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Individual Differences in the Disposition Effect

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## Individual Differences in the Disposition Effect

**Keywords:** disposition effect; personality traits; realization utility theory; five factor model; financial trading.

**Summary:** We investigate the disposition effect building on Realization Utility Theory and Big Five Model. Our experimental analysis, combining NEO IP-R personality measures with individual financial data from a trading simulation run by 230 individuals, shows that the disposition effect is driven by two distinct psychological processes, one related to holding losers and the other to selling winners. These two behavioral mechanisms are uncorrelated and influenced by different personality traits.

### Abstract

We model the role of personality traits in explaining the disposition effect building on Realization Utility Theory and Big Five Model and moving from an aggregate level to inter-individual differences. Our experimental analysis, combining NEO IP-R personality measures with individual financial data from a trading simulation run by 230 individuals in China and Italy, shows that the disposition effect is driven by two distinct psychological processes, one related to holding losers and the other to selling winners. These two behavioral mechanisms are uncorrelated and influenced by different personality traits. Controlling for different demographic variables we show: 1) a greater sensitivity of the rewarding system that motivate “extroverts” to quickly sell the stock at gain in order to receive a burst of utility; 2) a tendency for “conscientious” subjects to suppress impulsivity, patiently waiting for higher cumulative returns; 3) the importance of “openness to experience” to better value information to achieve higher outcomes.

### 1. Introduction

Over the last thirty years, an extensive body of literature has shown the effects of cognitive and behavioral biases on financial decisions. Several studies have documented the so-called disposition effect, when individuals tend to cash in quickly financial gains but hold on longer on trades at loss (Shefrin and Statman 1985; Weber and Camerer 1998; Odean 1998; Frazzini 2006). Yet, we still lack a clear understanding of what drives it and how different trading styles impact the formation of its determinants. Most of the previous studies have looked at the disposition effect at an aggregate level of analysis, masking considerable cross-section variation in the understanding of investors’ behavior (Odean 1999).

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3 Moreover, theoretical models based on information asymmetry or transaction costs have failed to give an  
4 interpretation of the heterogeneity in the tendency to ride losers and sell winners (Odean 1998).

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6 Finding a relevant explanation of the roots of the disposition effect is crucial, as the bias is clearly  
7 an investment mistake that leads to underperformance in a wide class of investors (Odean 1998; Dhar and  
8 Zhu 2006; Frazzini 2006). Following interdisciplinary approaches, which link decision-making under risk  
9 and psychological factors (e.g. Lauriola and Levin 2001), we model the role of personality traits as  
10 determinants of individual differences in the disposition bias. As in Durand et al. (2013), we use the Five-  
11 Factor Model (FFM, Tupes and Cristal 1961) where the personality is categorized in five broad  
12 dimensions: extraversion, conscientiousness, neuroticism, agreeableness and openness to experience. As a  
13 stable pattern of behaviors and cognitions (Fleeson 2001), personality traits contribute to explain  
14 individual choices in a financial setting. The stimuli given by each of the five traits in altering the attitude  
15 towards gains and losses justify the variation in the disposition effect level among investors with different  
16 personality profiles. In particular, we expect that a financial cue engages processes based on the  
17 underpinnings of personality (mainly reward/punishment system, impulsivity and seek for novelty), with  
18 extroverts exhibiting a greater propensity to sell winners compared to losers, neurotics postponing selling  
19 operations of stocks at loss, and conscientious and open investors holding longer before closing positive  
20 positions instead of negative.  
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24 We empirically test our model through a cross-sectional experimental analysis in a sample of 230  
25 students of Economics at the University of Bologna (Italy) and at the University of Wuhan (China).  
26 Subjects participated in a trading competition based on Weber and Camerer (1998) experimental task and  
27 were profiled according to the Big Five personality traits measures and their demographic characteristics.  
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31 Our results show that extroversion is positively associated with the disposition effect, while  
32 subjects with high conscientiousness and openness to experience are less biased. In line with the  
33 psychological literature that demonstrates a link between extraversion and high sensitivity to reward  
34 (Smillie 2013) we report that extroverts prefer short-term capital gains instead of delayed profits (Daly et  
35 al. 2009). Moreover, the fact that in our experiment open mind investors close negative positions faster  
36 than positive ones offers specific support for the role of the facets of intellect, curiosity and exploration in  
37 reducing harm-avoidance behavior through unconventional decision-making (Costa and McCrae 1992;  
38 Lauriola and Levin 2001). Finally, we show how low impulsive investors base their trading activities on a  
39 non-immediate aim-achievement leading them to follow long-term strategies for the main goal of higher  
40 returns (Daly et al. 2009).  
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44 This paper offers several theoretical, empirical and practical contributions. First, we build on  
45 previous literature in psychology and finance demonstrating the role of personality traits in explaining the  
46 disposition effect. Although Durand et al. (2013) first investigate the relationship between the personality  
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3 traits and the disposition effect, in this study we offer a more comprehensive analysis of the cognitive  
4 mechanisms, behind each trait, able to affect investor financial decisions in the domain of gains and  
5 losses. We leverage on a larger and more heterogeneous group of individuals in terms of nationality. In  
6 fact, our sample includes subjects from China and Italy that leads us to take into account differences in  
7 cultural and social values as potential moderators of the personality' role on the disposition bias.  
8 Furthermore, no prior study has put into a theoretical framework the relationship between PT and DE. We  
9 propose the Realization Utility Theory and the Five Factor Model as the keys to explain how and which  
10 condition certain associations should emerge.

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16 Second, in proposing a study at the individual level, we analyse investment heuristics for each  
17 different investor and we detect and monitor data features that are not visible in traditional trading  
18 databases. This clarifies the behavioral underpinnings of the disposition effect, giving the opportunity to  
19 disentangle the individual decision processes by analyzing directly the moment when wealth changes.

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23 Third, our insights might motivate theorists to accommodate the heterogeneity in personality  
24 traits in normative models that capture anomalies in asset pricing and portfolio choice as insufficient or  
25 naive diversification (French and Poterba 1991), excessive trading (Odean 1999) and underreaction  
26 (overreaction) to the events (Frazzini 2006). Finally, our study can raise the attention of investment firms  
27 and financial companies in guiding their recruiting and training practices, as well as that of regulators in  
28 educating individuals and help them make better investments.

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34 In the following sections, we first provide a review of the literature on disposition effect and  
35 personality traits and develop a set of hypothesis. In Section 3 we present the experimental protocol,  
36 while we describe the data and results in Section 4 and 5 respectively. Section 6 discusses the results and  
37 presents our conclusions.

## 38 39 40 41 42 **2. Literature Review**

### 43 44 *2.1 Disposition Effect*

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46 The attitude to ride losses instead of gains has always represented one of the most challenging trading  
47 anomalies to define. Starting from Shefrin and Statman (1985), the disposition effect has been widely  
48 investigated both in controlled environments and in market settings. After its first empirical  
49 demonstration (Odean 1998; Weber and Camerer 1998) and the evidence of a negative correlation with  
50 investment returns (Odean 1998), researchers have shifted their attention to the implication of the  
51 phenomenon in financial trading. Grinblatt and Han (2005), Frazzini (2006) and Birru (2015) show how  
52 the disposition effect can slow stock-price reaction to new information, while Goetzmann and Massa  
53 (2008) demonstrate how the bias is positively (negatively) associated with trading volume (volatility).

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3 Following Dhar and Zhu (2006) and Kumar and Lim (2008) we know that investors that execute more  
4 trades have a lower disposition effect, don't exhibit a disposition effect for some stocks (Kumar, 2009)  
5 and don't exhibit a disposition effect in mutual funds (Chang et al 2016).  
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8 In spite of many efforts to confirm these results and continue to explore the greatest paradoxes of the  
9 common financial advice "cut your losses and run your gains", private information, speculation,  
10 transaction costs and tax advantages failed to give an interpretation of the disposition effect (Odean  
11 1998).  
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14 Coming from a different perspective, many economists used the Prospect Theory of Kahneman  
15 and Tversky (1979) to show how individuals make decisions based on a reference point (Frydman and  
16 Rangel, 2014)<sup>1</sup>. According to the Prospect Theory, investors who exhibit disposition effect are risk-  
17 averse towards gains while they seek risk when they are experiencing losses. Barberis and Xiong (2009)  
18 have discussed the difficulties in formalizing this statement. In particular, when a subject computes his  
19 own preferences on annual gains/losses rather than realized gains and losses, he is more likely to observe  
20 a positive relation between prospect theory and the opposite of disposition effect. Accordingly, economic  
21 models better predict individual investment behavior if utility is derived not only from a total wealth  
22 experience (as annual gains/losses or on the entire portfolio) but from every investing episode. Along this  
23 line, Barberis and Xiong (2012) in a subsequent paper suggest that investors (especially if individuals  
24 rather than institutional) have separated burst of utility for different single events (e.g. "I purchased a  
25 share of Ferrari at \$40 and I sold at \$60"). Instead of computing their wealth as the sum of several  
26 investments, the amount of utility they experience is positively related to the size of the realized  
27 gains/losses on the assets they are trading. The higher the distance between the purchase price and the  
28 price at which the stock is sold, the greater the utility burst (*Realization Utility Theory*). Ben-David and  
29 Hirshleifer (2012) confirm these results, empirically finding that the disposition effect is driven by the  
30 magnitude of the gains and losses experienced by investors instead of a simple direct preference for  
31 realizing gains relative to losses. The authors are concerned with overconfidence-driven speculation  
32 motive for trades as an explanation for this phenomenon (*Expectation Based Theory*).  
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47 <sup>1</sup>The way in which the reference point is evaluated is an on-going debate. Especially, the theories based  
48 on narrow framing often use different reference points for the evaluation of gains and losses (risk-free  
49 rate, zero return and size of gains/losses). A recent model from Hartzmark (2014) suggests to consider  
50 portfolio composition as the key to explain differences in how investors evaluate holding stocks. In  
51 particular, the author introduces the rank effect, showing the tendency of the subjects to take selling  
52 decisions comparing the trend of the stocks in their portfolio (e.g. closing extremely winning and losing  
53 positions).  
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However, the **Expectation Based Theory** does not entirely fit with our paper, since, as we present in Section 3, our experimental design excludes any possibilities to speculate or have private information on the securities that participants are trading with.

Therefore, even if there is no unanimous consensus on what is the best behavioural model in predicting the disposition effect, employing the basic ideas underlying other relevant models, for our purposes, Realization Utility Theory offers a convincing framework in the study of the heterogeneity bias among investors (Frydman et al. 2014). This is particularly relevant as the analysis of the phenomenon at an aggregate level masks considerable cross-section variation in the understanding of the trading behavior (Odean 1999). Surprisingly, very few attempts have been made to detect investor characteristics able to explain inter-individual differences in the disposition effect. Besides, to the best of our knowledge, most attempts **just considered demographic and psychological characteristics**. Chui (2010) demonstrated a negative correlation between disposition effect and the trait of locus of control, while Dhar and Zhu (2006) focused on financial wealth, professional occupation and educational background, to demonstrate that “high-income” and “professional” investors display lower disposition effect. These results are later confirmed by Da Costa et al. (2013) who highlight “trading experience” as a driver to reduce disposition behavior, with the students in their sample showing higher level of disposition bias than professionals. **For our reference, Durand et al. (2013) are the first to investigate the relation between the FFM and the disposition effect. Through an experimental analysis, in a sample of 115 students, the authors found a positive association between the traits of agreeableness and conscientiousness with the net realized gains.**

## 2.2 Personality Traits

In a perfect standardized environment where agents have the same information, experience and knowledge, the variation in decisions made by individuals reflects the differences in the way automatic mechanisms (often unconscious) drive various cognitive processes. Psychological literature (e.g. Fleeson 2001) organizes this heterogeneity in stable patterns of affects, behavior and cognition that take the name of personality traits. Thoughts, emotions, actions are all elements of personality traits (Kassin 2003). Within the wide scientific area embraced by this notion, psychologists, from the seminal work of Allport **in** 1921, started a gold rush to better define and measure the basic traits of human personality.

A long stream of theories succeeded over the years defining them as **stable** over time, different across subjects and able to influence **people's** behavior. A long stream of efforts developed measurement scales to provide a better picture of human complexity. Tupes and Christal' five-factor model (1961), in particular, defines the basis of Big-Five with neuroticism, extraversion, conscientiousness, openness to experience and agreeableness describing the key psychological characteristics of individuals. The model has the advantage to take into account, for each trait, various **non-overlapping** dimensions. For example,

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3 sub-levels of neuroticism include the tendency to experience unpleasant emotions like anxiety, fear and  
4 anger. Table 1 provides a detailed description of lower dimensions for the five personality factors.  
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12 The heterogeneity of the resulting psychological constructs beyond each of the five traits is also  
13 the main criticism directed at the Big Five model (Boyle 2008). The fact that the underlying  
14 psychological processes of each trait are not always orthogonal (Saucier 2002) raises concerns about the  
15 Big Five construct validity. However, the Big Five model appears to show consistency in describing  
16 normal personality trait sphere and its structure seems to find reliability across ages and cultures (Schacter  
17 et. al 2011).  
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21 The accuracy of the Big-Five theory is widely accepted in psychological literature and the  
22 assessment of each trait takes place mainly through self-reported questionnaire. Several studies  
23 established substantial evidence in using these personality measurements to explain heterogeneity across  
24 population. From caffeine consumption to learning process, social psychologists employed the  
25 questionnaire to analyze an endless list of behaviors, often combining various research fields (Ozer and  
26 Benet-Martinez 2006). Since their role in the **understanding of** individual differences in subjects'  
27 cognitive, emotional and motivational processes, the traits result as the key to detect the differences  
28 across subjects in decision-making.  
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### 36 37 *2.3 Disposition Effect and Personality Traits*

38 Some researchers have started to analyse the effect of personality traits on financial decision making (e.g.  
39 Fenton-O'Creevey et al. 2004; Grinblatt and Keloharju 2009; Grinblatt et al. 2011; **Durand et al. 2013**;  
40 Conlin et al. 2015). This paper leverages on Frydman et al. (2014), who use neural networks to test the  
41 reliability and the implications of the Realization Utility on the disposition effect. In particular, in  
42 describing the cognitive process behind the Realization Utility, they clearly identify several key  
43 psychological constructs that might affect individual investment behavior as they state: "*If an investor*  
44 *derives pleasure from realizing capital gains and, moreover, is impatient, he will be keen to sell stocks at*  
45 *a gain. Conversely, if he finds it painful to sell stocks at a capital loss and also discounts future utility at a*  
46 *high rate, he will delay selling losing stocks for as long as possible.*"  
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53 Let's focus on the differences in the way subjects respond to positive and negative stimulus, i.e.  
54 the rewarding and punishment sensitivity (Eysenck 1967) and consider a scenario where subject A and  
55 subject B have the same stock  $i$  in their portfolio. If subject A is more sensitive to rewards than B and an  
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3 increase in the price of stock  $i$  from its purchase level occurs, subject A may ascribe more value to that  
4 capital gain than subject B. The distance in how the value is encoded could lead the two individuals to act  
5 differently. In particular, we should expect that being more sensitive to rewards, subject A will be more  
6 likely to sell the stock at gain faster than B and *vice versa*. Moreover, the fact that in some cases rewards  
7 and punishments are considered reinforcers, could amplify their influence on individual investment  
8 behavior increasing the probability that the subject will behave consistently to obtain the same output.  
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13 However, the clear effect on the realization utility and consequently on the disposition effect, is  
14 not exclusive to reward and punishment sensitivity. The same relationship can also be interpreted looking  
15 at another psychological construct, i.e. the impulsiveness trait, which is underpinning a greater sensitivity  
16 to rewards (Eysenck 1967; Torrubia et al. 2001) and that leads subjects to act with little or no concerns for  
17 future consequences (VandeBos G. 2007). These two elements combined depict an impulsive individual  
18 who, acting with small regards about her behavior, sells stocks as soon as a capital gain occurs. While  
19 being impulsive might drive differences in the gain' side of the disposition effect, in the realm of losses,  
20 the traits of anxiety, and **more generally** of neuroticism, is at the base of a negative relationship with the  
21 bias among investors. Indeed, in experiencing an increase reaction to negative signals (Eysenck 1967;  
22 Torrubia et al. 2001), a neurotic might **not sell the stocks quickly at a loss** waiting for possible price  
23 increases that could reduce their unpleasant feelings.  
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31 The list of psychological facets that may affect the individual utility formation, and **in turn the**  
32 financial decisions, is long and straightforward. Reward/punishment sensitivity, impulsiveness and  
33 anxiety are just three constructs of broader dimensions that see systematic interactions among multiple  
34 factors (as extraversion, sensation seeking, conscientiousness, intellect and openness - Costa and McCrae  
35 1992). Therefore, in analyzing the impact of the psychological variables on the disposition effect, we need  
36 a framework proposing a complete and clear categorization of the personality profile. The Five-factor  
37 model (Tupes and Christal 1961) answers our needs and in the next paragraph we use it to model the  
38 relation between the personality traits and different levels of disposition effect.  
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#### 45 *2.4 Big Five Model and the Disposition Effect*

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47 During the last years, scholars identified relevant correlations between big five personality dimensions  
48 and risky behavior (Lauriola and Levin 2001; Nicholson et al. 2005; Lo et al. 2005; Mishra and Lalumiere  
49 2011). Unfortunately, the results are limited to the parametrization of risk-taking level for specific  
50 domains (health, financial, career, social, safety and recreational risk), and empirically it remains hard to  
51 explain the difference in the magnitude of the correlation between personality traits and risk-preferences  
52 reported by studies relying on experimental design and those based on self-reported questionnaire.  
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3 Although these limitations do not help in showing evidence of a stable pattern among personality traits  
4 and decision-making under uncertainty, some attempts have been made to detect which personality traits  
5 relate to real financial decisions. Conlin et al. (2015) document a positive association between the  
6 dimension of extraversion with the stock-market participation in terms of the number of securities (debt  
7 and asset) held by the investors. Moreover, in a sample of 118 investment bankers, Fenton-O’Creevey et  
8 al. (2004) find that high openness to experience and both low extraversion and neuroticism significantly  
9 correlate with better trading performance. Grinblatt et al. (2011) use a Finnish dataset to match individual  
10 trading records to a measure of intelligence (IQ), one of the main elements of openness to experience  
11 (Harris, 2004). Coherently with the findings of Fenton-O’Creevey et al. (2004), they show that  
12 intelligence predicts lower levels of disposition effect and high returns. In the opposite direction are the  
13 results from a previous work of Grinblatt and Keloharju (2009), who study the effect of sensation seeking  
14 in altering individual investment choices. An individual who scores high on sensation seeking exhibits  
15 preferences for adventure sports, drugs intake and illegal activities, and the trait has been always  
16 attributed to impulsive and extraverted subjects (Eysenck 1990; Zuckerman 1969). In particular, Grinblatt  
17 and Keloharju (2009) point out how sensation seeker investors show higher level of trading activity but  
18 exhibit higher levels of negative returns.

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21 Finally, Durand et al. (2013) are the first to analyze a relation between the FFM and disposition  
22 effect. The authors found a positive association between the traits of agreeableness and conscientiousness  
23 with the net realized gains. While the results from Durand et al. (2013) demonstrate a relation between  
24 disposition effect and personality, in the next paragraphs we focus on the behavioral mechanisms, behind  
25 the traits, able to explain how and which conditions the personality affect the disposition effect, both in  
26 the domain of gains and losses.

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29 To analyze the effect of four of the Big Five personality trait on disposition effect, we start from  
30 the cognitive underpinnings of the traits to depict the most frequent behaviors of a given personality  
31 profile. These behaviors/preferences are then linked to expected trading strategies that the subjects will  
32 adopt in line with their psychological characterization. Following Dhar and Zhu (2006) and Frydman et  
33 al. (2014), who document the absence of a correlation between selling winners and holding losers, and in  
34 line with the previous literature on personality and risky choices (Kahneman and Tversky 1979; Lauriola  
35 and Levin 2001), we then model how investment operations influence the levels of disposition effect  
36 among individuals and whether these changes are more pronounced in the gain or loss domain. We will  
37 not develop any hypothesis for the trait of Agreeableness as there is no evidence of any relationship with  
38 decision-making attitudes (Barrick et al. 2002),

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41 Since the seminal work of Depue and Collins (1999), extraversion has been increasingly linked to  
42 reward systems (Smillie 2013; Fletcher, 2013) showing how extroverts enjoy more intensely rewarding

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3 situations than other individuals (Costa and McCrae 1992). This excitement in obtaining immediate  
4 rewards over delayed rewards (Daly et al. 2009), a key facet of extraversion (Eysenk 1967; Zuckerman  
5 1969; Aluja et al. 2003), determines the monetization of capital gains as soon as they appear. After a burst  
6 of utility in experiencing a reward, extroverts usually reinforce the positive value ascribed to an  
7 object/behavior/status increasing the likelihood of repeating previous actions to reach similar appetitive  
8 goals. With respect to a raise in a stock price from its purchase level, the greater sensitivity to capital  
9 gains might motivate extroverts to quickly sell the stock every time a potential short-term profit shows up.  
10 The dependent trading pattern that results from this strategy could further strengthen the probability for  
11 these investors to record higher disposition effect. We can therefore hypothesize the following:  
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19 Hypothesis 1. *Extraversion is positively related to the magnitude of the disposition effect through the side*  
20 *of gains.*  
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24 In the realm of losses, while psychological theories predict null or negative low correlation  
25 between extraversion and sensitivity to punishment, a positive high relation with neuroticism has been  
26 highlighted (Zuckerman et al. 1999; Torrubia et al. 2001). In particular, Larsen and Ketelaar (1989) show  
27 how neurotic individuals exhibit an amplified reactivity just to punishment-induced affects but not to  
28 positive cues. The sub-trait of anxiety acts as the main dimension in pushing people to respond strongly  
29 to negative signals and to avoid behaviour that might result in negative outcomes. A decrease in the stock  
30 price is a typical non-reward experience that investors face during their trading session and can lead  
31 neurotic individuals to not close rapidly loss positions. Indeed, these subjects are highly inclined to  
32 postpone the monetization of their capital losses, gambling on potential price' increases that could reduce  
33 their hurtful feelings. We can therefore hypothesize the following:  
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42 Hypothesis 2. *Neuroticism is positively related to the magnitude of the disposition effect through the side*  
43 *of losses.*  
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47 Conscientiousness is usually a good predictor of high individual job/academic performance  
48 (Almlund et al. 2011; Burks et al. 2015) since, according to Costa and McCrae (1992) is composed of  
49 different constructs that lead people to act dutifully and efficiently. In particular, conscientious subjects  
50 tend to suppress impulsivity working for goals (even monetary) that are not immediate (Daly et al. 2009).  
51 Along with the self-discipline construct that is implicated in the attitude to make sacrifices in order to  
52 obtain higher rewards, the trait of conscientiousness underlies the ability to anticipate future outcomes  
53 from current choices. This capacity allows subjects to temporally discount the potential payoff over time  
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3 horizons and to alter their emotional response in favor of more convenient and less biased decisions  
4 (Camerer 2008). From the analysis of this trait, we thus expect that a non-impulsive investor might  
5 simply not sell stocks at the first gains, patiently waiting for higher cumulative returns even if it would  
6 mean to support some losses during the trading pattern. We can therefore hypothesize the following:  
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11 Hypothesis 3. *Conscientiousness is negatively related to the magnitude of the disposition effect through*  
12 *the side of gains and losses.*  
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16 Openness to experience drives to better job performance in a similar manner to conscientiousness, but  
17 through different processes and with higher intensity (Almlund et al. 2011). This trait underlies the main  
18 sub-dimensions of intellect, curiosity, imagination and exploration, and it is possible to recognize how  
19 openness to experience uses different cognitive channels to affect successful decision-making. Although  
20 subjects who score high on this trait do not always outperform the less open counterparts, they are better  
21 at activating learning orientation toward higher long-term knowledge and skill acquisition (Rolfhus and  
22 Ackerman 1999). Being very interested in what surrounds them, high open individuals also enjoy trying  
23 different approaches to doing things (Costa and McCrae 1992). In particular, Costa and McCrae (1992)  
24 show how this trait leads subjects to be less categorical in ideas and more willing to accept novelty. They  
25 are less locked into pre-conscious mechanisms and this reduces their chance to repeat dependent and  
26 harm-avoidance behaviors and allows them to act differently every time something new occurs. When  
27 they engage in decision-task with reward, open persons have more sensitivity not to the reward itself but  
28 to the value of information that they can use to yield positive outcomes. The adaptability in new context  
29 leads subjects who score high on openness to experience taking better decisions (Le Pine et al., 2000). In  
30 a trading perspective, whereas the facet of intellect guides to a general learning predisposition and  
31 superior investment performances (Grinblatt et al. 2011), we might expect a less biased strategy in  
32 subjects who score high on openness experience. Especially, following the characterization of the trait in  
33 the gain and loss domains (Lauriola and Levin 2001), we could observe slower closing activities for  
34 positive positions rather than negative. We can therefore hypothesize the following:  
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49 Hypothesis 4. *Openness to experience is negatively related to the magnitude of the disposition effect*  
50 *through the side of gains and losses.*  
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54 Table 2 summarizes the different hypotheses for Extraversion, Emotion Stability, Conscientiousness and  
55 Openness.  
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*Insert Table 2 about here*

### 3. The Experimental setting

Following a long and established tradition in decision-making research, we built an experimental design where individuals react to well specified investment settings. Using personality inventory surveys as well as trading simulations, we construct measures of personality traits for each subject, and we correlate these measures with trading records. Building on the findings of individualism-collectivism cultural differences (Triandis 2001), we selected our individuals with a cross-country empirical setting to increase the variation of personality traits in our observations. This point is relevant because a heterogeneous reduced amount of subjects might not promptly catch the effect of personality sub-dimensions (Lo et al. 2005). We therefore engaged 234 undergraduate and graduate students between the ages of 19 and 31, 176 from the School of Economics of the University of Bologna (Italy) and 54 from the School of Economics of the University of Wuhan (China). Volunteers were gathered through announcements during lectures, where students were told that a trading contest would be conducted by the Department of Management of the University of Bologna.

Before the experiment started, all participants were asked to complete a questionnaire collecting socio-demographic variables that are known to be associated with the disposition effect (age, gender, education, stock-market knowledge and experience), as well as the International Personality Item Pool (IPIP) NEO which has been calibrated with responses from over 20,000 individuals (Goldberg 1999). Based on these calibrations and considering our setting, we used the 50-item public-domain version which can typically be completed within 5–10 minutes (<http://ipip.ori.org>). The questionnaire reports 10 items for each of the big five personality dimensions: (1) Extraversion; (2) Agreeableness; (3) Conscientiousness; (4) Emotional Stability and (5) Openness to Experience. Participants describe themselves using a 5-point scale varying between disagreement (1 = very inaccurate) or complete agreement (5 = very accurate). After completing the questionnaires, the subjects were engaged in a trading simulation. The experiment was completely anonymous as all booking and informational communications were done through numerical codes as a unique identifier for each subject.

The trading game software was based on the Weber and Camerer (1998) experiment. Participants have the chance to trade 2000 € for 14 periods in six risky assets, generally labelled from A to F to avoid the potential effect of different asset classes on the disposition effect (Chang et al. 2014), and with stock prices randomly generated and not affected by the subjects' trading actions. Individuals monitor 5 types of stocks which vary according to the changes of a price-increasing/decreasing sequence as reported in Table 3 and with an absolute variation of the stock price between 1 and 5 Euro. Participants are instructed

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3 about the probabilities of all six assets to rise and fall, but they are not aware of share-probability scheme  
4 matching. A short tutorial has been provided at the beginning of each experiment.  
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7 Even if there is a long-established literature in behavioral finance using students as experimental  
8 subjects, (e.g. Weber and Camerer, 1998; Bassi, Colacito and Fulghieri, 2013; Durand et al., 2013;  
9 Frydman et al., 2014; Frydman and Rangel, 2014), the limitations of a non-professional cohort (e.g. Bello  
10 et al., 2009 and Peterson and Merunka; 2014) leads us to carefully control for potentials external validity  
11 issues. In particular, participants were incentivized to perform well during the experiment. In real life, the  
12 career and wealth of a trader depend directly by their financial outcomes. For the participants in this  
13 study, their success in the competition, depends on their performance in the trading simulation. The  
14 competition had a total worth of €330,00 each session, therefore all the subjects had strong incentives to  
15 perform the best they could. In particular, the reward system has been set on the highest realized gain.  
16 The best performer receives a total prize of 165€, the runner up 100€, the third and the fourth 50€ and  
17 15€, respectively.  
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20 Finally, all students were informed that the chance to win the prizes was based also on the  
21 accuracy in answering the queries in the questionnaire. In case of clear random answers or inconsistency,  
22 the financial records from the participant would not be considered for the final rewards.  
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31 *Insert Table 3 about here*  
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34 The simulations begin with the software automatically generating the first 4 periods to provide  
35 the participants with the initial stock price path. Figure 1 illustrates an example of the stock prices  
36 evolution showed in the main screen of the simulation website.  
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41 *Insert Figure 1 about here*  
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44 Participants then trade for 14 periods of maximum 2 minutes each and the software takes the  
45 participant automatically to the next trading period after the 2 minutes, unless the participant decides to  
46 move early to the subsequent period. A short 4-period trial session of the simulation is provided to allow  
47 participants to familiarize with the software. Our final data set contains trading records from various  
48 experimental sessions run between May 2014 and November 2014. We excluded 4 participants who  
49 executed only buying trades during the simulation, thus leaving us with a total of 230 individuals. The  
50 voluntary basis of the participation in the trading competition lead us to experience unbalanced  
51 observations in terms of gender (90 females vs. 140 males) and country origin (176 Italian vs. 54 Chinese)  
52 which is accounted for in the analyses.  
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## 4. Data

### 4.1 Summary Statistics: Demographics and Personality Traits

Table 4 reports summary statistics of demographics and personality traits for our entire sample. Age varies between 19 and 31, with a mean value of 22. 112 participants were undergraduates, 111 graduates and 7 subjects had just passed their master diploma and were enrolled in PhD courses. As for their stock market knowledge, 119 participants declare that “My field of education is not related to trading in investment instruments, neither I hold/held a job position in this field”, 107 that “Only my education is related to trading in investment instruments” and just 4 subjects answer “In the last ten years I held/or I hold a job position in the financial sector”. Finally, as for their trading experience, 193 have never invested before, 17 have traded once a year, 11 once every three months and only 9 every month.

On average participants scored 33.66 on extraversion, 38.18 on conscientiousness, 30.97 on emotion stability, 35.31 on agreeableness and 37.17 on openness. We compared these findings with what reported by McAdams and Donnellan (2009). The authors used the IPIP to measure the personality scores for a large sample of first year students at a large university (n=529).

Their results were: extraversion 35.1, conscientiousness 36.3, emotion stability 32.0, agreeableness 36.6 and openness 33.8. The scores of our cohort are in line with the research of McAdams and Donnellan (2009), in particular, our results are slightly higher on conscientiousness and openness and lower on extraversion, emotion stability and agreeableness.

In line with previous literature on gender differences among personality traits (Feingold 1994), females score higher on conscientiousness than males ( $p < 0.01$ ). Men and women seem to differ also on emotion stability, where females score lower than males ( $p < 0.01$ ). No statistically significant differences in the personality traits raw scores are found between Chinese and Italian subjects. These results lead us to consider our sample as quite homogeneous, even with respect to trading experience and knowledge, and they seem to suggest a personality profile for subjects who want to engage or are interested in trading activities.

*Insert Table 4 about here*

Table 5 reports the correlation coefficients and we can see that the sign of the pairwise correlations among personality traits are coherent with the results of the meta-analysis on 212 Big Five studies conducted by Van der Linden et al. (2010), except for the one between agreeableness and extraversion which is here negative instead of positive. Gender has a positive significant correlation with

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extraversion (0.17 p<0.01), emotion stability (0.22 p<0.01) and openness to experience (0.18 p<0.01). Consistent with the evidence of higher academic performance for conscientious subjects (Almlund et al. 2011), conscientiousness relates with the level of education positively (0.22 p<0.01) while negatively with the knowledge on financial markets. The level of knowledge of financial markets has also a negative correlation with the traits of extraversion (-0.14 p<0.05), emotion stability (-0.13 p<0.05) and a positive one with trading experience (0.14 p<0.05). Finally, the correlation between openness to experience and trading experience is positive (0.17 p<0.01).

*Insert Table 5 about here*

#### 4.2 Summary Statistics: Disposition Effect

Following Odean (1998) the level of disposition effect varies between -1 and 1 and is computed as the difference between the Proportion of Gains Realized (PGR) and the Proportion of Losses Realized (PLR). PGR (PLR) are expressed as a ratio of realized gains (losses) over the sum of paper and realized gains (losses).

$$DE = PGR - PLR \quad (1)$$

where PGR and PLR are respectively:

$$PGR = \frac{\text{Realized Gains}}{\text{Realized Gains} + \text{Paper Gains}} \quad \text{and} \quad PLR = \frac{\text{Realized Losses}}{\text{Realized Losses} + \text{Paper Losses}}$$

For paper gains or losses, the reference is the number of securities not sold in the portfolio. Whether there will be a paper gain or loss is determined by comparing the high and low price for that day/period with the purchase price. If the disposition effect level is greater than 0 (PGR ratio is greater than PLR) the investor is selling winners too soon and/or holding losers too long, and vice versa if it is smaller than 0 (PGR ratio is smaller than PLR). When the disposition effect equals to 0 (PGR is equal to PLR) the investor ascribes the same value to gains and losses and he is indifferent in closing/riding capital gains or losses.

*Insert Table 6 about here*

Table 6 reports summary statistics for the disposition effect levels among our sample of 230 subjects. The mean of PGR, PLR and DE are 0.36, 0.34 and 0.02, respectively. As from Figure 2, in

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3 which we present the distribution of the DE, almost 45% of individuals do not exhibit DE or reveal an  
4 opposite behavior to the disposition bias.  
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8 *Insert Figure 2 about here*  
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11 Compared to previous research (e.g. Weber and Camerer, 1998), the shorter time-frame of our  
12 experiment is a potential explanation for the lower disposition effect level of our sample. Following the  
13 main proposition of Dhar and Zhu (2006) where the trading frequency negatively correlates with DE  
14 levels, in Table 6 we find that subjects who trade less frequently are more inclined to DE bias. In  
15 particular, we believe that the reduced time in which participants could trade pushed them to amplify the  
16 number of operations performed. In our sample, we show on average high frequency in the trading  
17 activities performed by the participants. The mean of the not-invested cash during the simulation is  
18 505.42 € and the number of trades executed by the subjects is 26 (around 2 operations for each period). In  
19 preferring higher trading frequency, on average students monetize capital gains when they experience a  
20 3% positive return and they usually close negative positions with a 2.2% negative return.  
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27 Another potential motivation for the documented low DE level might be that the experiment  
28 rewards only the top performers, leaving no different payoffs to the remaining participants. In particular,  
29 subjects with low performances might be encouraged to change their trading behaviour in the last periods  
30 of the simulation, taking more risk as a final chance to increase the returns and win a prize without losing  
31 anything. Indeed, these investors might be prone to close rapidly all their negative positions, betting the  
32 available budget on the current winners until the end of the simulation. This strategy, increasing the  
33 number of realized losses and the number of paper gains would in turn reduce the disposition effect. We  
34 test for this potential bias comparing the investment behaviour between subjects with low and high  
35 performances. We analyse whether the two subsamples differ in the trading activities performed next to  
36 the end of the simulation (last three periods) with respect to the investment style followed during all the  
37 simulation session, but we did not observe any statistically significant difference. During the last three  
38 periods of the simulation, the entire sample exhibits a tendency to reduce the number of stocks bought,  
39 while no differences are highlighted in the quantity of stocks sold and in the type of stocks traded, and  
40 low performance subjects keep their investment strategy stable over time.  
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50 In line with previous works (Dhar and Zhu 2006; Frydman et al. 2014) PGR and PLR show a  
51 negligible and non-significant correlation (0.115) confirming that the variation in the disposition effect  
52 among investors is better understood as a combination of separate psychological mechanisms governing  
53 selling behaviors in case of gains and losses. Consistently, Figure 3 shows how subjects who exhibit an  
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3 attitude to quickly close positions at gains do not necessarily behave in the same way in the loss domain.  
4 Similarly, those who delay cash gains unlikely ride longer positions at loss.  
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8 *Insert Figure 3 about here*  
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11 While we do not find any association between DE and gender, age and cross-country differences,  
12 disentangling the two components of the DE, we notice that Chinese sells more losers and winners stocks  
13 than Italians ( $PLR_{China}=0.46$ ;  $PGR_{China}=0.48$ ;  $PLR_{Italy}=0.30$ ;  $PGR_{Italy}=0.32$ ;  $p<0.001$ ). This result is in line  
14 with Statman (2008), who investigates the impact of cultural differences in the approach to investing,  
15 conducting a survey over 22 countries and over 4000 subjects to analyze how different religious, social  
16 and ethic belief/values affect the individual risk-preferences in a financial setting. This paper shows that  
17 people from more individualistic countries (Italy, Israel, United States, UK, Germany, Norway and  
18 Switzerland) are more risk-averse than those from collectivistic regions such as China, India, Vietnam,  
19 Taiwan but also France and Holland. In explaining **this insight**, the author relates to the “cushion  
20 hypothesis” introduced by Hsee and Weber (1999), in which the higher risk propensity in collectivistic  
21 societies is driven by a strong group-cohesion leading individuals to feel protected (safe cushion) in case  
22 of failure and that **motivates** their higher trading activity.  
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### 32 *4.3 Bayesian Optimal Trading Strategy*

33 We now characterize the optimal trading strategy for a risk-neutral Bayesian investor whose objective is  
34 to maximize the expected value of his earnings. According to Weber and Camerer (1998): *“The optimal*  
35 *Bayesian method corresponds to a simple heuristic way to judge which of the six stocks has which trend:*  
36 *count the number of times a share rose in price. The share with the most price increases is the most likely*  
37 *to have the trend ++; the share with the second highest number of price increases is most likely to have*  
38 *the trend +, etc.”* Therefore, an investor who uses a Bayesian optimal strategy will count at period 4 (the  
39 beginning of the experiment) the number of times each share rose in price and then will select the stock  
40 (or the stocks) with the highest number. For each period after the fourth, the investor will update his count  
41 and, based on that, he will adjust his portfolio composition.  
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49 For example, if at period 4 (at the beginning of the experiment) we observe that stocks “A” and  
50 “B” have risen in price 3 times, “C” and “D” only 1 time while “E” and “F” have only dropped in value,  
51 we may imply that stock “A” or “B” or both are more likely to have a ++ trend. Building the investment  
52 strategy on this heuristic, the expected-value subject will only equally invest in stock “A” and “B”.  
53 Suppose that at period 5 “A” shows a price increase while B exhibits a downturn. Now stock “A” has the  
54 highest number of price increases (4, while “B” still has 3) and is more likely to have the trend ++. At  
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3 period 5 the Bayesian trader will close the position in “B” and will buy more shares of “A”. The investor  
4 will repeat the same strategy in each and every next period.  
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7 The optimal strategy thus involves selling winners rarely and selling losing stocks more often,  
8 generating the opposite of the disposition effect. In particular, according to the sequence of prices in our  
9 experiment design, the difference between PGR and PLR for a Bayesian investor is -0.84. An expected-  
10 value trader will manifest high propensity to sell stocks at loss more quickly than stocks at gain. Across  
11 our sample, we find that the measure of PGR and PLR are 0.36 and 0.34 respectively. This implies a  
12 disposition effect value of 0.02, which, even if not significantly different from 0, is positive and  
13 significantly greater than the benchmark expected value of -0.84 ( $p < 0.001$ ).  
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20 *Insert Table 7 about here*  
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23 In particular, from Table 7, we show that, in contrast to the optimal trading strategy that a  
24 Bayesian investor could follow, the subjects exhibit a tendency to buy the stock with the trend “0” and to  
25 sell the stock with the trend “-“. These trading choices contrast with those of a Bayesian investor. For  
26 example, whilst the optimal strategy involves to construct a portfolio picking the “++” stock, in our  
27 sample subjects on average open positions with “0” stock.  
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32 *Insert Figure 4 about here*  
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36 Figure 4 provides some additional insights to the distance between our sample’ selling behavior  
37 and the one of the “optimal” expected value investor. The figure shows how our subjects’ preferences  
38 deviate from optimality, in terms of selling trading decisions. Following an expected-value trading  
39 strategy, on average the participant should realize gains on 2 occasions, demonstrating that almost 60% of  
40 our sample’ decisions to monetize capital gains are suboptimal. Again, the design of the experiment,  
41 based on short-term price momentum (Weber and Camerer 1998) encourages participants to keep stocks  
42 that are performing well in their portfolio and not to hold a stock at loss. This justifies sub-optimality in  
43 the 23% of subjects’ decisions to hold winning stocks and in more than 90% of participants’ decisions to  
44 hold losers.  
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## 50 51 **5. Results** 52

### 53 54 55 *5.1 Personality Traits and the Disposition Effect* 56 57 58 59 60

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3 From descriptive statistics and the correlations reported above, the heterogeneity in the elaboration of a  
4 strategy to realize losses and gains seems to be driven by the effect of inter-individual differences on  
5 various decision processes. To test this hypothesis and simultaneously control for the different factors  
6 described in Section 4, we run the following model:  
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$$DE = \alpha + \beta PT + \gamma X + \delta TF + \varepsilon \quad (2)$$

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11 where the level of disposition effect (DE) is defined as in Equation (1), PT is a vector of individual raw  
12 scores for each of the five personality dimensions (*extraversion, conscientiousness, emotion stability,*  
13 *agreeableness* and *openness to experience*), X is a vector of the different control variables (demographic,  
14 country of origin, stock-market knowledge and trading experience) and TF is uninvested cash, i.e. the  
15 budget that participants did not use during the simulation. Due to the censored nature of our dependent  
16 variable, we use Tobit regression to estimate our model and results are reported in Table 8.  
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29 In the baseline model (Column 1), consistent with Hypothesis 1, the coefficient of extraversion is  
30 positive and highly significant suggesting that extroverts are more likely to express a disposition effect  
31 than other individuals. Results also support Hypotheses 3 and 4. The traits of conscientiousness and  
32 openness to experience are negatively correlated with the disposition effect, demonstrating that, the  
33 behaviors based on a long-term goal achievement, low impulsivity and learning/explorative mechanisms  
34 reduce the costly bias. However, we do not find any significant role played by the trait of emotion  
35 stability, and especially of its sub-dimension anxiety, on the explanation of different levels of disposition  
36 effect.  
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42 The coefficient for the control variable “uninvested cash” is negative, confirming what was  
43 reported in Dhar and Zhu (2006) where the “trading frequency helps investors become more willing to  
44 sell losers, in turn reducing their DE”. Demographic characteristics, such as gender, country of origin,  
45 education, stock-market knowledge and trading experience, have no statistically significant effect on  
46 disposition effect, nor do the interaction variables between personality traits and the country dummy.  
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50 Columns 2 to 6 show the output of a reduced model where each personality variable is included  
51 without all the others. The results are similar to those in Column (1). In line with Mayfield et al. (2008),  
52 who use the Big Five taxonomy to understand students’ preferences on short-term/long-term investment  
53 intentions, we report a positive correlation between the trait of extraversion and the attitude to engage  
54 (avoid) short-term (long-term) investments (Column 2). As for extraversion, Columns (3) and (4) confirm  
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3 our propositions when just the traits of conscientiousness and openness to experience are respectively  
4 included in the regression. Whereas psychology studies link the openness to experience to the intellectual  
5 curiosity and intelligence (Harris, 2004), our results are in line with Grinblatt et al (2011), who document  
6 a negative correlation between disposition effect and IQ measures.  
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10 Our results hold both when we use alternative measures of DE, as in Dhar and Zhu (2006), and  
11 when we employ different regression models (Probit and OLS).<sup>2</sup> For robustness, we also run the  
12 regression in equation (2) for the Italian and Chinese sub-samples separately. Even if there is a drop in the  
13 statistical significance (mainly due to the sample size reduction), in both the cohorts all personality traits  
14 maintain the same direction in explaining the heterogeneity in disposition effect. Finally, as a potential  
15 concern, one may argue that the correlation within personality traits and between personality and  
16 demographics variables may produce multicollinearity problems and bias our findings. Specifically, Table  
17 5 displays a modest correlation between extraversion and conscientiousness (0.16). To separate the  
18 impact of these two variables and avoid multicollinearity issues, we substitute the variable extraversion  
19 with the residuals of the regression between extraversion and conscientiousness. The new variable  
20 therefore only captures the marginal explanatory power of the extraversion relative to what is already  
21 explained by the variable conscientiousness. We use this approach for each significant inter-correlation  
22 between our independent variables, but no significant changes are detected and our findings remain  
23 consistent.  
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### 34 *5.2 Personality Traits and the Proportion of Gains and Losses realized*

35 To better analyze and test our predictions on the role of personality traits in altering individual investment  
36 behavior we further disentangle the disposition effect focusing on the attitude to ride losers and winners  
37 separately. Especially, we are interested in observing whether the role of personality traits differs in  
38 explaining the financial decision-making in the domain of gains and losses. We therefore use the  
39 Proportion of Gains realized (PGR) and the Proportion of Losses realized (PLR) as dependent variables  
40 and run the same Tobit regression models specified in equation (2). Results are reported in Table 9.  
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47 *Insert Table 9 about here*

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50 Consistent with our hypotheses, we find a specific pattern among the traits of extraversion,  
51 conscientiousness and openness in influencing individual investment behavior. The coefficients in  
52 Column 1 show that extraversion and conscientiousness have a role in increasing and decreasing the  
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56 <sup>2</sup>The authors define the DE as (RG/RL) (PG/PL), where RG and RL are the number of sales of winners and losers,  
57 respectively and PG and PL are the number of paper gains and losses. This measure avoids the potential scaling bias  
58 in the computation defined by Odean (1998).  
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3 number of capital gains realized during the simulation. The coefficient of openness to experience is  
4 negative, thus showing that open subjects are not in rush to sell winners. Our hypotheses are also  
5 supported when looking at the coefficients reported in Column (2) that do not point to an attitude to close  
6 rapidly losers for the traits of extraversion and conscientiousness but for openness to experience. In line  
7 with our Hypothesis 4, we find indeed that those who **score high** on openness to experience keep winners  
8 in their portfolio longer than losers. Columns (1) and (2) confirm what emerged from descriptive  
9 statistics, i.e. that Chinese participants close more positive and negative positions than Italians. Finally,  
10 the amount of not-invested cash positively relates with the PGR and PLR. In particular, from Column (1)  
11 in selling a stock with a positive return the participant increases significantly the budget available to  
12 operate in the market, while, from Column (2), when a subject closes negative positions the increase in  
13 the not-invested cash is less strong.

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21 Other individual demographic characteristics, such as gender, education, stock-market knowledge  
22 and trading experience are not associated with the tendency to ride losers and winners (we find a small  
23 effect of gender only for the loss domain,  $p < 0.1$ ). As for the previous analysis, interaction variables  
24 between personality traits and the country dummy do not reveal any significant effect both on PLR and  
25 PGR. The results hold also employing OLS and Probit models and taking into account each of the big five  
26 personality traits individually. Our insights do not change also when we treat potential collinearity  
27 problems from the correlations among the dependent variables using instrumental variables.

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33 These results show that DE may be driven by two distinct psychological processes, one related to  
34 holding losers and the other to selling winners. We find that these two behavioral mechanisms are  
35 uncorrelated and influenced by different personality traits. In particular, we show: 1) a greater sensitivity  
36 of the rewarding system that motivate extroverts to quickly sell the stock at gain in order to receive a  
37 burst of utility; 2) a tendency for conscientious subjects to suppress impulsivity not selling the security as  
38 soon as it experiences an increase in the price while patiently waiting for higher cumulative returns; 3) an  
39 ability for people who score high on openness to experience to work efficiently ascribing more value to  
40 the new information that they can use to obtain better outcomes.

## 41 42 43 44 45 46 47 **6. Discussion and conclusions**

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50 Using personality inventory surveys as well as trading simulations, we model the role of personality traits  
51 **to explain** the heterogeneity in DE among investors. We build on Realization Utility Theory and Big Five  
52 Model to depict trading strategies that the subjects will adopt in line with their psychological  
53 characterization.  
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3 Although the existing literature demonstrates a wide tendency of investors to sell quickly stock at  
4 gains rather than at losses, our results document that almost half of the sample does not show a positive  
5 disposition effect. We investigate the drivers of this high variation in an individual psychological  
6 perspective. At odds to the usual picture of successful investors who trade aggressively and impulsively,  
7 we find that personality traits, like extraversion and conscientiousness, are respectively positively and  
8 negatively related with the biased financial behavior. In line with Fenton-O’Creevey et al. (2004) and  
9 Grinblatt et al. (2011) we find that less biased traders tend to be open to new experiences and less locked  
10 into pre-conscious mechanisms that lead them to repeat the same action over time.

11  
12 We document that personality traits influence the disposition effect by two distinct psychological  
13 processes, one dealing with holding losers and the other with selling winners. In particular, extraverted  
14 subjects have more chances than other individuals to ride losses instead of gains. Consistent with the  
15 evidence of higher sensitivity to rewarding system, extroverts respond strongly to immediate rather than  
16 postponed rewards. Subjects who score high on conscientiousness are instead less likely to be affected by  
17 “hot” impulse to monetize capital gains as soon as they appear. In obtaining higher rewards, they alter  
18 their emotional response and take the decisions that are more remunerative in the long term. These  
19 findings also show the ability of people who score high on “openness to experience” to work efficiently  
20 using new information to change trading strategies and obtain better payoffs. We also find that the same  
21 trait influences individual investment behavior both for gains and for losses, leading subjects to keep  
22 winners in their portfolio longer than losers.

23  
24 Among the demographic variables taken into account in our paper, we found that trading  
25 experience slightly moderates the role of personality traits in explaining the disposition effect level among  
26 the subjects. The small size of the effect detected may be due to a lack of power due to limited number of  
27 experienced investors in our sample. In a larger one or in one including also professionals’ traders, the  
28 effect of trading experience in altering the correlation between personality and investment behavior may  
29 become more pronounced. Moreover, employing an accurate analysis on traders’ real financial records  
30 might offer a better control for some other possible drivers, such as taxes, transactions costs and  
31 information asymmetry (Odean, 1998) excluded from our experimental setting. Even if we improved the  
32 external validity of our sample with a specific experimental design, we believe that the relation between  
33 personality traits and disposition effect begs for additional “real” data, particularly in light of Fenton-  
34 O’Creevey et al.’s (2004) where the trading performances of investment bankers have been studied.

35  
36 Our insights seem to suggest a specific “personality profile” less affected by the disposition effect  
37 that is coherent, for example, with previous studies on conscientiousness and high income (Boyce and  
38 Wood, 2011). The fact that personality traits explain part of the disposition effect variation among a  
39 population suggests an implementation of the behavioral models that describe anomalies in asset pricing  
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3 as naïve diversification and excessive trading. Especially, investigating whether the Five Factor Model  
4 affects higher/lower number of trading operations and/or differences in the portfolio composition (e.g.  
5 Brown and Taylor, 2014) offers insights for future analyses.  
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8 Our experimental design leads us to question the relation between personality traits and  
9 disposition effect over longer time horizon. We believe that, increasing the time frame in which analyze  
10 the financial records, we could observe more complete individual investment strategies. For example, in  
11 terms of trading frequencies (Dhar and Zhu, 2006; Kumar and Lim, 2008), we believe that a longer  
12 horizon will give us the chance to report a pronounced relation between personality traits and disposition  
13 effect, especially for the traits whose influence needs more stimuli to emerge (e.g. anxiety as in McCrae  
14 and Costa, 1992). Again, considering the trading volume, a larger variation in the magnitude of the trades'  
15 value could stimulate the sensitivity to reward differently, in turn affecting the timing of capital gains'  
16 monetization. Finally, from the literature on disposition effect and types of securities exchanged (Kumar,  
17 2009 and Chang et al., 2016), in a bigger trading window, we could observe how the personality traits  
18 influence the disposition effect when stocks, mutual funds and bonds are taken into account separately.  
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26 The specific interaction between personality traits and disposition effect deserves further  
27 investigations in terms of external factors. For example, from McCrae and Costa (1992) it should be  
28 interesting to test whether the introduction of a corporate news announcement or market events, moderate  
29 the intensity of the relation between the Five Factor Model and the disposition bias. Again, the evidence  
30 of individual psychological states **orientation** as a strategic outlook that people have in decision making  
31 (Higgins, 1997) leads to speculate about the influence of retrieving information processes (implicit  
32 memory, past experiences and context) in the relation between personality and individual financial  
33 choices.  
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39 Finally, our findings are also important for the investment firms and financial companies. On the  
40 one hand, professional investors might be interested to leveraged on the different personality profile to  
41 fine-tune their recruiting strategy. On the other hand, identifying a personality profile less influenced by  
42 the disposition effect might motivate financial advisors to make investors aware of such bias and help  
43 them to obtain better performances. Indeed, an investor who is informed about the consequences of the  
44 disposition effect could be triggered to close fast the negative positions, deduct the losses in tax filing,  
45 and increase the portfolio after-tax performance.  
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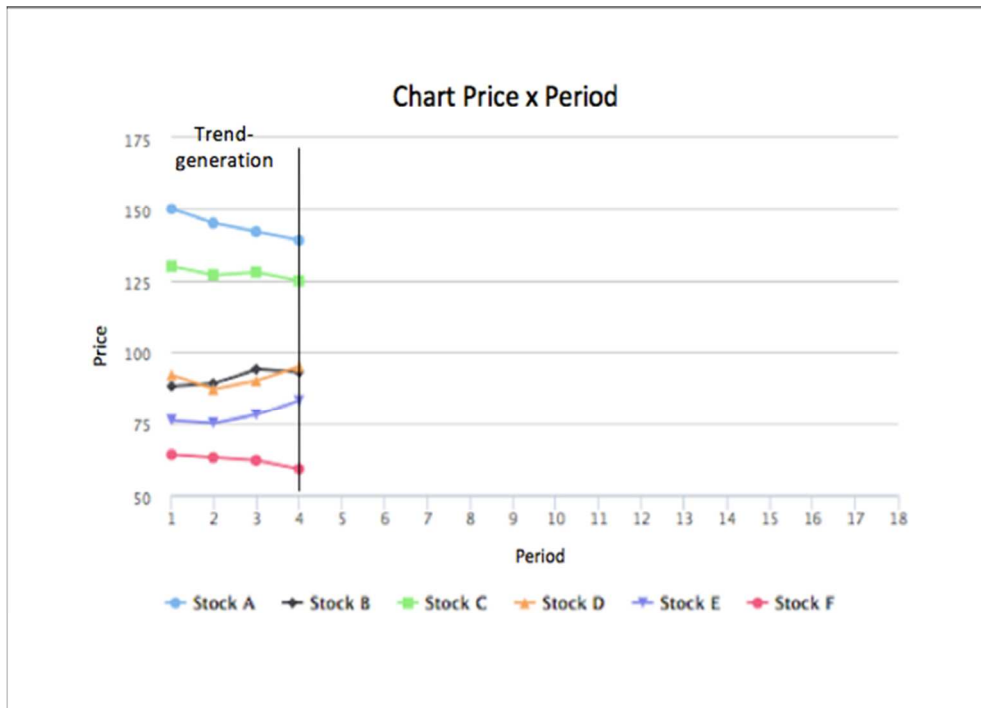
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Figure 1  
Chart price/period

Figure 1 shows the visual outcome of the price path generated by the simulation software. The whole period is divided into 18 sub-periods, 4 of which are not generated for trading purpose but only for allowing the participants to estimate the likelihood of future stock price increase.

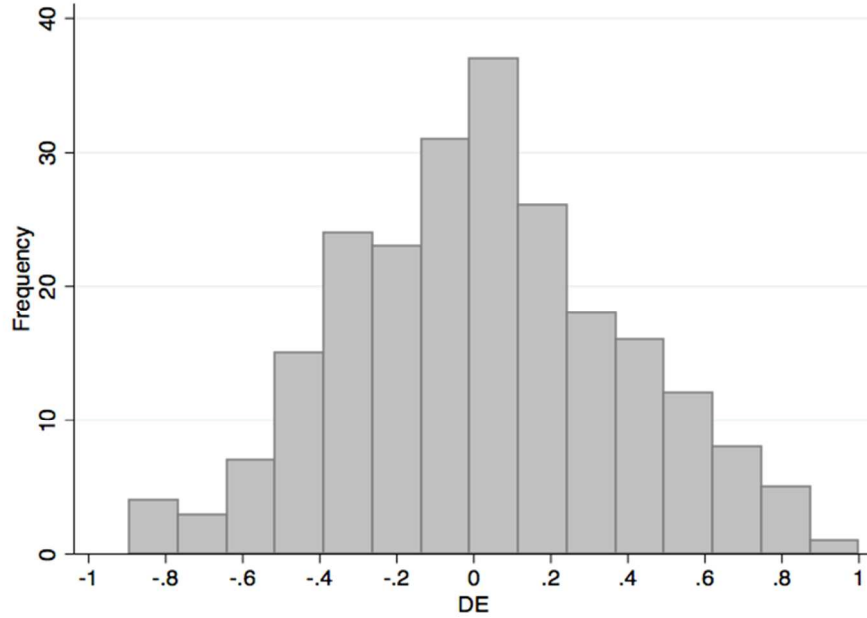


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**Figure 2**

**Distribution of Disposition Effect (DE) across the sample.**

The figure shows the distribution of the disposition effect levels across the participants. On the x-axis there is the disposition effect level while on y-axis there is the distribution frequency.

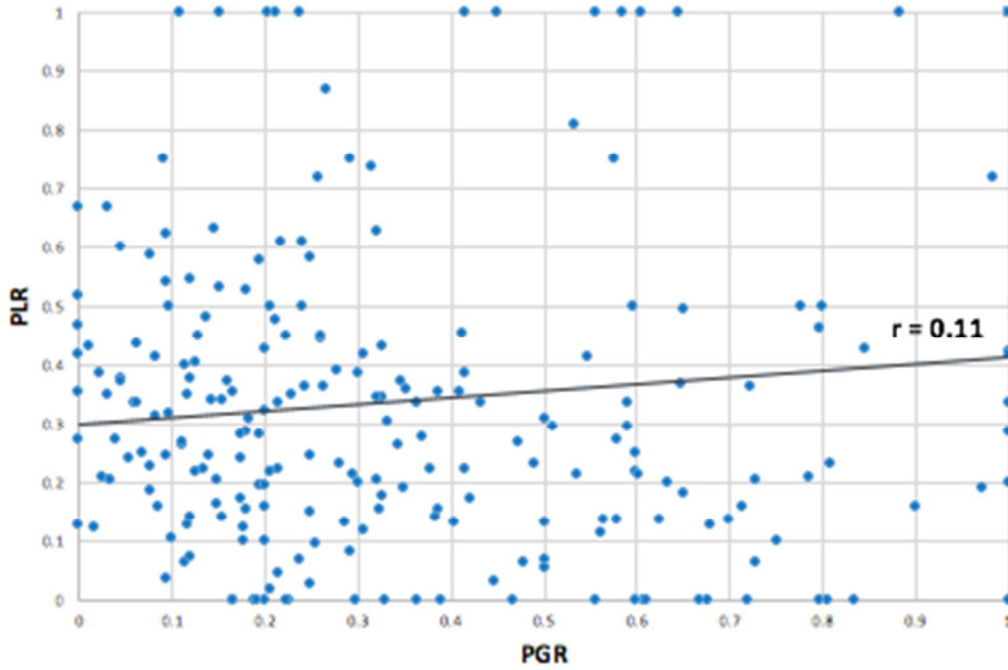


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Figure 3

Correlation between PGR and PLR.

The scatter plot relates the PGR (x-axis) to the PLR (y-axis). Each point represents a single participant.

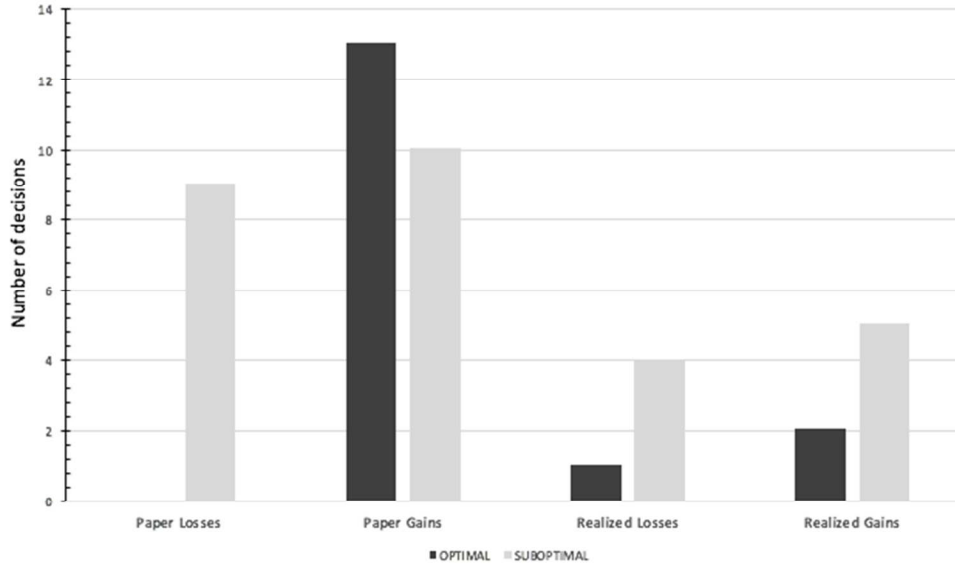


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**Figure 4**

**Number of sell decisions: optimality and sub-optimality.**

Figure 4 illustrates the number of sell decisions by type (realized gains, realized losses, paper gains, paper losses). The optimal number of decisions is based on a Bayesian strategy that involves buying the stock that has exhibited in the previous periods the larger number of price increases and selling all the other stocks; the suboptimal decision is any other choice different from the optimal.



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**Table 1 Big Five Personality Traits**

This table presents all the facets within each of the five personality traits of the Five Factor Model. The list of adjectives are from McCrae and Costa (1996) and from John and Srivastava (1999)

| <b>Five Personality Traits</b>        | <b>Constituent Traits (adjectives)</b>  |
|---------------------------------------|---|
| Extraversion (Introversion)           | Outgoing, energetic, sociable, friendly, talkative, assertive, enthusiastic, gregarious.          |
| Conscientiousness (Careless)          | Efficient, organized, prepared, dependable, self-disciplined, not careless, respectful of duties. |
| Openness to Experience (Cautiousness) | Inventive, curious, unconventional, excitable.  |
| Neuroticism (Emotion Stability)       | Anxious, irritable, shy, moody, not self-confident, depressed, tense, stressed out.               |
| Agreeableness (Antagonism)            | Modest, not demanding, warm, altruistic, generous, not stubborn, likeable, enjoyable.             |

**Table 2 Hypotheses relationship between personality traits and disposition effect**

This table reports, for each of the five personality trait, the main characterizations, the expected behavior and the hypothesis relative to their effect on the level of disposition effect.

| <b>Personality Trait</b> | <b>Extraversion</b>                             | <b>Conscientiousness</b>                                      | <b>Openness</b>   | <b>Emotion Stability</b>           | <b>Agreeableness</b>                                   |
|--------------------------|---|---|---|------------------------------------|--|
| <b>Domain</b>            | Rewarding System                                | Impulsivity system  | Willingness to novelty  | Punishment System                  |  |
| <b>Effect</b>            | Immediate rewards over delayed rewards          | Suppress impulsivity working for goals that are not immediate | Sensitivity to new information & less harm avoidance behavior | Weaker respond to negative signals | Plays a weak role in decision-making under uncertainty |
| <b>Expected behavior</b> | Monetize capital gains as soon as they appears. | Waiting in selling stocks at gain                             | Closing quickly negative positions                            | Closing faster negative positions  |  |
| <b>Expected DE sign</b>  | +   | -   | -   | -                                  |  |
| <b>Expected side</b>     | Higher number of gains realized                 | Lower number of gains realized                                | Higher number of losses realized                              | Higher number of losses realized   |  |

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**Table 3 Stock-price evolution mechanism**

The Table describes the mechanism behind the price updates of each type of stocks.

| Type of stock | Probability of a price increase | Probability of a price decrease |
|---------------|---------------------------------|---------------------------------|
| --            | 35%                             | 65%                             |
| -             | 45%                             | 55%                             |
| 0             | 50%                             | 50%                             |
| +             | 55%                             | 45%                             |
| ++            | 65%                             | 35%                             |

**Table 4 Summary Statistics - Socio-demographic and Personality**

The Table reports descriptive statistics on demographics and personality traits variables for the entire sample.

|                        | Obs | Mean  | Median | St. Dev. | Min.  | Max.   |
|------------------------|-----|-------|--------|----------|-------|--------|
| Demographics           |     |       |        |          |       |        |
| Age                    | 229 | 22.48 | 22.00  | 1.95     | 19.00 | 31.00  |
| Education              | 230 | 1.54  | 2.00   | 0.55     | 1.00  | 3.00   |
| Stock-Market Knowledge | 230 | 1.50  | 1.00   | 0.54     | 1.00  | 3.00   |
| Trading Experience     | 230 | 1.32  | 1.00   | 0.84     | 1.00  | 5.00   |
| Personality traits     |     |       |        |          |       |        |
| Extraversion           | 230 | 33.57 | 34.20  | 5.50     | 18.00 | 47.500 |
| Conscientiousness      | 230 | 38.25 | 38.70  | 5.43     | 20.00 | 50.00  |
| Openness               | 230 | 37.21 | 37.50  | 5.41     | 24.00 | 49.20  |
| Emotion Stability      | 230 | 31.14 | 30.80  | 7.22     | 13.00 | 48.30  |
| Agreeableness          | 230 | 35.38 | 35.80  | 5.37     | 17.50 | 48.20  |

Age is the age of the participant. Education is a categorical variable taking the following values if the participant: 1 is undergraduate; 2 is graduate; 3 is a post-graduate student. Stock market knowledge is a variable taking values of 1 whether participant has not knowledge on financial markets, 2 if he has a background education in finance or related areas and 3 if he works/worked for stock-market services. Finally, trading experience takes the following values of: 1 if the participant has never invested; 2 if he invested just one time; 3 whether she/he invested for maximum one year; 4 for maximum three years; 5 if he invested for more than three years.

**Table 5 Correlations: The Big-Five**

This table contains the pairwise Pearson correlations among the Big Five trait values and the pairwise Pearson correlation among the demographics variable and between the Big Five traits and the demographics variables.

| Personality Traits |              |                   |          |                   |               |
|--------------------|--------------|-------------------|----------|-------------------|---------------|
|                    | Extraversion | Conscientiousness | Openness | Emotion stability | Agreeableness |
| Extraversion       | 1.000        |                   |          |                   |               |
| Conscientiousness  | 0.157*       | 1.000             |          |                   |               |
| Openness           | 0.341**      | 0.355**           | 1.000    |                   |               |
| Emotion Stability  | -0.034       | 0.140*            | 0.067    | 1.000             |               |
| Agreeableness      | -0.127       | 0.414**           | 0.075    | 0.236**           | 1.000         |

| Personality and Demographics |              |                   |          |                   |               |
|------------------------------|--------------|-------------------|----------|-------------------|---------------|
|                              | Extraversion | Conscientiousness | Openness | Emotion Stability | Agreeableness |
| Gender                       | 0.175**      | -0.046            | 0.184**  | 0.224**           | -0.104        |
| Education                    | 0.102        | 0.211**           | 0.092    | 0.103             | 0.053         |
| Knowledge                    | -0.140*      | -0.084            | -0.072   | -0.131*           | -0.091        |
| Trading Exp.                 | 0.040        | 0.039             | 0.169**  | 0.020             | -0.004        |

| Demographics |        |           |           |              |
|--------------|--------|-----------|-----------|--------------|
|              | Gender | Education | Knowledge | Trading Exp. |
| Gender       | 1.000  |           |           |              |
| Education    | 0.013  | 1.000     |           |              |
| Knowledge    | -0.106 | -0.165*   | 1.000     |              |
| Trading Exp. | 0.072  | 0.068     | 0.142*    | 1.000        |

\* p<0.05 and \*\* p <0.01

**Table 6 Summary Statistics - Trading Records 1/2**

The table reports descriptive statistics of the level of the disposition effect (DE) along with the two components: the ratio of the number of stocks sold over those sold and not sold for both gain and losses (PGR = Proportion of gains realized = Realized Gains/ Realized Gains + Paper Gains; PLR = Proportion of losses realized = Realized Losses/ Realized Losses + Paper Losses). The table likewise displays the statistics for the control variables: *realized gains* is the number of stocks sold at gain, *realized losses* is the number of stocks sold at loss, *paper gains/losses* is the number of stocks hold at gain/loss but not sold. *Number of operations* is the total number of stocks traded by the participant during the simulation, while *number of operations – buy(sell)* refers to the number of stocks bought (sold) by the participant during the simulation. *Return from winner selling* describes the return that participant obtain when he sells stocks at gain, in contrast *loss from loser selling* is the loss the subject experiences when he sells stocks at price lower than the purchase price. *Uninvested cash* reflects the available budget that the participant does not use during the simulation.

|                         | Obs                                      | Mean   | Median                               | Std.   | Minimum          | Maximum |
|-------------------------|--|--------|--------------------------------------|--------|------------------|---------|
|                         | Deviation                                |        |                                      |        |                  |         |
|                         | Disposition Effect                       |        |                                      |        |                  |         |
| Paper Gains             | 230                                      | 50.37  | 37.50                                | 42.97  | 0.00             | 194.00  |
| Paper Losses            | 230                                      | 39.54  | 31.00                                | 35.01  | 0.00             | 181.00  |
| Realized Gains          | 230                                      | 23.33  | 17.00                                | 24.16  | 0.00             | 162.00  |
| Realized Losses         | 230                                      | 15.41  | 12.00                                | 13.43  | 0.00             | 70.00   |
| PGR                     | 230                                      | 0.36   | 0.27                                 | 0.27   | 0.00             | 1.00    |
| PLR                     | 230                                      | 0.34   | 0.28                                 | 0.27   | 0.00             | 1.00    |
| DE                      | 230                                      | 0.02   | 0.00                                 | 0.36   | -0.89            | 1.00    |
|                         | Trading Records                          |        |                                      |        |                  |         |
| Number of operations    | 230                                      | 15.94  | 15.00                                | 8.39   | 3.00             | 54.00   |
| Number of operations    | 230                                      | 10.32  | 9.00                                 | 6.65   | 1.00             | 43.00   |
| Number of operations    | 230                                      | 26.26  | 24.00                                | 14.48  | 5.00             | 97.00   |
| Return from winner      | 230                                      | 0.03   | 0.02                                 | 0.02   | 0.00             | 0.18    |
| Loss from loser selling | 230                                      | -0.02  | -0.02                                | 0.02   | -0.16            | 0.00    |
| Uninvested cash         | 230                                      | 576.51 | 505.42                               | 464.87 | 0.00             | 3711.71 |
|                         | Disposition Effect and trading frequency |        |                                      |        |                  |         |
|                         | (a) DE                                   |        | (b) DE                               |        | (a-b) Difference |         |
| Number of operations    | 10 <sup>TH</sup> Percentile = 0.055      |        | 90 <sup>TH</sup> Percentile = -0.040 |        | 0.095 (p<0.182)  |         |
| Uninvested cash         | 10 <sup>TH</sup> Percentile = 0.032      |        | 90 <sup>TH</sup> Percentile = 0.167  |        | -0.135 (p<0.132) |         |

**Table 7 Summary statistics - Trading Records 2/2**

This table presents trading descriptive statistics broken down by the type of stock and the number of subjects divided for type of stock sold and purchased. There are 6 stocks with 5 types of stock-trend: stock 1 or C (-) with a likelihood to experience a rising in price about 35 per cent; stocks B and D or 2 and 3 (-) of 45 per cent; stock A or 4 (0) about 50 per cent; stock E or 5 (+) 55 per cent and of 65 per cent for stock F or 6 (++) . During the simulation subjects trade with 6 stocks with two stocks of the same type (-) (B and D or 2 and 3).

|  | Obs   | Mean  | Median | Std.<br>Deviation | Minimum | Maximum |
|--|-------|-------|--------|-------------------|---------|---------|
| Type of stock                              |       |       |        |                   |         |         |
| Type of stock - sell                       | 198   | 3.62  | 3.00   | 1.65              | 1.00    | 6.00    |
| Type of stock - buy                        | 206   | 3.83  | 4.00   | 1.63              | 1.00    | 6.00    |
| Stock trend                                |       |       |        |                   |         |         |
| Stocks                                     | (1) C | (2) B | (3) D  | (4) A             | (5) E   | (6) F   |
| Trend                                      | --    | -     | -      | 0                 | +       | ++      |
| # of subjects selling<br>mainly this stock | 33    | 52    | 34     | 15                | 21      | 43      |
| # of subjects buying<br>mainly this stock  | 31    | 44    | 38     | 14                | 32      | 47      |

**Table 8 Regression Table: Disposition Effect**

This table contains a set of Tobit regressions in explaining the tendency to ride losers instead of gains for the entire sample. The dependent variable is the disposition effect as measured by Odean (1998),  $DE = PGR - PLR$ . The independent variables include the personality traits (extraversion, conscientiousness, emotion stability, agreeableness and openness), demographics data (gender, country origin, education, stock-market knowledge and trading experience) and a variable for the trading frequency (capital not-invested). The dummy gender takes value of 0 if female, 1 if male. The dummy country takes value of 0 if the participant is Chinese and 1 if Italian).

|                   | 1                    | 2                   | 3                    | 4                    | 5                  | 6                  |
|-------------------|----------------------|---------------------|----------------------|----------------------|--------------------|--------------------|
|                   | Disposition Effect   | Disposition Effect  | Disposition Effect   | Disposition Effect   | Disposition Effect | Disposition Effect |
| Constant          | 0.073<br>(0.27)      | -0.406**<br>(-2.19) | 0.356*<br>(1.82)     | 0.369*<br>(1.89)     | -0.097<br>(-0.60)  | 0.028<br>(0.13)    |
| Extraversion      | 0.017***<br>(3.55)   | 0.011**<br>(2.36)   |                      |                      |                    |                    |
| Conscientiousness | -0.013**<br>(-2.48)  |                     | -0.012***<br>(-2.74) |                      |                    |                    |
| Openness          | -0.014***<br>(-2.80) |                     |                      | -0.014***<br>(-2.83) |                    |                    |
| Emotion Stability | 0.002<br>(0.65)      |                     |                      |                      | 0.001<br>(0.24)    |                    |
| Agreeableness     | 0.005<br>(0.92)      |                     |                      |                      |                    | -0.003<br>(-0.55)  |
| Gender            | -0.009<br>(-0.18)    | 0.003<br>(0.06)     | 0.003<br>(0.06)      | 0.018<br>(0.35)      | 0.008<br>(0.16)    | 0.011<br>(0.21)    |
| Dummy Country     | -0.005<br>(-0.07)    | -0.073<br>(-1.14)   | -0.015<br>(-0.25)    | 0.044<br>(0.68)      | -0.019<br>(-0.31)  | -0.030<br>(-0.48)  |
| Education         | 0.044<br>(1.02)      | 0.031<br>(0.70)     | 0.051<br>(1.14)      | 0.028<br>(0.64)      | 0.028<br>(0.62)    | 0.032<br>(0.71)    |
| Knowledge         | 0.038<br>(0.86)      | 0.033<br>(0.73)     | 0.018<br>(0.40)      | 0.0193<br>(0.42)     | 0.024<br>(0.53)    | 0.020<br>(0.44)    |
| Trad. Experience  | -0.009<br>(-0.33)    | -0.029<br>(-1.00)   | -0.020<br>(-0.70)    | -0.007<br>(-0.25)    | -0.024<br>(-0.84)  | -0.024<br>(-0.83)  |
| Uninvested cash   | 0.194*<br>(1.87)     | 0.163<br>(1.55)     | 0.230<br>(2.17)      | 0.187<br>(1.79)      | 0.188<br>(1.76)    | 0.192<br>(1.80)    |
| N                 | 230                  | 230                 | 230                  | 230                  | 230                | 230                |
| R2                | 0.153                | 0.053               | 0.063                | 0.065                | 0.024              | 0.026              |

t -statistics in parentheses; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

**Table 9 Regression Table: PGR and PLR**

The Table reports two Tobit regressions where the dependent variables are the proportion of gains (Column 1) and losses (Column 2) realized as measured by Odean (1998),  $PGR = RG/(PG+RG)$  and  $PLR = RL/(PL+RL)$ . In both models the independent variables include the personality traits (extraversion, conscientiousness, emotion stability, agreeableness and openness), demographics data (gender, country origin, education, stock-market knowledge and trading experience) and a variable for the trading frequency (capital not-invested). The dummy gender takes value of 0 if female, 1 if male. The dummy country takes value of 0 if the participant is Chinese and 1 if Italian.)

|                    | 1                    | 2                    |
|--------------------|----------------------|----------------------|
|                    | PGR                  | PLR                  |
| Constant           | 0.361*<br>(1.85)     | 0.288<br>(1.41)      |
| Extraversion       | 0.015***<br>(4.61)   | -0.001<br>(-0.36)    |
| Conscientiousness  | -0.009**<br>(-2.46)  | 0.004<br>(0.98)      |
| Openness           | -0.006*<br>(-1.75)   | 0.008**<br>(2.09)    |
| Emotion Stability  | 0.003<br>(1.07)      | 0.001<br>(0.15)      |
| Agreeableness      | 0.001<br>(0.10)      | -0.004<br>(-1.14)    |
| Gender             | 0.054<br>(1.48)      | 0.063*<br>(1.66)     |
| Dummy Country      | -0.232***<br>(-4.85) | -0.227***<br>(-4.54) |
| Education          | -0.006<br>(-0.19)    | -0.050<br>(-1.54)    |
| Stock Market Know. | 0.034<br>(1.06)      | -0.004<br>(-0.14)    |
| Trading Experience | -0.016<br>(-0.77)    | -0.006<br>(-0.29)    |
| Uninvested cash    | 0.280***<br>(3.78)   | 0.084<br>(1.10)      |
| N                  | 230                  | 230                  |
| R2                 | 0.944                | 0.542                |

t-statistics in parentheses; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .