

The disposition effect and its manifestations in South African investor teams

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Abstract

Purpose – The study endeavours to determine (1) whether the disposition effect exists among South African investor teams, (2) whether it is causally intensified by a set of psychosocial factors and (3) whether the disposition effect causally reduces investor welfare.

Design/methodology/approach – Following a natural field experimentation design involving a sample of investor teams participating in the 2019 run of the JSE University Investment Challenge, the authors use regression adjustments as well as bootstrap tests to investigate the casual implications of a set of psychosocial factors on the intensity of the disposition effect, as well on the attenuation of market-adjusted *ex post* returns (i.e. investor welfare).

Findings – South African investor teams are susceptible to the disposition effect, and their susceptibility to the bias is associated with attenuated investor welfare. Furthermore, low female representation in an investor team causally intensifies the disposition effect, subsequently leading to a causal reduction in investor welfare.

Originality/value – Using evidence from real-world observation, the authors contribute to the literature on team gender diversity and investment decision-making, and – using Hofstede's (2001) cultural dimensions – the authors offer a comprehensive account for how differences in culture may lead to differences in gender-related disposition effects across different nationalities. The authors also introduce to the literature experimental evidence from the field that clearly demonstrates that – among South African investor teams – a causal relationship exists (1) between female representation and the disposition effect, and (2) between the disposition effect and investor welfare.

Keywords Investment decisions, Portfolio choice, Institutional investors

Paper type Research paper

1. Introduction

Prospect theory is understood to be one of the most important theoretical descriptive frameworks describing psychological biases in investment decision-making (i.e. decision-making under the condition of uncertainty) (Kahneman and Tversky, 1979). The theory asserts that people make decisions based on the potential losses and gains they face in relation to a specific reference point (e.g. the purchase price of a stock) rather than the final outcome (e.g. final state wealth as espoused by expected utility theory). Among the various

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ideas that it puts forward, prospect theory postulates that the tolerance of risk is different when it is concerning gains rather than losses, which stands contrary to expected utility theory's assertion that people's tolerance for risk is uniform (Dvorackova *et al.*, 2019). The disposition effect, which is perhaps closest to this postulation, is viewed as one implication of extending prospect theory to investment decision-making (Odean, 1998). First discussed in Shefrin and Statman (1985), the disposition effect refers to the tendency of investors to sell winning stocks too soon (risk-aversion-over-gains) and hold onto losers for too long (risk-seeking-over-losses), so as to maximise the S-shaped value function proposed in prospect theory (Kahneman and Tversky, 1979).

While there have been several studies in other emerging markets, studies of the disposition effect remain few – if at all existent – among African investment teams. The literature is particularly silent on the important issues underpinning the intensity and nature of the disposition effect among South African investor teams, as well as on the causal implications that the bias poses on investor welfare. In response to this apparent void in the literature, this research focuses on using experimental means to determine the intensity, nature and causal implications of the disposition effect among South African university student investor teams participating in the annual JSE University Investment Challenge in 2019.

As a context for studying the disposition effect, the JSE University Investment Challenge is interesting in several ways. First, participants to the game are required to organise themselves in investor teams of between two and four individuals, allowing for an investigation, and ultimately a better understanding of the relationship between group dynamics and disposition effects. Second, all trades made as part of the game are required to be executed upon on the JSE Investment Challenge trading platform; this effectively renders the Investment Challenge to be a complete market, with all trading data providing full information on the shares traded, share positions held and portfolios managed by investor teams. Third, investor teams participating in the game are geographically distributed across the country, as they study in universities located in all nine provinces of South Africa; this allows for an inquiry into how local factors – such as climate temperatures – may influence the intensity of the disposition effect. Finally, in an effort to understand the impact of the disposition effect on investor welfare, basing our inquiry on the 2019 run of the Challenge allows for enough time to pass, enabling us to look into the *ex post* returns of winning stocks sold and losing stocks held by the study's subjects over an investment horizon of 12 months.

In the remainder of this paper, section 2 provides a brief review of the literature on (2.1) the disposition effect in empirical and experimental studies, (2.2) the relationship between the disposition effect and several psychosocial factors of interest, (2.3) the disposition effect and its relationship with investor welfare, and (2.4) and (2.5) provide an overview of the JSE University Challenge and the study's hypotheses based on the literature reviewed (respectively). The methodology and data are discussed in section 3, and the results are covered in section 4. Section 5 concludes the paper.

2. Literature review and hypotheses

2.1 Findings from empirical and experimental research on the disposition effect

Beginning with Odean (1998) in a study conducted on trades executed by investors participating in the NYSE, AMEX, and Nasdaq stock markets, the literature on behavioural finance has provided ample empirical and experimental evidence that prior outcomes impact investment decision-making.

In a seminal empirical investigation of the disposition effect among the trades of US-based brokerage accounts, Odean (1998) found evidence which showed that individual investors have a strong propensity for realising gains from winning trade positions rather than realising losses in their portfolios. This disposition effect has been observed in numerous subsequent empirical studies in several other financial market contextual situations and

across a range of trader types and transactions, including (1) individual day trader transactions (Jordan and Diltz, 2004) and (2) professionally-managed trading accounts at a middle-eastern brokerage service provider (Shapira and Venezia, 2001), China-based stock market investors (Chen *et al.*, 2007). More recently, in empirical research using individual brokerage account-level by Duxbury *et al.* (2015), it was found that (1) both the disposition effect and the house money effect can coexist contemporaneously in the same stock market, (2) the investment decisions of the majority of individual investors are affected by both these bias and (3) the house money effect can act as a “natural antidote” which moderates – but not completely eliminates – the negative consequences of the disposition effect.

As compelling as the evidence from empirical studies of the disposition effect may be, it is not without its challenges at a research design level. What is perhaps the most significant limitation of such empirical studies is their inability to control, manipulate and isolate the causal impact of variables that are theoretically expected to affect investment decision-making. On the other hand, what Duxbury (2015) refers to as “the most potent weapon in the hands of the experimenter” is experimental analysis’ ability to manipulate the levels of treatment (i.e. intervention) factors, effectively allowing for causal measurements of relationships between variables of theoretical interest. As a result, it is arguable that experimentation is a more rigorous method of scientific inquiry seeing as – unlike the case in empirical enquiry – it is not subjected to the limitations of correlational analysis. In this regard, there is a significant amount of experimental evidence which not only asserts the existence of the disposition effect, but also explains its nature. For instance, Weber and Camerer’s (1998) seminal experimental research on the disposition effect confirms the bias’s existence, with winning stocks accounting for a relatively larger proportion of sales than losing stocks (60 and 40%, respectively). In addition to this, Weber and Camerer (1998) further find that the intensity of the disposition effect is weakened in a treatment condition where stocks held are automatically sold off at the end of a given period. The theoretical implication of this finding is striking – subjects’ investment decision-making cannot be driven solely by changes in price expectations if automatic selling at the end of the period has an impact on the intensity of the disposition effect, particularly since subjects are at liberty to repurchase previously sold stocks at the start of subsequent periods. Indeed, it is evident that the prior outcome of realising a loss or a gain from selling stocks (whether automatically or otherwise) has an impact on subsequent investment decision-making; an insight which could not possibly be surfaced without employing the basic tools of the experimentation method.

The experimental design in Weber and Camerer (1998) has been replicated in numerous subsequent studies, all which report findings supporting the existence, and explaining the nature of the disposition effect. For instance, Da Costa *et al.* (2008) assess the impact of gender differences on the extent to which investors succumb to the disposition effect and find that individual men exhibit a higher intensity of the disposition effect than women. More recently, Summers and Duxbury (2012) investigate the disposition effect in an experimental setting involving exogenous prices and using historic price sequences to analyse the effect using a between-subjects design, with subjects being assigned to a winner (bullish price trend) or loser (bearish price trend) condition. Interestingly, Summers and Duxbury (2012) find support for the disposition effect when individual subjects are responsible for their own prior gains and losses, however, they are unable to observe the effect in a treatment condition where prior gains and losses are experienced, but the responsibility for these outcomes lies with someone else. This finding speaks to the importance of an investor’s *locus* of control as a determinant of whether said investor exhibits the disposition effect in investment decision-making.

2.2 The disposition effect and its relationship with three psychosocial factors of interest

The literature on the disposition effect identifies several psychosocial factors that contribute towards this bias’s intensity; included among such factors are those relating to a given

investor's gender profiles (Da Costa *et al.*, 2008; Rau, 2014), the climate temperatures that they are subjected to (Shu *et al.*, 2005; Barber, 2007) and the number of members of a given investor team (Chen, 2013; Rau, 2015).

We begin with the psychosocial factor of gender, particularly as it relates to gender representation in the group decision-making context. Researchers have found compelling evidence to suggest that gender matters considerably to the intensity of the disposition effect, however, they tend to reach different conclusions on which gender is most prone to the effect. For instance, Da Costa *et al.* (2008) find that – among Brazilian investors – disposition effects are relatively more intense among men versus women. On the contrary, Rau (2014) reports the opposite result with regards to German investors; Rau (2014) concludes that cultural differences in loss aversion between Brazilian and German investors may account for these differences in findings. Given the significance of cultural differences, it would be interesting – and indeed novel – to determine the group-level gender differences in the disposition effects of South African investor teams. Regarding the impact of team gender diversity in investment decision-making, Bogan *et al.* (2013) find that having a male presence in an investment team increases loss aversion, which is understood to be a driver of the disposition effect (Shefrin and Statman, 1985). Nonetheless, Bogan *et al.* (2013) do not directly investigate the question of whether an investor team's disposition effect looms larger as male presence increases relative to female presence. Furthermore, Bogan *et al.* (2013) conduct their study as a conventional lab experiment, and thus their results are limited in terms of external validity (Harrison and List, 2004). Therefore, as partly a natural field experimental study into whether gender representation intensifies or dampens the disposition effect, this paper contributes to the literature on team gender diversity and investment decision-making with evidence from real-world observation.

Another psychosocial factor that is investigated in this study is concerning the locational weather temperatures that investor teams are subjected to; in this regard, we ask the question: do differences in the weather temperatures of separate locations have an impact on the intensity of the disposition effect among investor groups? Indeed, Goulart *et al.* (2013) find strong correlates between body temperature and the intensity of the disposition effect, and Wang (2016) finds compelling empirical evidence to suggest a positive relationship between weather temperatures in London and the intensity of the disposition effects of individual traders in the UK spread-trading market. In the latter study, the theoretical understanding – psychologically – is that weather conditions (and indeed, temperatures) affect mood, and mood changes cause behavioural changes. At a more nuanced level, Cao and Wei (2005) posit that lower temperatures lead to aggression and higher temperatures lead to feelings of apathy, *ceteris paribus*. In turn, aggression is understood to result in more risk-taking behaviour, whereas apathy is said to impede risk-taking. Given the disposition effect-related understanding that investment decision-makers are risk-seeking-over-losses and risk-averse-over-gains, one might hold the *a priori* expectation that there exists a causal relationship between (1) being subjected to low temperature weather conditions (thus being prone to aggression-cum-risk-taking behaviour) and (2) the intensity of the disposition effect (observably driven by loss aversion). The current study investigates whether such a causal relationship indeed exists.

Finally, concerning the psychosocial factors relating to the sizes of investor groups, both Cici (2012) and Rau (2015) find that some of the social forces involved in the group investment decision-making context can exacerbate the intensity of the disposition effect. In this regard, their research looks to the two social psychology-based group dynamics of groupthink (Janis, 1972) and group polarisation (Isenberg, 1986) as means of explaining this phenomenon; both of which are argued to exacerbate investors' proclivity to succumb to the disposition effect within the group-setting. On the contrary, a more recent experimental study by Prates *et al.* (2017) finds that the disposition effect is in fact attenuated in investment decisions made by two-person groups relative to decisions made by individuals; confirming a similar finding in Chui (2004). The explanation given for this finding is that groups make relatively less biased

decisions than individuals in competitive situations that involve an opportunity for the best performing participants to win a prize (Prates *et al.*, 2017). However, given an inability to statistically confirm the disposition effect for three-person groups, Prates *et al.* (2017) were unable to determine whether the disposition effect is further attenuated (or intensified) across different group-sizes. Since the nature of the relationship between team-size and the disposition effect is still not well-understood (particularly in studies using experimental data), and given the relatively greater variation in team-size data that we have available to us in the current study (which includes teams of two, three and four investors), we employ experimental means to answer the following question: does investor team-size have a causal effect on the intensity of the disposition effect?

2.3 The disposition effect and investor welfare

Researchers have long understood that letting go of winning stocks too soon and holding on to losing stocks for too long can be associated with sub-optimal portfolio outcomes. For instance, upon observing investment behaviour that is consistent with the disposition effect among subjects who participated in several lab experiments, Weber and Camerer (1998) reflect on how the disposition effect could be potentially harmful given the understanding that falling stock prices imply that the stock is on a downward trajectory and therefore should be sold at the soonest in order to minimise portfolio losses. On the other hand, rising stock prices suggest an upward trend and therefore should not be sold in order to maximise portfolio gains. However, investors do the opposite of this, potentially leading to sub-optimal portfolio outcomes. Odean (1998) takes this point a step further by calculating the *ex post* returns (in excess of the CRSP value-weighted index) of winning stocks sold and losers held over several investment horizons and finds that, for winning stocks sold, the average *ex post* return over the subsequent 12-month period is 3.4% higher than it is for losers held. Following an analysis like that of Odean (1998), Duxbury *et al.* (2015) conclude that the disposition effect may be costly to investors, having observed that winning stocks sold by the subjects of their empirical study had, on average, a 3.92% higher return than losers held over the subsequent year. These research efforts, and several others (Roger, 2009; Talpsepp, 2010; Shen and Shen, 2022), have contributed to our understanding of the negative correlation between the disposition effect and investor welfare; however, to the best of our knowledge, a finding that shows the causal effect of the disposition effect on portfolio outcomes has not been provided in the literature. Put differently, it is a common cause that the presence of the disposition effect is associated with sub-optimal portfolio outcomes. However, does this mean that the absence of the disposition effect is not associated with sub-optimal portfolio outcomes? This question – to which a scientifically-sound response would contribute towards our understanding of the causal relationship between the disposition effect and investor welfare – requires the involvement of a suitable counterfactuals in our inquiry.

2.4 The JSE University Challenge

The JSE Investment Challenge is a nation-wide, online-based trading game which spans over six months each year and involves thousands of university student-, and high school learner-teams comprising tens of thousands of team members (JSE, 2019).

In the university stream of the Challenge, which provides our experimental setting, university students from across the country organise themselves into teams (i.e. investor teams) of two to four members and are endowed with a starting portfolio of one million South African Rands (R1 million) in fictitious cash. Over the course of the subsequent six months, the investor teams work on growing their portfolios by trading (taking both long and short positions) in actual JSE shares, ETFs, warrants, and single stock futures (SSFs) at their actual live prices, and incur real-world transactions costs such as brokerage and settlement fees, and a securities transfer tax (STT) on each transaction. In these ways – and several others – the

Challenge mirrors the real JSE market context in every manner, save for the simulated nature of the currency used to trade in the share instruments. The three investor teams with the highest portfolio growth rates by the end of the six-month period win the Challenge, with prizes for 1st, 2nd and 3rd place comprising deposits of R25,000.00, R15,000.00 and R10,000.00 (respectively) per investor team into Satrix Investment Plan accounts in the names of the winning team members (JSE, 2020). In this way, it can be plausibly said that the Challenge's competitive context and prizes at stake sufficiently incentivise investor teams' engagement with the game.

2.5 Hypotheses

With the literature reviewed above in mind, we formalise our arguments in a series of five hypotheses which we test among South African university students participating in the annual JSE Investment Challenge. We begin by testing whether South African investor teams are in fact susceptible to the disposition effect (as per H1 below). Testing H1 is important, we believe, not only because studies which establish the disposition effect among African investor teams in general, and South African investor teams in particular, are non-existent – but also because the outcomes of testing H1 are critical to the validity of testing the subsequent hypotheses that follow. In these ways, the outcomes of testing H1 could potentially be both seminal to the literature at large, as well as foundational to the balance of the current study.

H1. South African investor teams are susceptible to the disposition effect.

On the condition that H1 is confirmed, the current study endeavours to test the remaining hypotheses below using experimental means. To test the causal impact of the female composition psychosocial factor on the extent of the disposition effect, we construct hypothesis H2 below. By testing H2, our intention is to – *inter alia* – determine the group-level gender differences in the disposition effects of South African investor teams, within the context of a natural field experiment. Given the role that cultural dynamics play in the susceptibility of different gender groups to loss aversion (Rau, 2014), thus the disposition effect, our view is that the outcomes of testing H2 will shed light on how this phenomenon plays out within the South African cultural context.

H2. *Ceteris paribus*, female composition has a causal effect on the intensity of the disposition effect among South African investor teams.

Our motivation for testing H3 below stems from our understanding that although empirical studies which sought to understand the impact of weather effects on stock market behaviour (Cao and Wei, 2005) and the disposition effect (Wang, 2016) exist, experimental research which endeavours to find out whether a causal relationship exists between the weather temperatures that people (and indeed, investor teams) are subjected to and the extent of their disposition effects is limited, if at all existent. Furthermore, we select weather temperature in particular for experimental examination as the outcomes of testing H3 may augment the explanation for the correlates found between low body temperature and the disposition effects of individuals in Goulart *et al.* (2013). H4 further below is constructed to test the causal impact of the investor team-size psychosocial factor on the extent of the disposition effect. By testing H4, our intention is to fill the apparent void in the literature (Chui, 2004; Cici, 2012; Rau, 2015; Prates *et al.*, 2017) regarding whether the disposition effect is progressively intensified or attenuated across different investor group or team sizes. Given the potential presence of the opposing forces of groupthink (Cici, 2012) and group participation in a competitive context (Prates *et al.*, 2017) – which have been found to intensify and attenuate, respectively, the disposition effects of investor teams – in the JSE University Challenge, testing H4 allows

for a novel determination of which of these forces have a greater bearing on the disposition effects of investor teams as investor team-sizes are varied.

H3. *Ceteris paribus*, climate temperatures causally intensify the disposition effects of South African investor teams.

H4. *Ceteris paribus*, investor team-size has a causal effect on the intensity of the disposition effect among South African investor teams.

Furthermore, the understanding that the disposition effect is associated with sub-optimal investor welfare (i.e. portfolio returns) has been well-established in the literature (Odean, 1998; Roger, 2009; Talpsepp, 2010; Shen and Shen, 2022); however, to the best of our knowledge – the literature is devoid of experimental studies from the field that investigate whether a causal flow exists between the psychosocial factors that characterise an investor team, the intensity of the disposition effects of said team, and their resultant investor welfare. Testing H5 below is thus our attempt at filling this apparent gap.

H5. *Ceteris paribus*, psychosocial factors which intensify the disposition effect causally reduce the investor welfare (i.e. portfolio outcomes) of South African investor teams.

3. Methodology

3.1 Subject pool and data

Of the 854 investor teams that actively traded (i.e. executed at least one trade) during the 2019 iteration of the JSE Investment University Challenge, we are able to confirm the gender compositions of 52 teams (due to missing data points in the dataset used for the study) who also attend universities domiciled in as wide a distribution of geographical locations across South Africa as possible (JSE, 2019). We therefore select these 52 teams as the subject pool for the current study, as they meet the standard requirement for field studies on the disposition effect (DE) of being active (Odean, 1998; Duxbury *et al.*, 2015; Frydman and Wang, 2020), as well as provide the necessary data to – *inter alia* – investigate the nature of the relationship between gender composition and the DE, as well as between climate temperature and the DE. With this as context, the current study – which unfolds as a natural field experiment – consists of the buy and sell trades of a sample of 52 active investor teams participating in the university stream of the 2019 JSE Investment Challenge, who are collectively characterised by a 4:1 men-to-women participant ratio, attend 21 universities located in 21 different cities or towns distributed across eight of South Africa's nine provinces, and have an average investor team size of two members per team. To test whether the intensity of the DE can be explained by the degree of female representation in each investor team, we consider the number of women in each team. To establish whether climate temperatures explain the intensity of the DE among the investor teams, we use the averages of daily maximum and minimum climate temperatures of the cities and towns in which the investor teams' universities are located over the course of the sample period (consistent with the approach in Cao and Wei (2005)) (TuTiempo.net, 2019). Finally, in testing whether investor team-size explains the intensity of the DE, we look at the number of investors in each team. The sample period for this natural field experiment is the full length of the 2019 run of the Investment Challenge which spanned from 11 March 2019 to 20 September 2019; a period in which the study's subject pool executed a combined total of 5,876 buy and sell trades.

3.2 Measurement techniques

Following a modified version of the methodology in Da Costa *et al.* (2013), the current study tests hypotheses H1–H4 using a panel data analysis approach. Specifically, we make use of the DE measures provided in Odean (1998), Weber and Camerer (1998), and Dhar and Zhu (2006).

An important consideration when measuring the DE is the nature of the reference point used in determining gains and losses. The prevailing understanding is that the DE arises when the purchase price of a stock or another price of the stock in a previous period is the reference point (Weber and Camerer, 1998; Da Costa *et al.*, 2008; Baucells *et al.*, 2011). The three DE measures named above do not make use of the same type of reference point: Odean (1998) and Dhar and Zhu (2006) use average purchase prices to measure DE at the group and individual investor levels, respectively, whereas the Weber and Camerer (1998) measure (an equation which defines what they refer to as the “disposition coefficient”) makes use of the previous period’s price. In the current study, we thus incorporate average purchase prices and average sale prices as reference points for long- and short-sell positions, respectively, in our use of the Odean (1998) and Dhar and Zhu (2006) measures, and incorporate previous trading day’s prices as reference points for long- and short-sell positions when calculating DEs using the Weber and Camerer’s (1998) measure.

Other distinguishing aspects of the current study’s methodology (particularly in relation to the methodology in Da Costa *et al.* (2013)) are that our experiment (1) is conducted in a live market context involving real-world share instruments (i.e. natural field experiment) instead of artificial ones, (2) observes the share instrument trades of investor teams instead of individual investors and (3) makes use of regression adjustments and bootstrap treatment tests to investigate whether there are causal links between different extents of psychosocial factors and the intensity of the DE. To test H5, we compute the cumulative market-adjusted *ex post* returns (i.e. *ex post* returns in excess of the FTSE/JSE All Share Index) for the winning stocks sold and losing stocks held (1) until the end of the Challenge on 20/09/2019, and (2) over the next 12 months of trading; an approach is similar to the one employed in Odean (1998). We once again make use of regression adjustments and bootstrap treatment tests, however, this time to conduct an inquiry into the causal links between the DE and investor welfare.

In making use of Odean’s (1998) measure, which considers the actual and potential share trades of investor team i during the sample period, we begin by computing the proportion of gains realised (PGR_i) and proportion of losses realised (PLR_i) as follows:

$$PGR_i = \frac{N_{gr}^i}{N_{gr}^i + N_{gp}^i}, \quad PLR_i = \frac{N_{lr}^i}{N_{lr}^i + N_{lp}^i} \quad (1)$$

where N_{gr}^i (N_{lr}^i) represents the number of share trades by investor team i with a realised gain (loss), and N_{gp}^i (N_{lp}^i) represents the number of potential share trades by investor team i with a paper gain (loss). Investor team i ’s disposition effect (DE_i) is thus:

$$DE_i = PGR_i - PLR_i \quad (2)$$

where $-1 < DE_i < 1$. Equation (2) therefore means that a positive value of DE_i is indicative of a smaller proportion of losing shares being sold relative to the proportion of winning shares being sold by investor team i , and thus – in such a case – investor team i exhibits the DE. The equation is evaluated by the following t -statistic:

$$t = \frac{PGR_i - PLR_i}{SE_i} \quad (3)$$

where the standard error SE_i is

$$SE_i = \sqrt{\frac{PGR_i(1 - PGR_i)}{N_{gr}^i + N_{gp}^i} + \frac{PLR_i(1 - PLR_i)}{N_{lr}^i + N_{lp}^i}} \quad (4)$$

Furthermore, the measures provided in Weber and Camerer (1998) and in Dhar and Zhu (2006) are employed. Contrary to the Odean’s (1998) measure, the PGR_i and PLR_i of the two former measures are not sensitive to investor teams’ portfolio sizes and trading frequencies, and thus contribute meaningfully to the robustness of the study’s analysis.

First, using the Weber and Camerer’s (1998) measure, we consider the difference between the number of share trades with realised gains by investor team i and the number of share trades with realised losses relative to the number of all trades, as follows:

$$DE_i = \frac{N_{gr}^i - N_{lr}^i}{N_{gr}^i + N_{lr}^i} \tag{5}$$

where $-1 < DE_i < 1$. Interpretively, the measure suggests that there is no DE if investor team i ’s number of share trades with realised losses matches their number of share trades with realised gains.

The Dhar and Zhu (2006) measure is provided as follows:

$$DE_i = \frac{N_{gr}^i}{N_{lr}^i} - \frac{N_{gp}^i}{N_{lp}^i} \tag{6}$$

4. Results and analysis

4.1 Disposition effects for grouped and individual subjects

Table 1 below provides the various terms involved in calculating DE following equation (2). At a 1% level of significance, we find that the group of investor teams does indeed succumb to the DE. Figure 1 provides the descriptive statistics for the DE calculated at an individual subject-level (i.e. calculated per individual investor team following equations (2), (5), and (6)), respectively. Further to this, Figure 1 provides two tests – parametric and non-parametric – on the significance of mean and median DEs. More specifically, the parametric t-statistic test investigates whether the hypothesised mean is equal to zero, whereas the non-parametric Wilcoxon z-statistic tests whether the distribution’s median is equal to zero. In this instance, the positive values of the DEs of the investor teams are significant at 1% when following equation (2) (Figure 1(a) and (b)) but not when following equation (5). With regards to equation (6) – an equation which, like equation (5), is not sensitive to portfolio size and trading frequency – the null is rejected in both parametric and non-parametric tests of the investor teams’ DEs at 5 and 1% significance, respectively. Summarily, these results – with the

Subject	Group of investor teams
Ngr	1,605
Nlr	1,352
Ngp	291
Nlp	477
PGR	0.8465
PLR	0.7392
DE	0.1073
SE	0.0132
t-Statistic	8.14***

Note(s): *p-value < 0.1

**p-value < 0.05

***p-value < 0.01

Table 1.
The disposition effect for the group of investor teams under study using Equation (2)

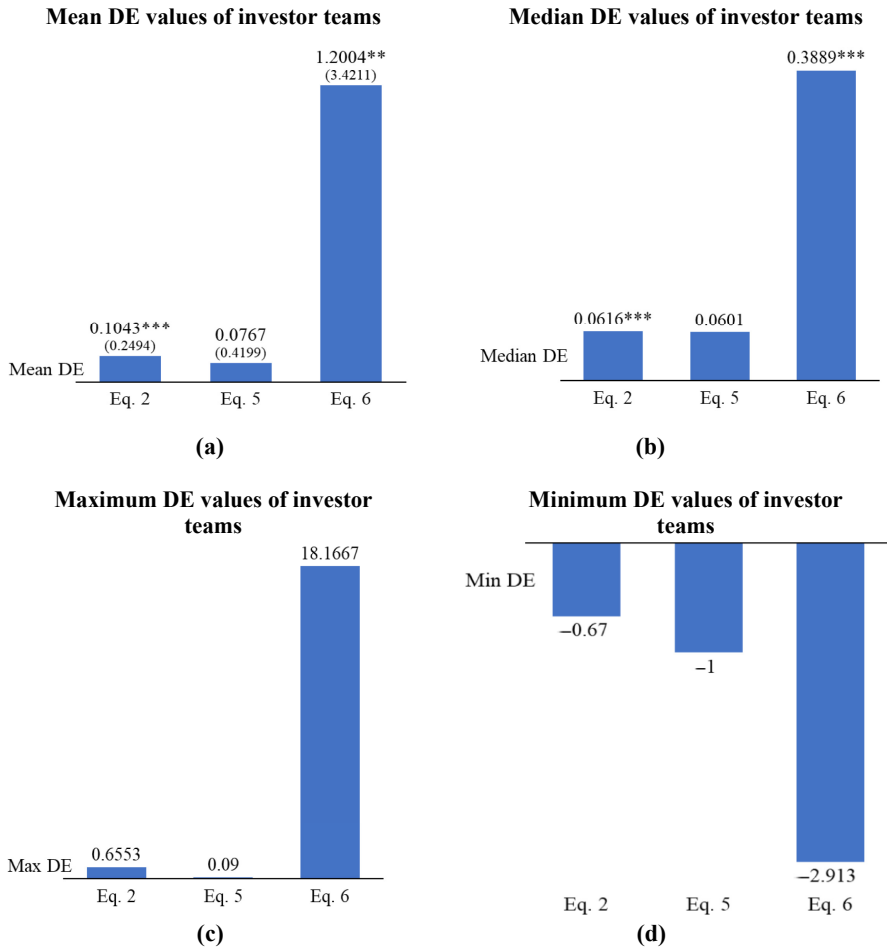


Figure 1. Mean, median, maximum and minimum disposition effects of full sample of individual investor teams

Note(s): $n = 52$

Standard deviations in parentheses

* p -value < 0.1. ** p -value < 0.05. *** p -value < 0.01

exception of those relating to [equation \(5\)](#) – are significantly indicative of the existence of the DE among the full sample of 52 investor teams, at both the group and individual investor team levels.

4.2 Testing for treatment effects

In this section, we begin by following a between-subject experimentation approach to estimate the average treatment effects (ATEs) of investor teams assigned to the (1) low and high female composition conditions, (2) low and high climate temperature conditions, and (3) small and large investor team-size conditions ([Moffatt, 2016](#)). We employ a sample segmentation approach similar to the one used in [Goulart et al. \(2013\)](#) to assign investor teams in our sample to the aforementioned conditions. Specifically, our full sample of investor teams

are arranged from highest to lowest values of the study’s psychosocial variables of interest, including only the top 18 teams with the highest values for the variables (e.g. 18 teams subjected to the highest climate temperatures) and the bottom 18 teams with the lowest values (e.g. 18 teams subjected to the lowest climate temperatures). Investor teams with mid-values are excluded. Subsequently, their corresponding individual DE values are calculated following equations (2), (5) and (6).

Across the study’s various conditions, ATEs are estimated using the following equation:

$$\tau_i = DE_{iT} - DE_{i\bar{T}} = DE_{i1} - DE_{i2} \tag{7}$$

where τ = ATE, DE_{i1} = mean DEs for the condition naturally subjected to treatment $T = 1$, and DE_{i2} = mean DEs for the condition naturally subjected to treatment $T = 2$ (Harrison and List, 2004). Mean DEs are given by equations (2), (5) and (6).

To determine the treatment effects’ significance, we estimate regression-adjusted ATEs, and review the p -values of said regression adjustments as well as those of bootstrap tests (with number of bootstrap samples $B = 9,999$) for differences in mean DEs. The bootstrap technique allows us to conduct parametric two-sample t -tests on our sub-samples of 18 investor teams (thus, 18 observations) per condition without relying on distributional assumptions (e.g. sub-sample sizes of 30 or more observations) regarding the normality of the data used (Efron and Tibshirani, 1993; Ellingsen and Johannesson, 2004; Moffatt, 2016). The bootstrap tests therefore serve as robustness checks on the results of the regression adjustments.

Table 2 begins by showing that the differences in the DEs of investor teams under the low female composition and high female composition conditions are significant at the 1% level with respect to the regression adjustment test and at the 5% level with respect to the bootstrap test, following the Weber and Camerer (1998) measure of DE (i.e. equation (5)). By implication, the evidence suggests that the DE is causally intensified by the presence of fewer females in investor teams and tapers off with greater female composition, when using the previous trading day’s prices as a reference point; an outcome which is strikingly similar to the finding in Da Costa et al. (2008) that female subjects do not sell more (less) experimental stocks when the sale price is above (below) the previous trading period’s price, whereas their male counterparts do.

Psychosocial conditions	DE equation	ATE (τ)	Regression Adjustment p -values	Bootstrap test p -values
$\tau = DE_{LOW\ COMP} - DE_{HIGH\ COMP}$	Equation (2)	0.0765 (0.0860)	0.373	0.415
	Equation (5)	0.3669 (0.1393)	0.008***	0.029**
	Equation (6)	0.3060 (0.9256)	0.741	0.801
$\tau = DE_{LOW\ TEMP} - DE_{HIGH\ TEMP}$	Equation (2)	0.0810 (0.0833)	0.331	0.343
	Equation (5)	0.1795 (0.1184)	0.130	0.157
	Equation (6)	1.0328 (1.2657)	0.414	0.428
$\tau = DE_{SMALL\ TEAM} - DE_{LARGE\ TEAM}$	Equation (2)	0.0060 (0.0657)	0.928	0.932
	Equation (5)	0.0793 (0.1304)	0.543	0.563
	Equation (6)	-0.1615 (0.8534)	0.850	0.867

Note(s): (a) $DE_{LOW\ COMP} - DE_{HIGH\ COMP}$ = low vs high female composition condition, (b) $DE_{LOW\ TEMP} - DE_{HIGH\ TEMP}$ = low vs high climate temperature condition, and (c) $DE_{SMALL\ TEAM} - DE_{LARGE\ TEAM}$ = small vs large investor team-size condition. Standard errors for the regression adjustment tests are provided in parentheses

* p -value < 0.1
 ** p -value < 0.05
 *** p -value < 0.01

Table 2. Testing for treatment effects: ATE values, regression adjustment p -values and p -values from bootstrap tests for differences in mean disposition effects

We also find that differences between the DEs of the low climate temperature condition versus the high temperature condition are statistically insignificant across all three measures of DE and both tests, and that none of the differences between the DEs of investor teams with small team-sizes relative to those with large team-sizes are significant across all measures of DE.

To provide a more visual comparison between the DEs of investor teams under the low and high female composition conditions, Figure 2 above illustrates the descriptive statistics of the aforementioned subsamples' DEs, as well as provides the outcomes of parametric and non-parametric one-sample significance tests conducted on their mean and median DE values. The figure shows that the mean and median DEs of low female composition investor teams (which vary in significance between the 1 and 5% levels) are consistently higher than those of teams subjected to the high female composition condition across all three measures; supporting the result relating to the female composition psychosocial variable in Table 2.

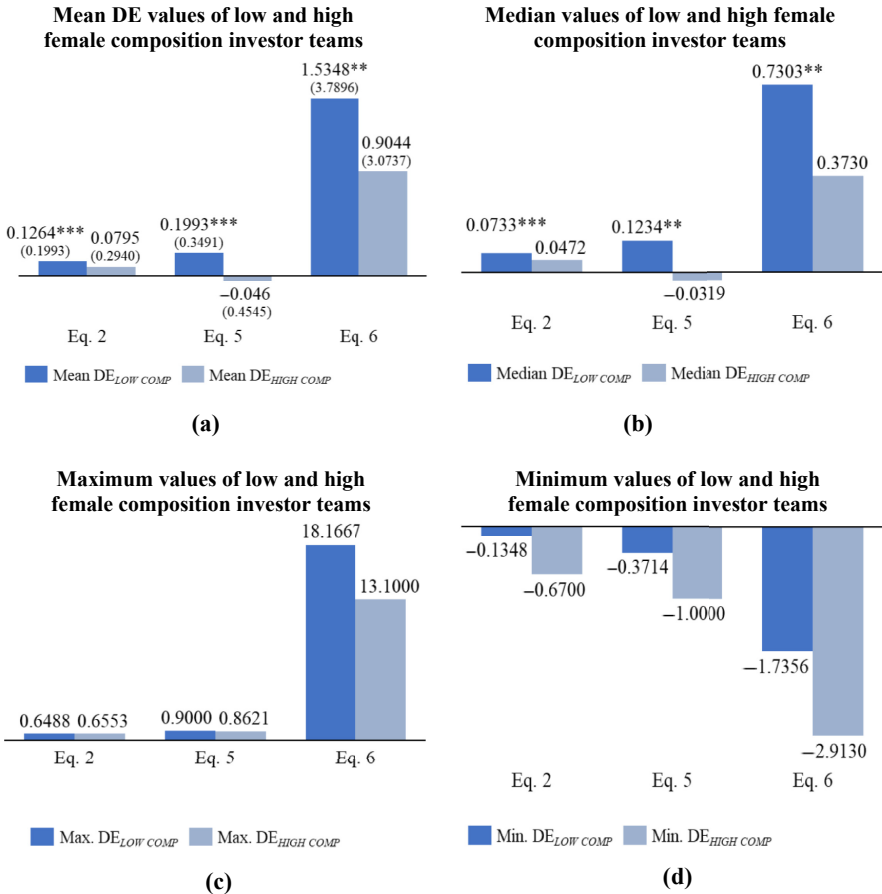


Figure 2. Mean, median, maximum and minimum disposition effects of individual investor teams split by female composition cohorts

Note(s): $n_1 = 18$; $n_2 = 18$

Standard deviations in parentheses

* p -value < 0.1. ** p -value < 0.05. *** p -value < 0.01

In proceeding towards an inquiry into the causal links between the DE and investor welfare, Table 3 provides two-tailed *p*-values of bootstrap tests (*B* = 9,999) into the significance of differences between the cumulative market-adjusted *ex post* returns (i.e. *ex post* returns in excess of the FTSE/JSE All Share Index) for the winning stocks sold and losing stocks held (for brevity, this difference in excess returns is denoted by the abbreviation DER) over two investment horizons, for the full sample of investor teams cohort, as well as for the low and high female composition cohorts.

We do not find any of the cohorts' DERs to be significant during the time horizon leading up to the end of the 2019 run of the Challenge. However, we find evidence (at the 1% level) suggesting the significance of the DERs over the next 12-month period, for the investor team and low female composition conditions. Interpretively, the positive DER for the investor team condition means that the winning stocks sold by investor teams had a cumulative market-adjusted return of 208 percentage points higher than that of stocks which incurred a paper loss over the subsequent 12-month investment horizon. For the investor teams under the low female composition condition, their winning stocks sold for a profit have a cumulative market-adjusted return that is 411 percentage points higher than that of their paper loss stocks. Summarily then, we find compelling evidence suggesting that the investor team and low female composition conditions – with the latter being understood to be causally-linked to intense levels of DE – are strongly associated with sub-optimal investor welfare, when looking at the *ex post* cumulative market-adjusted returns of winning stocks sold and losers held over the subsequent 12-month period. To understand whether a causal flow exists between the low female composition condition, the disposition effect, and investor welfare (as proxied by DER), we once again look to tests of treatment effects, this time following the equation below:

$$\tau_i = DER_{iT} - DER_{i\bar{T}} = DER_{i1} - DER_{i2} \tag{8}$$

where τ = ATE, DER_{i1} = mean of differences in cumulative *ex post* returns for the group naturally subjected to treatment $T = 1$, and DER_{i2} = mean of differences in cumulative *ex post* returns for the group naturally subjected to treatment $T = 2$ (Harrison and List, 2004).

Psychosocial conditions	Investment horizon	Ex post return on winning stocks	Ex post return on paper losses	Difference in ex post returns (DER)	Regression adjustment <i>p</i> -values	Bootstrap test <i>p</i> -values
Investor teams	Until 20 Sep '19	-0.0662	-0.1067	0.041	0.187	0.192
	Next 252 trading days	1.9855	-0.0919	2.0774	0.117	0.000***
Low female composition	Until 20 Sep '19	-0.1169	-0.1781	0.0612 (0.0428)	0.152	0.167
	Next 252 trading days	3.9741	-0.1381	4.1123 (2.6467)	0.120	0.001**
High female composition	Until 20 Sep '19	-0.0174	-0.0381	0.0206 (0.0382)	0.946	0.606
	Next 252 trading days	0.0733	-0.0474	0.1207 (0.0963)	0.210	0.251

Note(s): Standard errors for the regression adjustment tests are provided in parentheses

**p*-value < 0.1

***p*-value < 0.05

****p*-value < 0.01

Table 3. Cumulative market-adjusted *ex post* returns for the winning stocks sold and losing stocks held (a) until the end of the Challenge on 20/09/2019, and (b) over the next 12 months of trading

The results provided in Table 4 show that the low female composition condition's 12-month DERs are 399 percentage points greater than those of the high female composition condition, at a 1% level of significance under the bootstrap test. Interpretatively, this outcome suggests that – over a 12-month horizon – the loss in portfolio returns incurred by investor teams from selling winners too soon and letting go of losers too late is far greater when an investor team is characterised by low female representation than high female representation.

Finally, as a robustness check on our observed low female composition treatment effect on 12-month DERs (where a positive relationship between the independent and dependent variables is interpreted as meaning that the independent (i.e. treatment) variable causally reduces portfolio performance), we regress the DER variable on low female composition – along with two other control variables related to the psychosocial factors investigated in the current study – using ordinary least squares (OLS), involving robust standard errors:

$$DER_i = \beta_0 + \beta_1 LowFemaleComp_i + \beta_2 LowClimateTemp_i + \beta_3 LargeInvestorTeam_i + \mu_i \tag{11}$$

where DER_i = differences in cumulative *ex post* returns for investor team i ; $LowFemaleComp_i$ = a dummy variable that is equal to 1 if an investor team is characterised by low female composition, and 0 if otherwise; $LowClimateTemp_i$ = a dummy variable that is equal to 1 if an investor team is subjected to low climate temperatures, and 0 if otherwise; and $LargeInvestorTeam_i$ = a dummy variable that is equal to 1 if an investor team is regarded as being of a relatively large size, and 0 if otherwise.

Table 5 shows low female composition to be statistically significant at the 5% level. Interestingly, we also see a strong, positive relationship (significant at the 1% level) between

Table 4. Testing for treatment effects: ATE values, regression adjustment p -values and p -values from bootstrap tests for differences in cumulative market-adjusted *ex post* returns

Experimental conditions	Investment horizon	ATE (τ)	Regression adjustment p -values	Bootstrap p -values
$\tau = DER_{LOW\ COMP} - DER_{HIGH\ COMP}$	Until 20 Sep '19	0.0406 (0.0559)	0.468	0.477
	Next 252 trading days	3.9915 (2.6567)	0.133	0.009***

Note(s): $DER_{LOW\ COMP} - DER_{HIGH\ COMP}$ = low vs high female composition condition. Standard errors for the regression adjustment tests are provided in parentheses
 * p -value < 0.1
 ** p -value < 0.05
 *** p -value < 0.01

Table 5. OLS regressions on differences in cumulative market-adjusted *ex post* returns over the next 12 months of trading (psychosocial factors)

	Coefficient	Standard errors	t -stat	[95% confidence interval]
$LowFemaleComp_i$	7.1910**	2.922	2.46	1.3119–13.0701
$LowClimateTemp_i$	2.8704	2.570	1.12	–2.3007–8.0415
$LargeInvestorTeam_i$	8.0130***	2.852	2.81	2.2749–13.7512
Constant (β_0)	–6.8389**	2.899	–2.36	–12.6715–1.0063
F	3.88**			
n	51			

Note(s): * p -value < 0.1
 ** p -value < 0.05
 *** p -value < 0.01

the large investor team variable and the DER variable. Given that we are unable to identify a causal relationship between investor team-size and the DE in Table 2 above, we are of the view that the nature of the relationship between the large investor team variable and the dependent variable is more correlational than causal. This interpretation is consistent with Goldman *et al.*'s (2016) empirical finding that, on average, mutual funds ran by a single fund manager outperform those ran by a team of managers by as much as 1.3% per year. They point to a possible increase in moral hazard risk – due to increased team size – as a potential explanation. A further inquiry into this insight would thus be a deviation from our main investigation into the nature and extent of the disposition effect; we therefore conclude – on this point – that the potential causal flow between investor team size and reduced portfolio performance does not involve the disposition effect.

5. Discussion and concluding remarks

Given the outcomes of the analyses interrogating the existence of DEs among South African investor teams in both Table 1 and Figure 1, we conclude that there is sufficient empirical evidence to confirm hypothesis H1, a finding that supports the universality and robustness of the notion that the DE is a cognitive bias that human investors are susceptible to, the world over. Furthermore, this finding relates to a context where human subjects are proxied by South African investor teams participating in a live market that is real in every sense, save for in value of currency. In this way, the current study introduces to the literature externally valid findings that suggest that South African investor teams – similar to those one may encounter in asset management firms, investment banks, and hedge funds operating within the country – are susceptible to the DE.

We also find evidence of a strong causal relationship between the female composition and DE variables, following Weber and Camerer's (1998) measure. Specifically, the results in Table 2 suggest that the fewer the women in an investor team, the more intense the DEs of said team; Table 2's results thus confirm H2 that female composition explains the intensity of investor teams' DEs. Our confirmation of H2 poses several implications which could be of interest to both market participants and researchers alike. For instance, we introduce to the literature – for the first time – evidence from a natural-field experiment supporting the understanding that South African men are more susceptible to the DE than South African women; an insight that is indeed robust when one considers not only the internally valid results that support it (such as those in Da Costa *et al.*, 2008), but also – by way of the current study – the externally-valid results as well. Furthermore, if the susceptibility of different genders to the DE is contingent on cultural context as espoused by Rau (2014), then this study's findings introduce to the literature the understanding that – similar to the Brazilian context (Da Costa *et al.*, 2008), and contrary to the German one (Rau, 2014) – South African men are more susceptible to the DE than their women counterparts. Taking a closer look at the cultural drivers of DEs in these three geographies, we find Hofstede's cultural dimensions to be especially relevant (Hofstede, 2001). In this regard, the finding in Breitmayer *et al.* (2019) that long-term orientation is negatively-correlated with susceptibility to the DE is applicable; particularly when considering both the facts that (1) Germans score more than twice as high as South Africans and Brazilians (on average) in the long-term orientation (Hofstede Insights, 2021), and (2) women have been shown to generally score higher than men in long-term orientation (AlAnezi and Alansari, 2016). The conjecture that flows from this is that – like Brazilian investors – South African investors exist within a cultural context where long-term orientation is valued relatively lowly, which in turn renders South African investors prone to the DE across the gender-divide (a mechanism which also explains our findings in relation to H1). Looking more pointedly at gender, our sense is that South African male investors – who are predisposed to being less long-term oriented due to their gender – would resultantly

exhibit more intense DEs relative to their female counterparts, even within the context of a national population that is already generally prone to succumbing to the bias. These deductions offer the most comprehensive explanation for how differences in culture may lead to differences in gender-related DEs across different nationalities.

Turning more deliberately to the finding that investor teams composed of fewer women exhibit higher DEs, we find an explanation for this occurrence by conflating the conjectures above relating to the cultural dynamics at play with the literature on the effects of gender composition in collaborative groups. In this regard, [Karpowitz et al. \(2012\)](#) find compelling experimental evidence which suggests that in instances where women are assigned to be the numerical minority in deliberating groups (i.e. teams) that are required to make decisions based on majority rule, women are less likely to voice their opinions and be rated by their peers as being more influential than (1) men in their groups, (2) men in the same numerical minority status, and (3) women in other groups. [Karpowitz et al. \(2012\)](#) refer to this phenomenon as the “gender role hypothesis” and assert that this gender gap in participation and influence in the group decision-making context is especially pronounced when the deliberation’s subject-matter is perceived to be of a masculine nature, resulting in men being perceived as being more competent on the topic thus enjoying a higher status in discussions ([Karpowitz et al., 2012](#); [Mendelberg et al., 2014](#)). Given the cultural and numerical dominance that men have in the professional investments industry ([Riach and Cutcher, 2014](#); [Preqin, 2019](#)), it is reasonable to hold that asset allocation may be one such subject that is perceived as being particularly masculine. With all of the aforementioned in mind, we conjecture that in investor teams characterised by low female composition, men have a greater bearing on the team’s investment decision-making by virtue of the gender role hypothesis ([Karpowitz et al., 2012](#)); thus, in view of men’s relatively low long-term orientation ([AlAnezi and Alansari, 2016](#)) as discussed above, it follows that the investment decisions of teams where men are the numerical majority would be highly susceptible to the DE.

Finally, by finding that low female composition in an investor team causally reduces investor welfare via the DE, our study confirms [H5](#) and demonstrates in no uncertain terms how psychosocial factors empirically understood to intensify the DE can negatively impact investor welfare. Indeed, upon encountering this finding, market participants such as discretionary investors in the South African financial markets seeking out, perhaps, investment funds to invest in may deem it useful to consider gender diversity as part of their selection criteria when choosing between fund management teams to invest with. In our view, employing such a selection strategy may potentially assist in ensuring that they invest with fund management teams that are likely to deliver superior returns.

What about the psychophysiological factors that have previously been found to correlate with the disposition effect [Goulart et al. \(2013\)](#)? Can a similar causal impact on investor welfare be expected? We leave these questions open to be answered by future experimental research; the findings of which would not only contribute new evidence-based views to the literature on the various human nature-related mechanisms through which the disposition effect is intensified – but would also guide market practitioners on how to build investor teams in such a way that the altogether costly disposition effect is mitigated against.

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The disposition
effect and its
manifestations

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