect persists significantly (t-statistic is much higher than 0 in absolute value), with a PLR-PGR value of −0.176.

4.3.4.3. Transaction costs. According to Frino et al. (2015), selling winners instead of losers can be rational behavior if the losing stocks do not have a high value or if the absolute returns they generate are relatively low compared to transaction costs (brokers' commissions and other trading costs). This could then explain the tendency to hold on to losers without necessarily indicating a behavioral bias in the trading activity of market participants on the Tunisian stock market. Thus, we test whether the disposition effect disappears after accounting

[4] E.g., shoot a "birdie" putt that would earn them a score one stroke under par or shoot an "eagle" putt that would earn them a score two strokes under par.

[5] E.g., shoot a "bogey" putt that would earn them a score one stroke over par or shoot a "double bogey" putt that would earn them a score two strokes over par.

[6] The coefficient equal $\alpha = \frac{(S_+ - S_-)}{(S_+ - S_-)}$ with $S_+(S_-)$ the total number of sales after an increase (decrease) in price. The coefficient is zero if the number of realized sales after a rise/fall in price in the previous period is the same.

for a low purchase price and a fairly limited absolute return on investment. First, we study the distribution of brokerage commissions by grouping statistics made on all brokers' commissions in percentage (Appendix Table A14).

This allows us to treat sales transactions differently: transactions in which the absolute value of the difference between the price the dealer paid for a security and the price the buyer pays ((average purchase price - selling price)/selling price) is higher than 1.19% and transactions in which the absolute value of the difference between the price the dealer paid for a security and the price the buyer pays ((average purchase price - selling price)/selling price) is less than 1.19%.Using Odean (1998) method, we thus divided our stocks into four groups of equal size by the average purchase price (APP) of a security (APP <7 dinars and APP $\geq$ 7 dinars), on the one hand, and by the percentage of the absolute return on investment ($|R| < 1.19$ and $|R| \geq 1.19$), on the other hand.

Appendix Table A15 reports the PLR-PGR divided by stock price and by the absolute value of the return on investment (R) for all accounts for the full sample period (January 1, 2009–September 30, 2014). Like Odean (1998), we find that the disposition effect is pretty weak for low-value stocks (APP< 7), which could be losers if we add eventual brokers' commissions ($|R| <1.19$). However, the disposition effect is much more pronounced for low-value stocks (APP< 7) that are either winners or losers even after taking into account eventual brokers' commissions ($|R| \geq 1.19$). This might be a behavioral bias due to the fact that we either have to act in time to stop, limit losses, and let gains run or decline to act and accentuate the disposition effect.

5. Conclusion

To illustrate the phenomenon called the "disposition effect," we performed an empirical study on the Tunisian stock market for the period from January 1, 2009, to September 30, 2014. Our results indicate that Tunisian investors exhibit the disposition effect. We first performed initial tests to see, at the individual level and at time scale, the degree of difference in behaviors of distinct individuals in terms of characteristics such as age and gender or features related to portfolio management and bull or bear market conditions. The study showed that the disposition effect depended on investor characteristics that could be summarized in age, gender, type of management, trading frequency, trading in round numbers, the number of securities held over the study period, and trading volume. Considering the parameters one by one, we found greater exposure to the disposition effect among male than female investors. This can be explained by the high level of risk aversion among females (Booth & Nolen, 2012; Rau, 2014; Sutter & Rützler, 2010), which allows them to sell falling stocks quickly without a lot of emotional attachment. Similarly, we note that the disposition effect is weaker among older traders. This result is consistent with previous studies by Dhar and Zhu (2006) and Korniotis and Kumar (2011). Age therefore seems to have a positive effect on people's ability to make effective investment decisions because older investors have greater experience and a better understanding of the fundamental principles of investment. Their accumulated wisdom allows them to make more efficient investment decisions. Also, we found that the disposition effect follows a curve inversely proportional to the degree of experience and sophistication of Tunisian investors, in particular with regard to trading frequency, trading volume, and the number of shares held. Moreover, stocks managed by professionals are significantly less exposed to the disposition effect than stocks managed independently by individual investors, which parallels the results about experience. The tendency to trade in round numbers has been demonstrated to be a behavioral bias that fits into the perspective of heuristics. According to our study, such a bias makes the investor more subject to the disposition effect. It is overall the same for trading volume, which increases the disposition effect when it rises. Our study also shows that the disposition effect depends on the market condition, that is, if it is bullish, it has a significant impact: when market is bullish, the disposition effect increases, while this effect decreases in a bearish market. This result can be explained by behavioral factors. Indeed, in a bull market, investors more easily make gains, so they prefer to account them to avoid feeling regret from a subsequent fall in stock prices. On the contrary, the realization of losses in such a market implies a bad previous purchase decision that is difficult to accept psychologically. Investors therefore prefer to hold on to losers. In a bear market, investors accept their losses more easily because they attribute them to external factors.

A simultaneous observation of internal and external factors that influence the disposition effect produces fairly relevant results: human behavior is rarely determined solely by the impact of nature (internal factor) or the impact of the market (external factor). The simultaneous study of age and gender as well as other trader characteristics allows us to update some results of prior research that, for example, found that older investors had a higher disposition effect. Our approach, based on simultaneous observation of parameters that are innate (gender) and evolve over time (age and experience), in addition to external influences, provides more precision and detail on the real behavior of individuals, which considerably reduces the margin of error. Finally, and after the robustness tests that we have conducted that eliminate other rational explanations of the disposition effect, such as portfolio rebalancing and transaction costs, we conclude that the disposition effect is indeed a behavioral bias that exists in the Tunisian stock market in a significant way and cannot be explained by the traditional theory of the informational efficiency of markets.

Conflict of interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Appendices.

Appendix Table A1
The Mann-Whitney *U* Test based on gender, age, type of portfolio management, and market trend.

	U-Mann	Ew	Vw		Lower 95%	Upper 95%	Risk of dependence
Gender: M/F	386,070	422,852	248,584	0.137	−0.811	1.811	60−65%
Age: <35/65<	74,878	83,226	44,977.1	−0.072	−0.811	1.811	40−45%
Management: M/I	451,045.6	470,186	276,010	−0.048	−0.811	1.811	45−50%
Bull/Bear	75,953	96,455	52,502.9	−0.31	−0.811	1.811	20−25%

Appendix Table A2
Tests for the equality of means and variances based on gender, age, type of portfolio management, and market trend.

Gender	Male	Female
Observations	1143	769
Mean	−0.18	−0.22
δ^2	0.27	0.46
Risk	10.91	
Age	**<35**	**65<**
Observations	948	415
Mean	−0.23701166	−0.17381124
δ^2	0.33287679	0.25304461
Risk	3.64	
Type of management	**Managed**	**Independent**
Observations	921	1143
Mean	−0.18040538	−0.19964442
δ^2	0.24795897	0.28948175
Risk	45.33	
Market trend	**Bull**	**Bear**
Observations	1046	195
Mean	−0.20395506	−0.00990621
δ^2	0.22544944	0.27619118
Risk	0.0001S	

Appendix Table A3
Results of disposition effect test based on gender, age, and type of portfolio management. Sample Period: January 1, 2009, to September 30, 2014.

	PL	RL	PG	RG	PGR	PLR	PLR-PGR	PGR/PLR	t-statistic
Observations: 60,260Transactions									
				Disposition Effect					
Full Sample(925)									
Total	14,393	6418	14,034	11,198					
Mean	16.591DD	7.35	16.25	13.21	0.448	0.307	−0.141	1.459	−32.891
Male(560)				**Disposition Effect - Gender**					
Total	12,539	5187	11,391	8757					
Mean	23.56	9.63	22.7	16.44	0.421	0.291	−0.131	1.479	−30.027
Female(365)									
Total	1854	1231	2643	2441					
Mean	6.923	4.62	7.429	8.143	0.523	0.400	−0.123	1.275	−13.247
<35(292)				**Disposition Effect - Age**					
Total	1965	1008	1924	1979					
Mean	7.131	3.55	7.026	7.198	0.506	0.332	−0.184	1.524	−14.739
35−65(578)									
Total	11,606	5142	10,679	8643					
Mean	19.88	7.72	18.75	14.37	0.434	0.279	−0.155	1.556	−29.479

(*continued on next page*)

Appendix Table A3 (*continued*)

	PL	RL	PG	RG	PGR	PLR	PLR-PGR	PGR/PLR	t-statistic
65<(55)									
Total	822	268	1431	576					
Mean	19.66	4.7	27.64	12.51	0.311	0.193	−0.118	1.611	−7.635
Independent(776)				**Disposition Effect − Types of management**					
Total	7422	4027	7640	7344					
Mean	11.03	4.24	10.353	9.812	0.486	0.278	−0.208	1.748	−31.164
Managed(149)									
Total	5971	2391	6394	3854					
Mean	53.14	21.5	54.33	32.81	0.376	0.288	−0.089	1.305	−14.347
Male(560)				**Disposition Effect − Gender and Age**					
<35(159)									
Total	895	339	889	890					
Mean	6.644	2.43	6.304	6.14	0.493	0.267	−0.226	1.846	−14.063
35−65(352)									
Total	10,552	4528	9679	7379					
Mean	28.22	11.3	25.87	19.31	0.427	0.285	−0.142	1.498	−27.207
65<(49)									
Total	916	216	1304	512					
Mean	24.65	6.52	34.36	14.15	0.291	0.209	−0.082	1.392	−6.874
Female(365)									
<35(147)									
Total	1080	699	1072	1098					
Mean	8.838	5.88	8.796	8.972	0.505	0.403	−0.102	1.253	−8.259
35−65(205)									
Total	935	623	1067	1254					
Mean	5.514	3.74	6.108	7.119	0.538	0.404	−0.134	1.332	−10.512
65<(13)									
Total	15	12	23	65					
Mean	1.267	1.02	1.933	6.333	0.766	0.446	−0.32	1.717	−3.697
Male(560)				**Disposition Effect − Gender and Type of management**					
Independent(451)									
Total	7555	3510	6864	6004					
Mean	16.69	7.1	14.93	12.8	0.461	0.298	−0.163	1.547	−27.648
Managed(109)									
Total	4821	1634	5040	2784					
Mean	59.67	20.7	62.43	34.81	0.358	0.257	−0.101	1.392	−14.139
Female(365)									
Independent(300)									
Total	675	489	856	1417					
Mean	2.316	1.74	2.946	4.81	0.620	0.429	−0.191	1.445	−11.926
Managed(65)									
Total	1342	785	1274	993					
Mean	35.12	21.01	33.14	26.14	0.440	0.374	−0.066	1.176	−5.670
Independent(776)									
<35(263)				**Disposition Effect − Age and Types of Management**					
Total	508	308	496	1090					
Mean	2	1.12	1.963	4.239	0.683	0.359	−0.324	1.902	−15.851
35−65(468)									
Total	7130	3403	6539	5814					
Mean	14.67	6.65	13.31	11.75	0.469	0.311	−0.158	1.508	−26.34
65<(45)									
Total	490	185	592	426					
Mean	10.77	3.98	12.85	9.142	0.415	0.270	−0.145	1.537	−7.542
Managed(149)									
<35(33)									
Total	1460	711	1458	917					
Mean	64.05	31.6	63.87	40.33	0.387	0.330	−0.057	1.172	−5.171

Appendix Table A3 (*continued*)

	PL	RL	PG	RG	PGR	PLR	PLR-PGR	PGR/PLR	t-statistic
35−65(107)									
Total	4349	1753	4205	2786					
Mean	43.91	17.6	42.55	28.03	0.397	0.286	−0.111	1.388	−14.618
65<(9)									
Total	456	58	744	165					
Mean	75.4	9.05	122.6	26	0.175	0.107	−0.068	1.635	−4.688
Male(560)				**Disposition Effect − Gender, age and Type of management**					
Independent									
<35(132)									
Total	384	202	310	642					
Mean	2.938	1.61	2.454	4.923	0.667	0.354	−0.313	1.885	−13.997
35−65(289)									
Total	6196	2641	5473	4505					
Mean	21.20	8.7	18.56	15.14	0.449	0.290	−0.159	1.548	−24.16
65<(40)									
Total	476	174	570	364					
Mean	13.41	4.78	16	10.15	0.388	0.263	−0.125	1.476	−6.248
Managed									
<35(18)									
Total	534	156	590	276					
Mean	40.21	11.3	44.61	20.45	0.314	0.220	−0.094	1.427	−5.133
35−65(72)									
Total	4301	1847	4169	2785					
Mean	56.67	21.7	54.76	34.83	0.388	0.276	−0.112	1.406	−14.462
65<(9)									
Total	463	65	751	172					
Mean	90.5	11	149.3	33.6	0.183	0.107	−0.076	1.710	−4.867
Female(365)									
Independent									
<35(129)									
Total	144	124	194	456					
Mean	1.044	0.9	1.455	3.518	0.707	0.463	−0.244	1.526	−7.608
35−65(179)									
Total	527	383	661	913					
Mean	2.945	2.14	3.62	5.17	0.588	0.421	−0.167	1.396	8.71
65<(13)									
Total	24	21	32	74					
Mean	1.279	1	2	5.806	0.743	0.438	−0.305	1.695	3.679
Managed									
<35(13)									
Total	936	565	878	650					
Mean	85.19	51.3	79.81	59.17	0.425	0.376	−0.049	1.130	3.677
35−65(31)									
Total	408	240	406	361					
Mean	13.18	7.4	12.75	11.52	0.474	0.359	−0.115	1.320	5.25
65<(0)									

Notes: RG = realized gain; RL = realized loss; PG = paper gain; PL = paper loss; PGR = proportion of gains realized; PLR = proportion of losses realized; PLR-PGR = difference between PLR and PGR; and PGR/PLR = PGR to PLR ratio.

Appendix Table A4
The disposition effect based on the type of trading volume.

	Round numbers	Not round numbers
Observations	594	7063
Mean TV	340	198
Median TV	110	52
Minimum TV	10	1
Maximum TV	50,000	17,283
Mode TV	100	35
PL	89	13,302
RL	119	5351
PG	163	12,874
RG	635	9550
PGR	0.796	0.425
PLR	0.572	0.286
PLR-PGR	−0.224	−0.139
PGR/PLR	1.392	1.486
t-statistic	−6.992	−30.767

Notes: TV = trade volume; RG = realized gain; RL = realized loss; PG = paper gain; PL = paper loss; PGR = proportion of gains realized; PLR = proportion of losses realized; PLR-PGR = difference between PLR and PGR; and PGR/PLR = PGR to PLR ratio.

Appendix Table A7
The disposition effect based on the number of stocks held. Number of stock holdings over the period 2009 and 2014 - Quartile Groups.

	1	2	3	4
Minimum	1	4	8	16
Maximum	5	9	17	34
PL	269	801	2495	9933
RL	418	677	1261	3217
PG	343	899	2453	9455
RG	1208	1949	1986	5347
PGR	0.779	0.684	0.447	0.361
PLR	0.608	0.458	0.336	0.245
PLR-PGR	−0.171	−0.226	−0.111	−0.116
PGR/PLR	1.281	1.493	1.330	1.473
t-statistic	−9.086	−15.395	−11.842	−22.335

Notes: RG = realized gain; RL = realized loss; PG = paper gain; PL = paper loss; PGR = proportion of gains realized; PLR = proportion of losses realized; PLR-PGR = difference between PLR and PGR; and PGR/PLR = PGR to PLR ratio.

Appendix Table A5
The disposition effect based on trading frequency volume. Trading Frequency Volume (1: the least active traders, 10: the most active traders) - Decile groups.

	1	2	3	4	5	6	7	8	9	10
Minimum	1	4	7	10	18	29	47	66	97	156
Maximum	3	6	9	17	27	46	64	82	142	277
PL	77	247	256	927	1057	1897	1791	2194	2999	1958
RL	260	185	216	530	661	473	706	596	1078	766
PG	154	395	332	942	1006	1920	1687	2043	2913	1632
RG	728	890	891	877	924	1273	1045	1014	1595	962
PGR	0.8254	0.6926	0.7285	0.4821	0.4787	0.3986	0.3825	0.3316	0.3538	0.3708
PLR	0.7715	0.4282	0.4576	0.3637	0.3847	0.1995	0.2827	0.2137	0.2644	0.2812
PLR − PGR	−0.0539	−0.2644	−0.2709	−0.1184	−0.094	−0.1991	−0.099	−0.1179	−0.090	−0.090
PGR/PLR	1.070	1.617	1.592	1.325	1.244	1.998	1.353	1.551	1.338	1.319
t-statistic	−1.911	−9.650	−10.219	−6.807	−5.685	−16.616	−7.655	−10.189	−8.968	−6.940

Notes: RG = realized gain; RL = realized loss; PG = paper gain; PL = paper loss; PGR = proportion of gains realized; PLR = proportion of losses realized; PLR-PGR = difference between PLR and PGR; and PGR/PLR = PGR to PLR ratio. Our population is divided into ten subgroups, from the first decile to the last decile of the total number of transactions. The first decile is that of the least active population, i.e., those who performed no more than three sales transactions from January 1, 2009, to September 30, 2014, while the tenth decile is that of the most active.

Appendix Table A6
The disposition effect based on the volume of trade. Volume of Trade (1: the smallest trade volume, 10: the biggest trade volume) - Decile groups.

	1	2	3	4	5	6	7	8	9	10
Minimum	1.112	1.195.3	2584	3995.7	5677.6	7715.6	9980.1	13,062	18,801	34,745.4
Maximum	1194.85	2584.7	3990	5667	7698.1	9965.8	13,057	18,598	34,254	130,100
PL	7175	2155	1174	811	608	478	338	311	225	100
RL	3118	974	507	298	247	131	73	69	58	26
PG	6893	2016	1169	854	604	468	401	300	218	91
RG	6217	1257	891	529	413	276	258	187	137	44
PGR	0.475	0.384	0.433	0.382	0.406	0.371	0.392	0.384	0.385	0.326
PLR	0.302	0.312	0.301	0.269	0.289	0.215	0.177	0.181	0.204	0.206
PLR -PGR	−0.173	−0.072	−0.132	−0.113	−0.117	−0.156	−0.215	−0.203	−0.181	−0.12
PGR/PLR	1.572	1.230	1.439	1.421	1.404	1.725	2.215	2.122	1.887	1.583
t-statistic	−27.269	−6.152	−8.405	−6.146	−5.330	−6.473	−8.140	−6.907	−5.248	−2.290

Notes: RG = realized gain; RL = realized loss; PG = paper gain; PL = paper loss; PGR = proportion of gains realized; PLR = proportion of losses realized; PLR-PGR = difference between PLR and PGR; and PGR/PLR = PGR to PLR ratio. Our population is divided into ten subgroups, from the first decile to last decile of the total amount of transactions. The first decile is that of low-value transactions, i.e., those that do not exceed 1195 dinars from January 1, 2009, to September 30, 2014, while the tenth decile is that of transactions with the highest value.

Appendix Table A8
The disposition effect based on the year.

	2009	2010	2011	2012	2013	2014 (until September 2009)
Observations	1095	1672	1164	2821	859	144
PL	1238	3054	2859	3828	2160	375
RL	448	1425	1346	1180	1040	162
PG	1409	2070	2106	5837	1300	432
RG	1412	2034	1408	3901	1087	467
PGR	0.501	0.495	0.400	0.402	0.456	0.519
PLR	0.266	0.318	0.320	0.236	0.325	0.301
PLR-PGR	−0.235	−0.177	−0.080	−0.167	−0.131	−0.218
PGR/PLR	1.883	1.556	1.250	1.703	1.404	1.725
t-statistic	−17.928	−17.292	−8.533	−22.332	−10.695	−9.786

Notes: RG = realized gain; RL = realized loss; PG = paper gain; PL = paper loss; PGR = proportion of gains realized; PLR = proportion of losses realized; PLR-PGR = difference between PLR and PGR; and PGR/PLR = PGR to PLR ratio.

Appendix Table A9
The disposition effect based on the market trend (Bull/Bear).

	Bull	Bear
Observations	7678	973
PL	11,304	2081
RL	4212	1314
PG	11,955	1087
RG	9369	806
PGR	0.439	0.426
PLR	0.271	0.387
PLR-PGR	−0.168	−0.039
PGR/PLR	1.619	1.101
t-statistic	−33.504	−2.528

Notes: RG = realized gain; RL = realized loss; PG = paper gain; PL = paper loss; PGR = proportion of gains realized; PLR = proportion of losses realized; PLR-PGR = difference between PLR and PGR; and PGR/PLR = PGR to PLR ratio.

Appendix Table A11
The disposition effect at the end of the year.

	January to November 2013	December 2013
Observations	916	28
PL	2094	71
RL	1010	12
PG	1217	85
RG	1031	36
PGR	0.458	0.297
PLR	0.325	0.144
PLR-PGR	−0.133	−0,153
PGR/PLR	1.409	2.062
t-statistic	−11.027	−2.766

Notes: RG = realized gain; RL = realized loss; PG = paper gain; PL = paper loss; PGR = proportion of gains realized; PLR = proportion of losses realized; PLR-PGR = difference between PLR and PGR; and PGR/PLR = PGR to PLR ratio.

Appendix Table A10
The disposition effect based on month.

	January	February	March	April	May	June	July	August	September	October*	November	December
Observations	404	553	319	1008	701	934	1144	661	698	557	406	376
PL	805	1135	564	1122	1306	1381	1530	1110	1465	1264	918	893
RL	288	591	291	367	459	516	459	273	702	721	465	411
PG	926	1305	588	1549	1517	1341	1236	1007	1613	912	498	616
RG	758	694	399	985	899	1096	1544	1068	972	778	531	501
PGR	0.450	0.347	0.404	0.388	0.372	0.450	0.555	0.514	0.376	0.460	0.516	0.448
PLR	0.263	0.342	0.340	0.246	0.260	0.272	0.231	0.197	0.324	0.363	0.335	0.315
PLR-PGR	−0.187	−0.005	−0.064	−0.142	−0.112	−0.178	−0.324	−0.317	−0.052	−0.097	−0.181	−0.133
PGR/PLR	1.711	1.014	1.188	1.577	1.430	1.654	2.402	2.609	1.161	1.268	1.540	1.422
t-statistic	−11.746	−0.549	−3.497	−10.274	−8.319	−13.35	−25.324	−21.51	−4.53	−7.059	−10.4	−8.013

Notes: RG = realized gain; RL = realized loss; PG = paper gain; PL = paper loss; PGR = proportion of gains realized; PLR = proportion of losses realized; PLR-PGR = difference between PLR and PGR; and PGR/PLR = PGR to PLR ratio. *PLR-PGR is −0.028 during the first half of October 2010.

Appendix Table A12
Calculation of alpha coefficient following investor characteristics.

	Gender		Age			Type of management	
	Male	Female	<35	35−65	65<	Managed	Independent
Observation	548	355	254	556	52	145	758
PLR-PGR	−0.130	−0.137	−0.155	−0.141	−0.106	−0.091	−0.192
α	0.1735	0.1929	0.227	0.1517	0.33	0.1949	0.1794
Median	0.2	0.2	0.2	0.2	0.35	0.128	0.2

Appendix Table A13
The disposition effect based on the total liquidation of securities.

PL	4928
RL	2591
PG	4906
RG	5354
PGR	0.521
PLR	0.345
PLR-PGR	−0.176
PGR/PLR	1.510
t-statistic	−23.549

Notes: RG = realized gain; RL = realized loss; PG = paper gain; PL = paper loss; PGR = proportion of gains realized; PLR = proportion of losses realized; PLR-PGR = difference between PLR and PGR; and PGR/PLR = PGR to PLR ratio.

Appendix Table A14
Percentage of gross brokerage commissions amount.

Mean	0.010725029
Median	0.011899732
Mode	0.01190
Minimum	0.002439145
Maximum	0.295891308

Appendix Table A15
Results of PLR-PGR partitioned by average purchase price and absolute return oninvestment.

	APP <7	APP ≥7
$\|R\| < 1.19$		
PL	2168	3801
RL	1136	1426
PG	1716	3850
RG	1474	2329
PGR	0.462	0.377
PLR	0.343	0.272
PLR-PGR	−0.119	−0.105
PGR/PLR	1.347	1.386
t-statistic	−9.667	−11.944
$\|R\| \geq 1.19$		
PL	2642	4870
RL	1009	1904
PG	2021	5459
RG	2833	3570
PGR	0.584	0.395
PLR	0.276	0.281
PLR-PGR	−0.308	−0.114
PGR/PLR	2.117	1.405
t-statistic	−29.915	−14.853

Notes: RG = realized gain; RL = realized loss; PG = paper gain; PL = paper loss; PGR = proportion of gains realized; PLR = proportion of losses realized; PLR-PGR = difference between PLR and PGR; and PGR/PLR = PGR to PLR ratio.

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