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TRADER PERSONALITY AND TRADING PERFORMANCE
A framework and financial market experiment

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Abstract

To date, the main source of inspiration for behavioral finance scholars has been cognitive psychology. Cognitive psychology offers a rich set of insights into human decision-making, and the biases that tend to influence it. Such biases provide important reasons as to why anomalies may characterize financial market behavior. This study builds on this tradition by merging in insights from yet another psychology sub-discipline: personality psychology. We argue that a human being's personality is a key determinant of her behavior and performance. We illustrate, for a limited subset of six personality traits (locus of control, maximizing tendency, regret disposition, self-monitoring, sensation seeking and type-A/B behavior), how this logic can be applied in the context of the study of trader behavior and performance. We explore this line of reasoning in an illustrative asset market experiment, involving 34 economics students. The results suggest that different personality traits affect distinct components of trading behavior, and so trading performance. In particular, more relaxed types who are more susceptible to regret trade less frequently (a performance enhancing strategy). Impatient, urgency-driven types with low sensitivity for environmental cues tend towards the disadvantageous price-taker role (accepting limit orders posted by other traders) and exhibit a lower tendency towards exploiting arbitrage opportunities.

Keywords: Upper echelon theories; Personality traits; Financial market experiments;Trader behavior

JEL classification: C91, D8, G1, and G11

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INTRODUCTION

Over the past few decades, research in experimental and behavioral economics has begun to uncover, inspired by cognitive psychology, systematic biases in human decision-making processes (cf. Mullainathan and Thaler, 2000; Gilovich, Griffin, and Kahneman, 2002). The emerging literature on behavioral finance (see e.g., Barberis et al., 1998, and, for an opposite view, Fama, 1998) argues that such biases provide important reasons as to why anomalies characterize financial market behavior. Empirical evidence from field and laboratory studies suggests, first, that prices do not always reflect fundamental values, and, second, that individual behavior and forecasts of prices are often inconsistent with rational expectations theory. Within this behavioral finance framework, two streams of research have emerged (Mullainathan and Thaler, 2000). The first is primarily concerned with asset prices and the controversy about the efficient market hypothesis, focusing, for example, on phenomena such as bubbles and crashes. The second focuses on investor/trader behavior, and phenomena such as mental accounting and loss aversion.

However, beyond finding evidence on the existence of biases in individual behavior and forecasts, prior studies have also pointed to variations across individuals – first, in their susceptibility to such biases (e.g., Fenton-O'Creevy, Nicholson, Soane, and Willman, 2005; Malmendier and Shanthikumar, 2007; Chen, Kim, Nofsinger, and Rui, 2007), second, in their trading styles and strategies (e.g., Barber and Odean, 2001; Oliven and Rietz, 2004), and, third, in their trading performance (e.g., Oliven and Rietz, 2004; Smith, Suchanek, and Williams, 1988). These variations are, to date, largely unexplained. The present study contributes to addressing this gap.

So far, the main source of inspiration for behavioral finance has been cognitive psychology. Cognitive psychology offers a rich set of insights into human

decision-making, and the biases that tend to influence human decision-making processes. In the current study, we build on this insightful tradition by merging in insights from yet another psychology sub-discipline: personality psychology. We argue that a human being's personality is a key determinant of her behavior and performance, and so contributes to explaining differences between individuals in terms of susceptibility to biases and with respect to styles of trading behavior.

In the behavioral management sciences, studies into the relationship between individual human features and organizational outcomes abound. In this study, we suggest to apply ideas from this literature to behavioral finance. Starting point in behavioral management is the assumption that what happens in and to an organization can – at least in part – be explained with reference to key features of the human beings who together keep the organization going. Ignoring the large micro-micro literature in organizational behavior, which deals with individual-level research in such areas as employee motivation (Robbins, 2002), we focus here on that part of behavioral management research that seeks to improve the explanation of differences in organizational performance by introducing behavioral insights into the theory of the firm (van Witteloostuijn, 1998, 2003; Jansen et al., 2007).

So far, only a limited number of studies have begun to address the personality psychology – behavioral finance interface. McInish (1980, 1982), in two early studies, linked riskiness of investment opportunities to risk attitude and to a personality trait called locus of control. This trait captures the degree to which individuals feel that they are in control of their own life and have the capacity to influence their environment (Rotter, 1966). Individuals with a strong control belief are referred to as internals, and their counterparts as externals. Based on a student sample, McInish (1980) concluded that externals favored less risky portfolios. In a subsequent study of

actual investors, though, McInish (1982) found that externals tended to choose more risky portfolios. Chui (2001) experimentally examined the disposition effect – the tendency to sell winning assets too soon and hold losing assets for too long – and the influence of the locus of control trait. He found externals to be less affected by the disposition effect. Biais, Hilton, Mazurier and Pouget (2005) considered the influence of overconfidence and a personality trait referred to as self-monitoring on trading performance in an experimental asset market. In general, high self-monitors possess greater social sensitivity than low self-monitors, and low self-monitors are less aware of others' reactions – or, at least, less concerned with them (Snyder, 1987). Biais et al. (2005) found support for their hypothesis that high self-monitors achieve superior trading performance, possibly due to strategic behavior. However, the effect was significant only for male subjects. Fenton-O'Creevy et al. (2005) studied the influence of illusion of control – a cognitive bias – and a set of personality characteristics referred to as the Big Five (Costa and McCrae, 1992a, 1992b) on total remuneration. Illusion of control refers to a tendency to act as if chance events were accessible to one's control (Langer, 1975). The Big Five (neuroticism, extraversion, openness, agreeableness and conscientiousness) represent a set of factors designed to captured a wide spectrum of personality traits, each consisting of several lower-level traits such as anxiety, modesty or self-discipline (cf. Matthews, Deary, and Whiteman, 2003). The personality-related investigation was part of a larger study by Fenton-O'Creevy et al. (2005) of 118 traders and trader managers in four London investment banks between 1997 and 2002. Based on a sub-sample of 64 traders who were given a simple computerized task, they found a negative effect of illusion of control and certain traits, such as neurotism and emotionality, as well as a positive effect of openness to experience. Grinblatt and Keloharju (2006) considered the links between

trading activity, overconfidence, and the personality trait "sensation seeking". This trait captures the degree to which individuals seek varied, intensive sensations and experiences. In their study of Finish equity trading data, sensation seeking was associated with higher trading frequency.

This paper offers a three-fold contribution to this emerging, but still limited "personality finance" literature. First, we develop a *general framework* that captures the relationships between trader features, trading behavior (judgment and strategies) and performance, including moderating effects of market microstructure. Second, we illustrate this general logic in some detail for a *focused conceptual framework* that zooms in on a number of selected concepts and relationships. Specifically, unlike prior research that has tended to consider individual personality traits at a time, we focus on the simultaneous impact of six personality traits that can be expected to be relevant: locus of control, maximizing tendency, regret disposition, self-monitoring, sensation seeking and type-A/B behavior. We consider them both separately and in the form of profiles. With respect to trader behavior, we focus on three different choices in terms of trading styles – that is, trading frequency, tendency to self-select into the roles of market-maker or price-taker, and "arbitraging". Third, building on this focused framework, we explore our arguments in an illustrative *experimental asset market* with 34 economics students.

GENERAL THEORETICAL FRAMEWORK

To date, a number of studies have documented variations across individuals in (a) their susceptibility to cognitive biases, (b) their trading strategies and styles, and (c) their performance. For example, Malmendier and Shanthikumar (2007) found differences across traders in their reactions to stock recommendations by security

analysts. Fenton-O'Creevy et al. (2005) found subjects to differ with respect to the illusion of control bias. Substantial parts of these differences were not accounted for by variations in available information or available actions. Barber and Odean (2001) reported differences in trading frequency and portfolio choice. Oliven and Rietz (2004) identified differences in subjects' tendency to self-select into the roles of market-makers and price-takers. Market-makers were defined as traders that posted limit orders, while price-takers were those who accepted these limit orders by submitting market orders. A market order generated a trade at the price specified in the limit order that it filled. With respect to performance, Smith, Suchanek and Williams (1988), for example, found that some subjects were much better forecasters than others. Oliven and Rietz (2004) found subjects to differ in their rate of violations to rationality – that is, some engaged much more frequently in inferior trading deals despite the availability of better trading terms.

Researchers have been able to explain these differences only partially based on "objective" characteristics such as gender, age, experience, and nationality (Barber and Odean, 2001; Powell and Ansic, 1997; Oliven and Rietz, 2004; Frijns, Koellen, and Lehnert, 2008, Chen et al., 2007). Consequently, as indicated in the Introduction, a limited number of studies have begun to fill the remaining gap by considering subjective properties as well, such as personality traits, attitudes and opinions.

Interestingly, similar evidence has been reported by researchers in related fields such as behavioral management. At the same time, this literature has emphasized more strongly the underlying theoretical foundations, and may, in this respect, have something to contribute to a deeper understanding of unexplained variations across individuals in financial market settings. The behavioral management literature analyzes the relationship between individual human features, organizational

behavior and outcomes, with corporate demography and upper echelon theories as two of the most prominent theoretical frameworks (cf. Boone, De Brabander, van Olffen, and van Witteloostuijn, 2004). The corporate demography perspective (Pfeffer, 1983) argues that organizational behavior and performance can largely be explained by studying the distribution of demographic or "objective" characteristics of an organization's personnel (in terms of the mean and spread of, e.g., age, education and tenure). Upper echelon theory (Hambrick and Mason, 1984) argues that the individual features of key decision makers – i.e., members of the top management team (TMT), including the Chief Executive Officer (CEO) – need to be taken into account when searching for an explanation of the organization's behavior and performance. In addition to "objective" characteristics, upper echelon theory emphasizes the role of "deeper" and "subjective" features such as attitudes and personalities. For example, studies into the impact of CEO personality have revealed that the locus of control trait is a stable predictor of small firms' performance (e.g., Miller and Toulouse, 1986; Lee and Tsang, 2001).

Drawing on both the behavioral finance and the behavioral management literatures, this study proposes a general framework for how trader features are related to trading performance, mediated by effects of trader features on judgment and trading behavior, and moderated by market microstructure (see Figure 1).

INSERT FIGURE 1 ABOUT HERE

We suggest to distinguish three key effects. First, individuals may prefer particular types of trading strategy (e.g., trend following vs. contrarian trading), driven by their objective and subjective features ("preference effect"). Second, given particular

circumstances (e.g., different microstructures, and level of noise in prices), different trading strategies may be associated with different outcomes, at the level of the individual trader (e.g., profit) and the market at large (e.g., volatility) ("strategy effect"). And third, certain traders may be good at carrying out some trading strategies, but not others ("alignment effect"). For instance, an individual trader might be able to perform well in trend following, but less so in value investing.

ILLUSTRATIVE STUDY: FOCUSED CONCEPTUAL FRAMEWORK

The present illustrative study focuses on a selection of concepts and relationships from this general framework. Specifically, we look at preference and strategy effects only, ignoring alignment effects and abstracting from potential moderating effects. Figure 2 depicts the resulting focused conceptual framework. The grey shaded boxes in Figure 2 mark the concepts and relationships tested here, for the sake of illustration.

INSERT FIGURE 2 ABOUT HERE

First, we note that we use the term "trader" in a generic sense to refer to individuals who engage in trading stocks for their own accounts.[1] We do not explicitly distinguish between different types of traders (e.g., based on fixed roles implied in a particular market institution design; cf. O'Hara, 1995). While prior work has suggested that differences might exist between the investment and trading behavior of professionals and non-professionals (e.g., King, Smith, Williams, and van Boening, 1993; Anderson and Sunder, 1995; Chen et al., 2007), results have been inconclusive (e.g., Törngren and Montgomery, 2004). Hence, we leave explicit differentiations between types of traders for future research.

Components of final trading outcome: "noise-free" trading performance and chance. A controlled experimental setting allows for the decomposition of an individual trader's final performance (in terms of profits) into its components. In our experimental asset market, each trader's profits at the end of a particular trading round were a function of (1) her portfolio's expected value, (2) her portfolio's risk composition (i.e. the degree to which it consisted of shares, yielding an uncertain return based on a known probability distribution), and (3) chance (in the form of the realizations of this probability distribution). A portfolio's expected value and its risk composition, therefore, determined a trader's "noise-free" trading performance.[2]

Strategy effects: the influence of trading strategies on "noise-free" trading performance. Prior research has linked different types of trading strategies to trading performance (e.g., Carhart, 1997; Barber and Odean, 2000; Oliven and Rietz, 2004). Here, we focus on a trading frequency, self-selection into different roles, and the degree to which trading strategies make use of arbitrage opportunities ("arbitraging").

First, in support of theoretical models, empirical studies suggest a negative association of trading frequency and performance (Carhart, 1997; Barber and Odean, 2000). Looking at individual households' investments through a large discount broker during 1991 to 1996, Barber and Odean (2000) proposed overconfidence as the decisive cause of frequent trading and attributed its negative performance effects to transactions costs (for a recent review, see David Allen and Evans, 2005). While there are no transaction costs in our experimental setting, it could still be that more frequent trading might hurt performance if achieved by trading at unfavorable terms – selling below and purchasing above the asset's fundamental value.

Second, prior research suggests that the degree to which subjects self-select into the roles of market-makers and price-takers might be related to different levels of

susceptibility to mistakes and violations to rationality (Oliven and Rietz, 2004). Market-makers can be defined as traders that post limit orders, while price-takers are those who accept these limit orders by submitting market orders (Oliven and Rietz, 2004). A market order generates a trade at the price specified in the limit order that it fills. Oliven and Rietz (2004) found that, on average, market-makers outperformed price-takers. They found evidence that market-makers were less prone to mistakes such as violating arbitrage restrictions, or trading at prices that were not the best available. Market-makers appeared to be less affected by mental biases, and to be more rational in their trading. In their attempt to discriminate between market-makers and price-takers based on demographic criteria, Oliven and Rietz (2004) identified gender as the primary explanatory variable, but stated that, overall, "the choice of roles remains largely unexplained, in contrast to the predictability of violation rates" (Oliven and Rietz, 2004: 348). Finally, we also directly consider differences as to the degree to which traders pursue arbitrage opportunities in their trading strategies (i.e., arbitraging) (Oliven and Rietz, 2004).

Preference effects: the influence of trader features on the choice of trading strategies. We explore the impact of trader features on strategy choices in terms of trading frequency, tendency to self-select into a market-maker role, and arbitraging. As objective trader features, we consider age (Barber and Odean, 2001; Frijns et al., 2008), gender (Powell and Ansic, 1997; Barber and Odean, 2001; Oliven and Rietz, 2004), and trading experience (Frederickson and Miller, 2004; Frijns et al., 2008). Primarily, though, we focus on exploring the impact of a selection of personality traits, which are explained in detail in the next section.

SIX PERSONALITY TRAITS

Building on earlier work in behavioral finance (e.g., McInish, 1980, 1982; Chui, 2001; Biais et al., 2005; Fenton-O'Creevy et al., 2005), and in combination with well-established insights from behavioral management (e.g., Boone, De Brabander, and van Witteloostuijn, 1999a, 1999b; Boone et al., 2004) and personality psychology (e.g., Schwartz et al., 2002), we selected, as a first step, six personality traits. We used four criteria to guide our selection:

1. The traits had to be easily and reliably measurable with standard scales that are well-established in the psychometric literature.
2. The traits had to be real traits – that is, they have to be relatively independent of the individuals' age.
3. The traits needed to have clear and, in our context, relevant behavioral consequences.
4. The traits needed to have worked well in earlier work in behavioral finance, behavioral management or personality psychology.

Based on these criteria, we selected six personality traits for the illustrative experimental study: locus of control, maximizing tendency, regret disposition, self-monitoring, sensation seeking, and type-A/B behavior. For sure, there are many more traits that we could have selected, either in the form of comprehensive sets such as the Big Five (see, e.g., Fenton-O'Creevy et al., 2005), or individual traits such as need-for-closure (Ford and Kruglanski, 1995; Kruglanski and Webster, 1996). As to the consideration of a comprehensive set such as the Big Five, two lines of arguments needed to be balanced. On the one hand, research has shown that the Big Five cover the broad domain of personality to a large extent (Robbins, 2002). On the other hand, other scholars have argued that different, specific personality constructs may be more useful in certain contexts, especially when the aim is to identify in detail which

specific personality constructs drive certain outcomes (e.g., performance outcomes or strategy choices; see e.g., Robertson, 1994). As a result of balancing these arguments in the context of this study, we opted for individual traits. We used the outlined criteria to identify a baseline set of personality constructs, leaving its expansion to future work.

First, locus of control is an important and well-documented personality trait that refers to individual differences in a generalized belief in internal versus external control (Rotter, 1966). People with an internal locus of control see themselves as active agents and masters of their fates, and trust in their capacity to influence the environment. Conversely, those with an external locus of control view themselves as passive, and believe that the events in their lives are due to forces beyond their control. The trait indicates fundamental differences between individuals (Boone and De Brabander, 1993). Control perceptions appear to be salient in explaining effective management (Miller and Toulouse, 1986; Boone, De Brabander, and van Witteloostuijn, 1996), and to potentially influence behavior in financial settings (McInish, 1980, 1982; Chui, 2001).

Next, maximizing tendency and regret disposition refer to interpersonal differences in choice behavior (Schwartz et al., 2002; Iyengar, Wells, and Schwartz, 2006). So, second, maximizing tendency reflects the degree to which individuals strive for maximization as a goal in choice situations, as opposed to "satisficing" (Simon, 1955). While satisficers aim for any solution that at least satisfies their acceptability threshold, maximizers search for the optimum. Third, regret disposition captures the extent to which individuals are sensitive to regret experience. Regret refers to the (potential) negative psychological effects *after* a choice has been made, when the chosen outcome falls short of expectations and/or the outcome of the

rejected option turns out to have been superior. Regret theory (Janis and Mann, 1977; Bell, 1982) postulates that anticipation of potential regret has profound consequences for choice behavior. Fear for future regret influences current behavior, for example, by inducing people to ponder more extensively before taking decisions. Individuals that are more prone to regret experience are likely to have more severe doubts when they cannot fully search or assess all options, whether for practical or principle reasons. While it remains an unresolved issue, empirically, *how* precisely anticipation of regret (and the desire to avoid it) affects choice behavior, the notion *that* it does so emerges as a rather stable result (Zeelenberg, 1999; Shani and Zeelenberg, 2007) – and so does the finding that individuals differ in their disposition to experience regret.

Fourth, self-monitoring captures that people differ in the extent to which they observe and control their expressive behavior and self-presentation (Snyder, 1974, 1987). Individuals high on self-monitoring regulate their expressive self-presentation for the sake of desired public appearances, and are highly responsive to social and interpersonal cues of appropriate performances (Snyder and Gangestad, 1986). Persons low on self-monitoring lack the ability or motivation to regulate their self-presentations. Their expressive behavior functionally reflects their own enduring and momentary inner states, including attitudes, feelings and traits. Overall, greater sensitivity to cues might provide high self-monitors with an edge in decoding a particular environment and the behavior of other players, allowing them to exploit these features to their advantage.

Fifth, sensation seeking is defined by the seeking of varied, intensive sensations and experiences, as well as the willingness to take physical, social, legal and financial risks for the sake of such experience (Zuckerman, 1979, 1994). Research in behavioral genetics, neuropsychology and psychophysiology has revealed evidence of

a substantial genetic determination of sensation seeking (De Brabander, Boone, and Gerrits, 1995). Differences in sensation seeking are related to individual differences in optimal levels of stimulation and arousal. Prior work has found sensation seeking to be positively associated, for example, with behavior such as alcohol use and gambling (Bratko and Butkovic, 2003). High sensation seekers tend to be more inclined to actively seek risky and novel situations. Low sensation seekers prefer stable, safe and predictable situations.

Sixth, type-A behavior is revealed by individuals who are involved in an aggressive and incessant struggle to achieve more and more in less and less time (Friedman and Rosenman, 1974). They are characterized by time urgency, interpersonal hostility, aggression, irritability, impatience and a high level of competitiveness (Baron, 1989). Those who have not developed such behavioral patterns are called type-B individuals. Type-A persons, due to their impatience and competitiveness, are less likely to show cooperative behavior, and also have greater difficulties to learn the most beneficial strategy in Prisoners' Dilemma situations (Boone et al., 1999b). Prior research has also found type-A persons' situational and organizational preferences to be associated with high performance standards and an urge to display effort (Feather and Volkmer, 1988).

Finally, in practice, the importance of the personality of individuals is based on combinations of personality characteristics, which can be summarized in so-called profiles. In a profile context, the effects of the underlying traits may vary depending on their interplay with the specific set of accompanying traits. Until now, prior work has tended to analyze the effects of separate personality traits only (e.g., Chui, 2001; Biais et al., 2005; Fenton-O'Creevy et al., 2005). As a result, recent studies have begun to look into the combined effects of different personality characteristics, on the

one hand, and the shape of the relationship between personality factors and behavioral and performance-related aspects, on the other hand (Semeijn, Boone, van der Velden, and van Witteloostuijn, 2005). Hence, we use the selected traits both separately and combined into profiles (as produced by cluster analysis) in our analyses.

EXPERIMENT

Experimental design

We studied the preference and strategy effects of individual traders in a computerized experimental market (building on Gneezy, Kapteyn, and Potters, 2003; using the z-Tree software: see Fischbacher, 2007). Participants could trade multiple units of a risky short-lived asset in a continuous open-book double auction market in a sequence of 24 trading periods. At the beginning of each period, a trader was endowed with a cash balance of 200 cents and three units of the asset. Each unit of the asset was a lottery ticket that, at the end of a trading period, paid 150 (virtual) cents with probability 1/3 and 0 cents with probability 2/3, based on a random number draw.

If a trader bought a unit, the price was subtracted from her cash balance, and one unit of the asset was added to her portfolio. If a trader sold a unit, the price was added to her cash balance and a unit of the asset was subtracted from her portfolio. At the end of the trading period, the asset expired and a lottery revealed its value. Subjects learned about the realized value of the asset – i.e. the outcome of the lottery draw – through a message on their computer screens. A trader's earnings for the period were equal to: 200 + (prices received for units sold) – (prices paid for units bought) + (number of units in portfolio at the end of the period) x (value of the asset (0 or 150) as determined by the lottery). Earnings were transferred to a trader's accumulated earnings, and the next period started with each trader again having a

portfolio consisting of 200 cents in cash and three units of the asset. Traders could not use accumulated earnings from earlier rounds. They were not allowed to go short in either assets or cash.

During the experiment, all amounts were denoted in cents. Traders could submit bids to buy and orders to sell. All traders were instantaneously informed about all bids and orders submitted to the market. At any time during a trading period, traders could decide to buy at the lowest order price or to sell at the highest bid. When a unit was traded, the accepted bid or order was withdrawn from the market, and all traders were informed that a trade had occurred at that price. Units traded one by one: all bids and orders were for one unit only. Traders could submit as many bids and orders, and could sell and buy as many units as they liked, provided they had sufficient cash or asset reserves, respectively. An individual improvement rule was enforced, requiring a new order (bid) price to be lower (higher) than the trader's standing order (bid). Each effective trading period lasted three minutes.

Procedures

Several weeks prior to the experimental sessions, we administered a questionnaire survey among participants in order to collect data on demographic and personality features. As for the experimental sessions themselves, no subject was allowed to participate more than once. Upon entering the lab, subjects were randomly seated behind computers. Trading instructions were distributed and read aloud to them. Then, they could examine the instructions more carefully, and privately ask questions. Subsequently, they practiced with the market rules during two training periods. The training periods contained no feedback as regards dividend draws. Then, after a clear break, actual trading started. At the end of the session, subjects were paid their

accumulated earnings in private. The exchange rate was 0.00253, resulting in an *ex ante* expected payoff to each subject of €21.25. In addition, each subject received a €5 participation fee.

Participants

Participants were recruited among third year students of an economics programs at a European university. In total, 34 students participated, spread over five sessions, with five to eight participants in each session. All experimental sessions were run within the space of three weeks in December 2005. Of the 34 participants, 29 per cent were female and 71 per cent male, with an average age of 23. The majority of the participants were Dutch (58.8 %), followed by Chinese (26.5 %). Regarding educational level, 17 per cent had a previous Bachelor degree outside economics, 41.2 per cent were studying for a Bachelor degree, and the remainder for a Master's. The participants specialized predominantly in Finance (76.5 per cent), with Marketing ranking second (23.5 per cent). Also, 38.2 percent had trading experience of some kind.

Empirical measures

Strategy effects: the influence of trading strategies on "noise-free" trading performance. Subjects could influence two out of the three components of their final trading outcome with their trading behavior: the expected value and the risk composition of their portfolios at the end of each trading period. Therefore, *Expected value* and *Risk composition* were the outcome (dependent) variables in considering the influence of strategies on "noise-free" trading performance. We measured the *Expected value* of a participant's portfolio in the following way. For each period of

trading, we computed the expected value of the subject's end-of-period portfolio, based on her holdings of assets and cash, prior to the dividend draw. Subsequently, we took the average of these period-specific expected value figures across all trading periods, to obtain a measure of *Expected value* for each participant. *Risk composition* refers to the degree to which a portfolio consisted of shares, again measured as an average across all trading periods. At the end of each period, we measured the risk composition of a portfolio as the percentage contribution of the risky component (shares) towards the portfolio's expected value, prior to the dividend draw.

The first of the strategy (independent) variables was *Trading frequency*, measured as a participant's total number of transactions across all trading periods. Second, we included the degree to which subjects tended to self-select into the role of market-maker (*Market-maker role*), measured as the percentage of completed transactions that the participant had initiated by submitting a limit order, out of all transactions completed by this individual during the session. Third, we measured *Arbitraging* as the difference between the average price across all trading periods at which a subject sold shares and the average price at which she bought shares.

Preference effects: the influence of trader features on the choice of trading strategies. *Trading frequency*, *Market-maker role*, and *Arbitraging* now represented the strategy (dependent) variables in analyzing the influence of trader features on the choice of trading strategies. As feature (independent) variables, we considered, first, the selected personality traits. As we used established and validated scales, the explanation of these measures can be brief (cf. Boone et al., 1999a; Schwartz et al., 2002). *Locus of control* (Cronbach's α = .49) was measured with the Rotter scale (Rotter, 1966), *Maximizing tendency* (Cronbach's α = .44) and *Regret disposition* (Cronbach's α =.67) with the Maximization and Regret scales (Schwartz et al., 2002),

respectively, *Self-monitoring* (Cronbach's α = .63) with Snyder and Gangestad's improved Self-monitoring scale (Snyder and Gangestad, 1986), *Sensation seeking* (Cronbach's α = .77), with the updated Sensation Seeking Scale (Zuckerman, 1979, 1994), and *Type-A/B behavior* (Cronbach's α = .72) with the "Student Jenkins Activity Survey" (SJAS) presented by Yarnold and co-authors (1986), based on the "Jenkins Activity Survey" (JAS) developed by Jenkins, Zyzanski and Rosenman (1979). The values for Cronbach's α's tended to be relatively low in this study, presumably due to the low number of observations in this study. Still, they were above the threshold of acceptability of 0.6 for our type of research (Hair, Black, Babin, Anderson, and Tatham, 2006) for *Regret disposition*, *Self-monitoring*, *Sensation seeking*, and *Type-A/B behavior*. They were below acceptable levels for *Locus of control* and *Maximizing tendency*. We removed these two traits from further analyses, but, for the sake of completeness, report the descriptive statistics.

We included a limited number of standard demographic variables, capturing objective trader features: *Age* in years, and *Gender* (coded as 1 for females, and 0 for males). Prior *Trading experience* was captured by a dummy which was set to 1 if a participant indicated to have any kind of prior trading experience (e.g., from participation in stock exchange games, or managing their own private trading account), and 0 otherwise.

RESULTS

Descriptive statistics

The study covered 34 participants and, after excluding outliers, 32 observations (see below). Due to these low numbers, the outcomes are indicative only, yet promising, especially given that the experiments were conducted for the purpose of illustration

rather than hypothesis testing. Table 1 provides means, standard deviations and correlations.

INSERT TABLE 1 ABOUT HERE

Multicollinearity was not an issue. Yet, a number of interesting significant correlations emerged. For instance, sensation seeking and self-monitoring were positively correlated, hinting at self-conscious, thrill-loving personalities. In line with prior work we also found gender to be negatively correlated with locus-of-control: On average, women are more likely to be externally minded. Regression assumptions were met to a satisfactory degree. Visual inspection of the corresponding normal probability plots yielded sufficient approximations of the normal distribution for all models analyzed with OLS. We inspected the residual plots for heteroscedasticity, finding no indication that this was present.

Personality profiles

In order to account for possible differences in the effects of individual traits depending on their interplay with other traits (as part of profiles) we submitted the four personality variables that passed Cronbach α's reliability threshold to hierarchical cluster analyses to check whether their scores would group together in distinct and interpretable personality clusters (cf. Semeijn et al., 2005). Multicollinearity among the clustering variables was not a problem. No significant correlations existed, with the exception of sensation seeking and self-monitoring, which were significantly but not highly correlated. In the cluster analyses, we first conducted an initial pass through the data in order to identify outliers (Ketchen and

Shook, 1996), using a single-linkage algorithm based on squared Euclidean distance. This resulted in the exclusion of two cases, supported by robustness analyses with other agglomerative hierarchical algorithms. For the remaining 32 cases, we proceeded with Ward's method, based on squared Euclidean distance, resulting in the three-cluster – four-dimension solution that is listed in Table 2.[3] Scores for the two left-out measures – *Locus of control* and *Maximizing tendency* – are reported as well.

INSERT TABLE 2 ABOUT HERE

The face value of the three personality profiles, interpreting the score differences as to the four traits that discriminate across our three clusters, is satisfactory and suggests the following interpretation.

1. Profile 1 (n = 8) refers to individuals who have a strong regret disposition, have a dislike for sensation seeking, and reveal type-B behavior. Profile 1 reflects relaxed persons, not very susceptible to thrill seeking.
2. Profile 2 (n = 18) captures persons high on self-monitoring and sensation seeking. It implies self-conscious, thrill- and adventure-loving persons.
3. Profile 3 (n = 6) includes individuals who are associated with type-A behavior and relatively low self-monitoring. Profile 3 relates to impatient, competitive persons with little to channel this drive according to environmental demands.

Participants with these profiles were spread over the sessions. Below, we ran multivariate analyses with this set of three personality profiles as our independent variables, as well as with the underlying traits included as separate variables.

Testing the focused conceptual framework

Strategy effects: the influence of trading strategies on "noise-free" trading performance. Model 1a in Table 3 presents the results of an OLS regression with individual traders' *Expected value* regressed on *Trading frequency, Market-maker role*, and *Arbitraging*.

INSERT TABLE 3 ABOUT HERE

With an adjusted R^2 of 0.507 ($p < 0.001$), the model explains variations in *Expected value* across subjects rather well. All three aspects of trading strategies are significant predictors of *Expected value*. *Trading frequency* has a negative effect on *Expected value*. As transaction costs cannot account for this in our experiment, we speculate that high *Trading frequency* was achieved by sacrificing deal "quality" for deal "quantity", to some extent – that is, by selling at lower prices and buying at higher prices. In line with prior research (Oliven and Rietz, 2004), we find that subjects' tendency to self-select into the *Market-maker role* is significantly positively related with their portfolio's *Expected value*. As could be expected, *Arbitraging* was strongly and significantly positively associated with *Expected value*. Turning to Model 2a, neither of the three variables can, however, explain variances in *Risk composition*. The overall model is poor as well. Only *Market-maker* role is close to significant ($p = 0.11$). We speculate about reasons for this discrepancy in explanatory power in the Discussion section.

Preference effects: the influence of trader features on the choice of trading strategies. Next, we ran OLS regressions with *Market-maker* (Model 4) and *Arbitraging* (Model 5) as dependent variables. For *Transaction frequency*, a count variable, we used zero-truncated Poisson regression (Model 3). The results are

presented in Table 4. Models 3a, 4a, and 5a contain personality profiles as explanatory variables, while Models 3b, 4b, and 5b use the four individual traits that exhibited satisfactory reliability separately.

INSERT TABLE 4 ABOUT HERE

Model 3a captures the impact of the control variables *Age*, *Gender*, *Trading Experience* and the two personality dummies, *Profile 1* and *Profile 3*, on *Trading frequency*. The overall explanatory power of the model is reasonable, with a Pseudo-R^2 of 0.244. *Gender* has a negative effect, in line with previous evidence suggesting that women tend to trade less (Barber and Odean, 2001). *Trading experience* also reduces *Trading frequency,* as one might expect given that more experience should go along with a better notion of the underlying fundamental value of the asset, and superior insights into potential hazards of frequent trading. The dummy for *Profile 1* also has a significant negative effect, pointing towards less frequent trading by relaxed persons high in regret disposition and low in sensation seeking. Turning to the effects of individual traits, Model 3b captures the impact of the control variables and the four personality constructs *Self-monitoring*, *Sensation seeking*, *Type-A/B behavior* and *Regret disposition* on *Trading frequency*. Again, *Gender* and *Trading experience* are significantly negatively associated with *Trading frequency.* Among the four traits, only *Type-A/B behavior* is significant, and is positively related with *Trading frequency*. Taken together, Models 3a and 3b, therefore, suggest that the type-B trait lowers trading frequency, especially when combined with the other personality characteristics that make up *Profile 1*.

Model 4a relates to subjects' tendency to self-select into a *Market-maker role* as the dependent variable. While the overall explanatory power of the model is low, the *Profile 3* dummy has a significant negative effect. All other coefficients are not significant. Model 4b captures the impact of the control variables and the four personality constructs *Self-monitoring*, *Sensation seeking*, *Type-A/B behavior* and *Regret disposition* on *Self-selection into market-maker role*. *Self-monitoring* is the only variable that is (marginally) significantly related to the tendency to self-select into a market-maker role. Interestingly, in the profile context (Model 4b), it is *Profile 3* that has a significant and negative impact. So while *Self-monitoring* on its own has a positive, yet only marginally significant effect, a lack of it, combined in one profile together with other traits such as *Type-A/B behavior* and high *Sensation seeking*, has a more powerful but then negative effect on *Market-maker role*.

Model 5a regresses *Arbitraging* on the two personality dummies, *Profile 1* and *Profile 3*, and the control variables *Age*, *Gender*, *Trading Experience*. *Profile 3* emerges as the only significant predictor, with a negative effect. Overall, Model 5a has a considerably higher explanatory power than Model 4a, with an adjusted R^2 of 0.203 ($p = 0.051$). Considering the underlying traits separately in Model 5b reduces the overall explanatory power drastically, though. *Type-A/B behavior* is the only significant effect, with a negative sign. The effect is less pronounced in terms of significance than the corresponding effect of *Profile 3* in Model 5a, in which type-A behavior is coupled, among others, with low self-monitoring. It seems that subjects' tendency *not* to use arbitraging is driven by their competitive impatience, especially when combined with certain other traits.

From our results, it can be taken that the explanatory power of some models is limited. Yet, our focus was on the contribution of theoretically motivated covariates,

rather than explaining as much variation in the dependent variables as possible. Additional analyses (using ANOVA; available upon request) further support the impressions from the regression models. For example, the difference between *Profile 3* and the other two profiles appears to be a strong driver of self-selecting behavior ($p = 0.051$). Figure 3 illustrates this graphically.

INSERT FIGURE 3 ABOUT HERE

DISCUSSION AND CONCLUSION

In this paper, we suggested to draw on insights from personality psychology in order to improve our understanding of the reasons for observed differences across individuals in trading performance, styles and strategies, and judgment. We proposed a general framework to capture the links between trader characteristics and their performance, behavior and judgment, and developed a focused conceptual framework consisting of a number of selected concepts and relationships. In terms of trader features, it comprised six personality traits (locus of control, maximizing tendency, regret disposition, self-monitoring, sensation seeking and type-A/B behavior) and several demographic variables (e.g., age and gender). With respect to trading strategies, we considered trading frequency, tendency to self-select into the roles of market-maker or price-taker, and arbitraging. Finally, we tested the focused framework in an illustrative experimental study with 34 economics students. In the analyses, we had to exclude two of the personality traits, locus of control and maximizing tendency, because of unsatisfactory levels of reliability. The remaining traits were used both as separate constructs, and combined into personality profiles.

We found, first, that a participant's trading frequency, tendency to self-select into a market-maker role, and arbitraging behavior explained the expected value of her portfolio rather well. Higher frequency had a significant negative effect, presumably because it was achieved by engaging in a rather large number of trades at inferior terms (i.e., lower sales prices and higher purchase prices). In line with prior work (Oliven and Rietz, 2004), we found that a tendency to self-select into the market-maker role had a significant positive effect. We speculate that the different behaviors inherent to the two roles (spelling out ones' terms, then waiting for the other traders to react as in the case of market-makers, versus reacting in response to others' revelation of their deal terms, as done by price-takers) might have implied differences in the degree to which participants compromised on their desired deal conditions. Price-takers might have deviated, on average, more often or more strongly.

As regards the explanatory power of the above-mentioned behavioral components, the same variables that explained expected value reasonably well, did poorly in explaining risk composition. As to potential reasons for this discrepancy, we speculate that other factors, perhaps related to a subject's preferences for certain portfolio structures (e.g., risk preference or perceived trading competence) might be better suited to explain variations in *Risk composition*. As a tentative test, we ran additional analyses with *Trading experience* included as a crude proxy for perceived trading competence, reported in Models 1b and 2b (with *Expected value* and *Risk composition* as dependent variables, respectively; see Table 3). Including *Trading experience* increased the overall explanatory power for Model 2b (*Risk composition*), but not for Model 1b (*Expected value)*. In support of our speculations, *Trading experience* was significantly and positively related to the percentage of the risky

component in a subject's portfolio (*Risk composition*), but not with *Expected value*. The idea that different factors might drive decisions relating to *Expected value* and *Risk composition* is supported by recent work in neurophysiology, which suggests that the brain codes expected value and uncertainty separately (Schultz, 2006).

Second, generally, our findings suggest that personality affects trading strategies, which, in turn, influence performance. Indeed, personality characteristics might have the potential to fill the gap identified by Oliven and Rietz (2004). Specifically, different aspects of personality impacted on different components of trading behavior. We ran analyses both with individual traits, and with profiles bundling together several personality characteristics. Type-B behavior (as typical of a *Profile 1* personality) was associated with significantly lower trading frequency – a performance-boosting strategy. Self-selection into the market-maker role, another performance-enhancing strategy, was hampered by having a *Profile 3* personality. *Profile 3* subjects tended to self-select into the price-taker role, stemming possibly from a lack of self-monitoring abilities, especially in interplay with the other *Profile 3* characteristics. Market-makers submitted limit orders. Thereby, they set out the terms of the deal at which they wanted to trade. Those who accepted acted as price-takers, and appeared, on average, to take losses compared to their market-making counterparts. The finding that *Profile 3* subjects had a greater tendency to self-select into the disadvantageous price-taker role is in line with prior work by Locke and Sarajoti (2004). They characterized the placing of limit orders as less "aggressive" than the placing of market orders. "Aggressiveness" referred to a tendency to bid relatively high and offer relatively low. Such behavior fits well with the urgency drive (type-A behavior) and assertive stance (low self-monitoring) of *Profile 3* persons. Finally, related, *Profile 3* subjects exhibited lower arbitraging. They tended to trade at

lower selling and higher buying prices. Together with the analysis based on separate traits, the result seemed to be driven largely by *Profile 3* subjects' impatience and competitiveness. The interplay with low self-monitoring and low regret disposition, traits that could counteract the tendency to forego arbitraging opportunities, appeared to further aggravate the effect.

LIMITATIONS AND FUTURE RESEARCH

Our study exhibits several limitations, pointing towards future research avenues. To start with, there is the small sample size. This restricted us in the investigation of potentially interesting interaction effects. For example, subjects might differ, depending on their personalities, in their reactions to discrepancies between expected values and realized values of favorable dividend draws. Replications with a larger number of participants would be valuable. Ideally, the extended subject pool should include professional traders as well, and subjects with different educational backgrounds (e.g., physicists and psychologists). Also, future "replications" should include a larger set of personality traits. For example, the low explanatory power of our models explaining subjects' tendency to self-select into the roles of market-maker and price-taker suggests that we might have missed out on important factors for this component. An example of such a factor is need-for-closure (Ford and Kruglanski, 1995; Kruglanski and Webster, 1996). Need-for-closure relates to a person's desire to come quickly to a closure in decisions and judgments. It captures the need to settle for any answer, rather than remain in a state of ambiguity. Individuals with low need-for-closure tend to postpone decisions. Both high and low need-for-closure carry costs, and have been associated with judgmental mistakes (van Hiel and Mervielde, 2002). Further, future work should seek to move beyond a focus on trading strategies, so as

to unravel intermediate mechanisms by exploring the link between trader features and judgments. For instance, individuals with an internal locus of control have previously been shown to be more likely than externals to develop optimistic judgments. Finally, future research should find it worthwhile to begin to systematically investigate moderating effects of market microstructure (Cheng, 2007).

NOTES

[1] We do not cover analysts, fund managers, and so on. Consideration of the behavior of professionals who act as agents for other people requires taking into account additional complications such as those arising from delegation problems.

[2] While we considered expected value as a performance characteristic, we did so in a similar way as a firm employing traders would. In this study, we are not trying to infer subjects' beliefs from their behavior. As a result, we do not investigate which particular utility functions best fit our experimental data. Instead, we looked for drivers of trading performance, in terms of trading profits.

[3] Other hierarchical algorithms yielded similar, though slightly less, clear results for the cluster solution. We ran the cluster analyses both with the raw data and based on standardized values.

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Table 1: Descriptive statistics and bivariate correlations (cases = 32)

Variables	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Risk composition	56.78	23.07																
2. Expected value	350.13	8.16	0.60***															
3. Trading frequency	97.47	59.02	-0.14	-0.31*														
4. Market-maker role	48.28	29.23	0.37**	0.57***	0.11													
5. Arbitraging	0.34	1.85	0.40**	0.67***	-0.24	0.65***												
6. Profile 1	n.a.	n.a.	0.14	0.15	-0.23	0.07	0.34*											
7. Profile 2	n.a.	n.a.	-0.09	0.16	0.04	0.21	0.14	-0.66***										
8. Profile 3	n.a.	n.a.	-0.04	-0.37**	0.20	-0.35*	-0.55***	-0.28	-0.55***									
9. Locus of control	12.22	2.86	0.15	-0.02	0.06	0.05	0.02	0.03	-0.04	0.02								
10. Maximizing tendency	3.86	0.63	0.17	0.07	-0.05	0.15	0.11	-0.01	0.16	-0.19	0.26							
11. Regret disposition	4.31	1.07	0.41**	0.17	0.06	0.12	0.09	0.27	-0.13	-0.14	0.39**	0.23						
12. Self-monitoring	8.72	3.02	-0.04	0.10	0.01	0.38**	0.19	-0.24	0.49***	-0.36**	-0.09	0.25	-0.10					
13. Sensation seeking	20.13	5.06	-0.02	0.24	0.15	0.21	0.11	-0.68***	0.76***	-0.21	0.18	0.04	-0.08	0.36**				
14. Type A/B behavior	7.09	3.59	-0.07	-0.33*	0.41**	-0.18	-0.44**	-0.47***	-0.21	0.78***	0.10	-0.07	0.00	-0.266	0.07			
15. Age	23.25	2.37	0.43**	0.10	0.03	-0.09	-0.13	0.06	-0.07	0.02	0.08	-0.10	0.26	-0.01	0.07	-0.01		
16. Gender	0.31	0.47	-0.01	-0.10	-0.24	-0.22	-0.24	-0.23	0.19	0.02	-0.32*	0.14	0.01	0.02	-0.10	0.04	-0.10	
17. Trading experience	0.34	0.48	0.38**	0.28	-0.10	0.24	0.12	-0.11	0.11	-0.01	0.41**	0.23	0.13	0.25	0.33*	0.04	0.21	-0.35*

Correlation is: ***significant at the 0.01 level (two-tailed); **significant at the 0.05 level (two-tailed); AND *significant at the 0.10 level (two-tailed).

Table 2: Personality profiles: Descriptives for personality traits

Personality trait (score range)	Profile 1		Profile 2		Profile 3	
	Mean	s.d.	Mean	s.d.	Mean	s.d.
Regret disposition (1-5)	4.80	.99	4.19	1.19	4.00	.55
Self-monitoring (0-18)	7.50	3.59	10.00	2.40	6.50	2.17
Sensation seeking (0-40)	14.25	2.12	23.44	3.67	18.00	2.53
Type-A/B behavior (0-21)	4.25	1.98	6.44	2.15	12.83	2.14
Locus of control (0-23)	12.38	1.15	12.11	0.67	12.33	1.20
Maximizing (1-5)	3.86	0.20	3.95	0.17	3.62	0.10

Table 3: Strategy effects

Dependent variable:	Model 1a *Expected value*	Model 1b *Expected value*	Model 2a *Risk composition*	Model 2b *Risk composition*
Constant	347.638***	347.109***	49.260***	45.912***
Trading frequency	-0.036*	-0.033*	-0.061	-0.043
Market-maker role	0.111**	0.100**	0.269	0.199
Arbitraging	1.880**	1.936**	1.283	1.641
Trading experience		2.227		14.097*
Cases in the analysis	32	32	32	32
Adjusted R^2	0.507	0.507	0.088	0.147
F	11.634	8.979	2.002	2.332
P	0.000	0.000	0.136	0.081

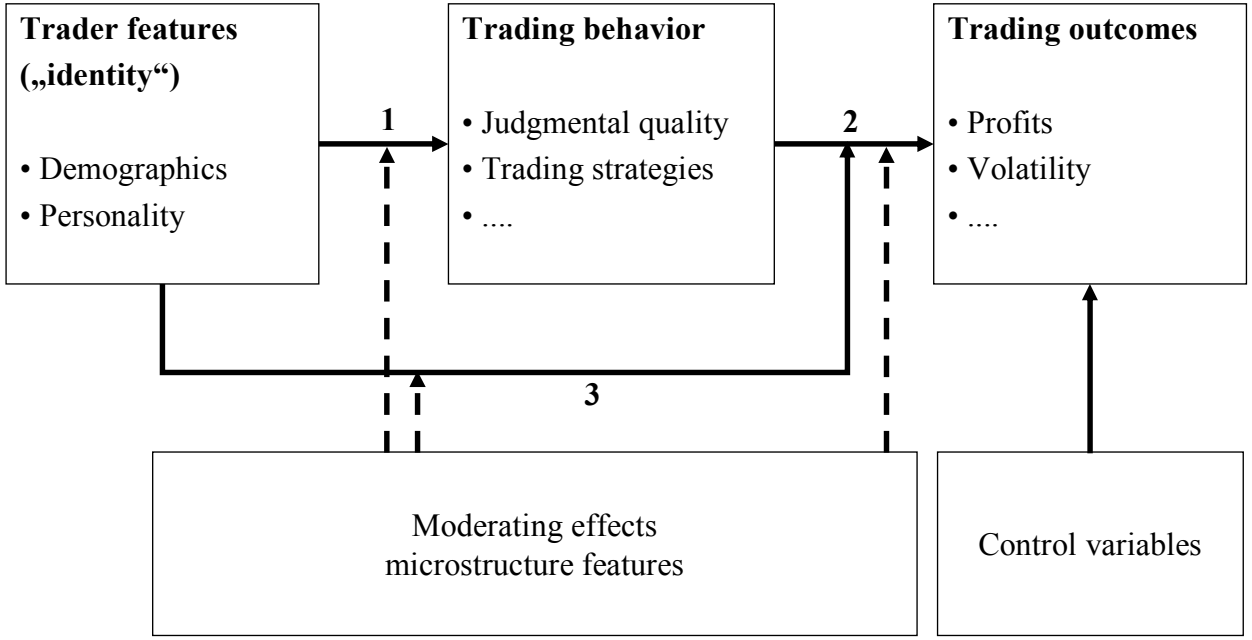
* p<0.1, ** p<0.05, *** p<0.01

Table 4: Preference effects

Dependent variable:	Model 3 *Trading frequency*	Model 4 *Market-maker role*	Model 5 *Arbitraging*
	Model 3a *Trading frequency* (Personality profiles)	Model 4a *Market-maker role* (Personality profiles)	Model 5a *Arbitraging* (Personality profiles)
Constant	4.598***	93.510*	2.833
Age	0.014	-1.754	-.098
Gender	-0.533***	-10.337	-0.464
Trading experience	-0.350*	12.238	0.358
Profile 1 (dummy)	-0.479***	-2.359	0.663
Profile 3 (dummy)	0.151	-25.787**	-1.869**
Cases in the analysis	32	32	32
(pseudo-)R^2	0.244	n.a.	n.a.
LL	-391.722	n.a.	n.a.
Adjusted R^2	n.a.	0.067	0.203
F	n.a.	1.445	2.576
P	n.a.	0.242	0.051
	Model 3b *Trading frequency* (Individual traits)	Model 4b *Market-maker role* (Individual traits)	Model 5b *Arbitraging* (Individual traits)
Constant	3.276***	46.543	2.633
Age	-0.000	-2.377	-0.127
Gender	-0.475***	-14.756	-0.738
Trading experience	-0.413**	3.572	0.045
Self-monitoring	0.042	3.290*	0.031
Sensation seeking	0.0142	0.480	0.036
Type-A behavior	0.0748**	-0.7115	-0.171*
Regret disposition	0.0831	6.292	0.250
Cases in the analysis	32	32	32
(pseudo-)R^2	0.3661	n.a.	n.a.
LL	-391.722	n.a.	n.a.
Adjusted R^2	n.a.	0.0635	0.016
F	n.a.	1.30	1.074
P	n.a.	0.292	0.410

* p<0.1, ** p<0.05, *** p<0.01

Figure 1: A general conceptual framework



1: Preference effect

2: Strategy effect

3: Alignment effect

Figure 2: A focused conceptual framework

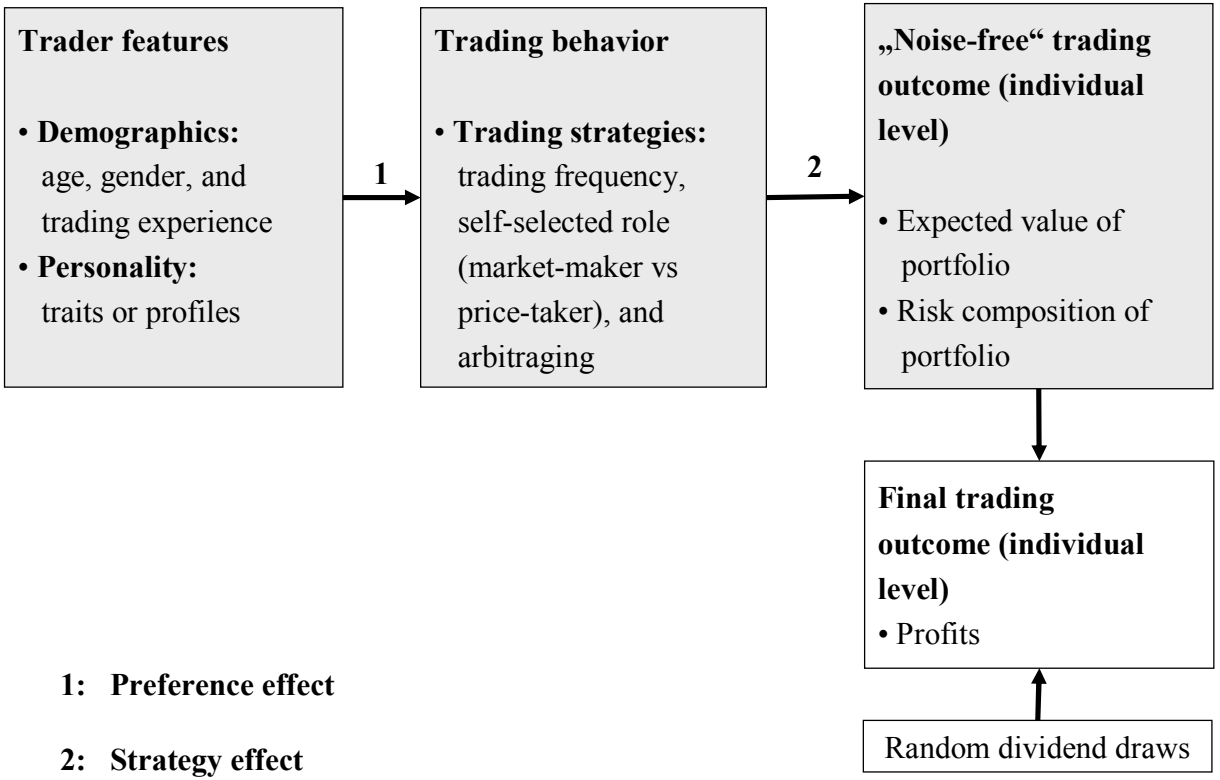


Figure 3: The influence of personality profile on the tendency to self-select into a market-maker role