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Prospect theory and trading patterns

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ABSTRACT

Reference dependence, loss aversion, and risk seeking for losses together comprise the preference-based component of prospect theory that sets its value function apart from the standard risk-aversion model. Using an elasticity analysis, we show that this distinctive preference component serves to underpin negative-feedback trading propensities, but cannot manifest itself in behavior directly or holistically at the individual-choice level. We then propose and demonstrate that the market interaction between prospect-theory investors and regular CRRA investors allows this preference component to dominate in equilibrium behavior and hence helps to reestablish the intuitive link between prospect-theory preferences and negative-feedback trading patterns. In the model, the interaction also reconciles the contrarian behavior of prospect-theory investors with asymmetric volatility and short-term return reversal. The results suggest that prospect-theory preferences can lead investors to behave endogenously as contrarian noise traders in the market interaction process.

"Two souls, alas, are dwelling in my breast, and one is striving to forsake its brother." ——— Faust Part I, Goethe.

1. Introduction

For a variety of reasons, prospect theory (Kahneman and Tversky, 1979; henceforth, PT) has become a major hypothesis for individual behavior in economic analysis. In particular, many scholars have referred to the S-shaped value function from PT as a leading preference-based explanation for negative-feedback trading patterns including short-term contrarian behavior (buying after prices decrease and selling after prices increase) and the disposition effect (individuals are more likely to sell nominal winners than losers),[1] both of which are supported by a substantial body of evidence (e.g., Barber and Odean, 2013). However, some recent theoretical studies (Barberis and Xiong, 2009; Hens and Vlcek, 2011) find counterintuitive results, indicating that the value function of PT as a whole does not necessarily lead to trading behavior that is consistent with the disposition effect in formal portfolio choice models. In this paper, we suggest a decomposition approach to the implications of PT's value function and its components to understand how investors trade in response to price changes, and we further show that PT preference can yield negative-feedback trading patterns at a market-interaction level, despite failing to do so at the individual-choice level.

Our decomposition is motivated by the statement of Kahneman (2011, Page 288) that "prospect theory was accepted by many scholars … because the concepts that it added to utility theory … were worth the trouble; they yield new predictions that turned out to be true." Specifically, although the value function favors risk aversion in the domain of gains, it deviates from the standard risk-aversion model (e.g., based on its gain function) in three distinct ways: (1) reference dependence (framing a decision problem around a reference point), (2) loss aversion (overweighting losses with respect to comparable gains), and (3) risk seeking for losses. For brevity, we refer to these combined characteristics as PT's *loss aversion component*. However, few studies have examined this preference component in isolation from (conventional) risk aversion. This lack of research raises questions about whether the loss aversion component of PT has the capability of yielding negative-feedback trading propensities, and when it manifests itself in behavior. Moreover, trading actions are outcomes in exchange relationships. Such actions are not just autonomous at the individual level, but also a derivative of the interaction process between different market participants. Another question that has yet to be

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[1] As noted by Grinblatt and Keloharju (2000) and Grinblatt and Keloharju (2001), the disposition effect can be easily interpreted as contrarian behavior with respect to price changes.

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answered is whether market interaction helps to reestablish the link between PT and negative-feedback trading behavior.

We begin with the case of individual choice by conducting an elasticity analysis. We interpret the CRRA (Constant Relative Risk Aversion) utility function in the value function, i.e., its gain part, and the deviation of the value function from the benchmark CRRA function as the manifestations of PT's risk and loss aversion components, respectively. The elasticity technique allows us to explicitly decompose the variation in a PT investor's stock holdings (i.e., the investor's trading behavior) due to price changes into the contributions from the two preference-based components. We find that the risk aversion component is generally characterized by a positive constant elasticity, while the loss aversion component is mainly characterized by state-dependent negative elasticities. The risk aversion component can therefore be interpreted as a source of the positive-feedback wealth (or portfolio-rebalancing) effect, and the loss aversion component can be considered as a source of psychological motives in favor of negative-feedback trading.

We further show that the loss aversion component can become largely irrelevant in determining PT investor's trading patterns under certain circumstances. Under the standard parametric specification of PT suggested by Tversky and Kahneman (1992), the value function is flat in the gain domain and hence the risk aversion component becomes close to risk neutral. The very low risk aversion then yields a prominent positive-feedback trading propensity in the portfolio-choice context with reasonable financial parameters. So, although the loss aversion component continues to favor negative-feedback trading, the risk aversion component overcomes this effect and produces a relation between PT preference and positive-feedback trading. This relation gradually breaks down as the value function becomes more concave for gains. Accordingly, *the partial reflection hypothesis* (i.e., utility is rather concave for gains, but mildly convex for losses; see, e.g., Loewenstein and Prelec, 1992; Wakker et al., 2007) becomes a possible candidate for delivering negative-feedback trading patterns at the level of individual choice, although still in a different way from that suggested by the loss aversion component.

We then consider a market interaction case by extending the previous partial equilibrium analysis into the general equilibrium case in an economy consisting of two types of investors: PT and regular CRRA investors. The equilibrium results reveal the dominance of the loss aversion component in the form of preference heterogeneity. As a consequence, the negative-feedback trading propensity of PT investors becomes reliably prominent, even when we use the parameter values obtained by Tversky and Kahneman (1992). Our analysis also suggests that PT's negative-feedback trading actions are associated with price pressures that are consistent with the asymmetric volatility effect (Black, 1976; Glosten et al., 1993; Avramov et al., 2006; Hibbert et al., 2008) and short-term return reversals (Jegadeesh, 1990; Lehmann, 1990). The properties are consistent with the basic intuition of the noise trading models (e.g., De Long et al., 1990; Campbell and Kyle, 1993; Campbell et al., 1993) that noise traders' demand shocks give rise to a source of volatility and price reversal when demand curves are downward sloping. In this sense, because of the non-informational trading reasons introduced by the loss aversion component, PT investors can behave endogenously as contrarian noise traders in the market interaction process.

With further analysis, we evaluate the validity and general applicability of our elasticity (sensitivity) results. We test whether our basic conclusions are still valid when we measure the disposition effect with the method used by Odean (1998), as was done by Barberis and Xiong (2009). In doing so, we complement the literature on the disposition effect by calibrating our PT portfolio choice model with the seasonality of trading characteristics reported by Odean (1998). The calibration yields results that are consistent with a partial reflection hypothesis.

This paper relates to the literature on PT in financial analysis. Of the notable works in this area, ours is most related to those of Barberis and Xiong (2009), Berkelaar et al. (2004), and Berkelaar and Kouwenberg (2009). From a technical point of view, this study can be considered an extension of the portfolio choice and asset pricing models in Berkelaar et al. (2004) and Berkelaar and Kouwenberg (2009) to a stock-holding elasticity (or sensitivity) analysis. The individual-choice case in the current work can be thought of in part as a continuous-time analogy of Barberis and Xiong (2009). We use a continuous-time market setting and elasticity concepts to yield a rigorous understanding of how different preference-based components of PT give rise to different trading propensities. This allows us to shed more light on both the power and limits of PT in the analysis of trading behavior. Moreover, to our knowledge, no study formally investigates the possibility that market interaction helps to reestablish the link between PT and negative-feedback trading behavior, or the possibility that PT contributes to reconciling contrarian behavior with noise trading. In addition, the return reversal prediction in our market-interaction case is contrary to the argument of Grinblatt and Han (2005) that by generating trading actions consistent with the disposition effect, PT preferences lead to momentum in stock returns. We thus have a different model and different results from theirs in terms of the nature of contrarian behavior or the implications of PT preferences for price and trade dynamics.

The remainder of this paper is organized as follows. In Section 2, we build stock demand (holding) as a function of stock price based on a continuous-time portfolio model, and analyze its price elasticities to examine how PT predicts trading behavior at the individual-choice level. In Section 3, we extend the previous partial-equilibrium setting to a general-equilibrium setting, and investigate how the market interaction between CRRA and PT investors determines investor and price behavior. In Section 4, we verify that the obtained results can also be extended very readily to the case of the disposition effect defined by the empirical methodology of Odean (1998), and offer an empirical calibration based on data from the literature. Section 5 concludes the paper.

2. Elasticity decomposition, trading patterns, and PT

2.1. Basic setup

This section uses a partial equilibrium complete market framework to analyze trading pattern issues. The framework can be considered the standard continuous-time analogy used by Barberis and Xiong (2009). There are two assets. The first asset is a riskless bond with a constant interest rate, r_f, while the second asset is a risky stock whose price $S(t)$ satisfies

$$\frac{dS(t)}{S(t)} = \mu dt + \sigma dB(t), \quad S(0) = S_0, \tag{1}$$

where both parameters μ and $\sigma > 0$ are constants and $B(t)$ is a standard Brownian motion. As suggested by Barberis and Xiong (2009), this one risky asset assumption is reasonable in a multi-stock setting when the investor is prone to "mental accounting," or when the initial wealth is interpreted as the maximum amount the investor is willing to lose in any one stock.

In this setting, we can obtain the following unique state price density process:

$$d\zeta(t) = -\zeta(t)(r_f dt + \theta dB(t)), \quad \zeta(0) := \zeta_0, \tag{2}$$

where $\theta = \sigma^{-1}(\mu - r_f)$ denotes the market price of risk (or the Sharpe ratio).