Reference Dependence, Trading Experience and the Disposition Effect

1 Introduction

The disposition effect, one of the stylized anomalies in the financial market, refers to investors' tendency of liquidating winners too early and riding losers too long when making selling decisions. Rational explanations of the disposition effect, such as portfolio rebalancing, insider information, and beliefs in mean-reverting returns, do not find much empirical support (Odean, 1998). On the other hand, the seemingly intuitive and appealing but informal behavioral explanation for the disposition effect, the prospect theory proposed by Kahneman and Tversky (1979), has been widely accepted. Several early analytical works lend support to this argument either with modified prospect theory specifications or with an endowed indivisible risky asset (Gomes, 2005; Kyle, Ou-yang, Xiong, 2006). However, Barberis and Xiong (2009) shows that prospect theory preference fails to predict the disposition effect for a wide range of reasonable parameters, casting doubt on whether prospect theory indeed generates disposition effect if investors *ex ante* anticipate that *ex post* they are subject to this behavioral bias and therefore won't buy the stock in the first place.

Most of the previous studies investigating the relationship between prospect theory and the disposition effect assume an exogenous reference point that is dynamically invariant. However, in a dynamic setting the reference point may shift in response to prior gains and losses (Kahneman and Tversky, 1979; Thaler and Johnson, 1990). To formalize this idea, Kőszegi and Rabin (2009) develops a dynamic reference-dependent model in which the gain-loss utility of a loss-averse agent is defined over changes in his *recent probabilistic beliefs*, which in turn depends on both prior outcome and expectation of the future. Some recent empirical studies are consistent with theoretical prediction of the model. Meng (2010) finds favorable evidence that expectation of future stock returns is the most reasonable reference point. Chiyachantana and Zong (2010), using data of institutional trades, documented evidence suggesting that prior outcomes and recent expectations jointly contribute to reference point adaptation and hence influence the magnitude of the disposition effect.

This paper adopts Kőszegi and Rabin's idea of reference-dependant preference to examine whether trading experience helps eliminate the disposition effect. It has been documented that investors with more experience with trading are less prone to the disposition effect (Shapira and Venezia, 2001; Dhar and Zhu, 2006). However, Kaustia (2010) finds an asymmetric relationship between stock trading periods and the disposition behavior. That is, longer trading periods reduces investors' tendency to liquidate winners but does not seem to impact their attitudes towards losers. To account for the empirical facts, this paper extends Meng (2010)'s model to incorporate an endogenous reference point as suggested by Kőszegi and Rabin and finds that in our experimental settings trading experience indeed influences individual disposition effect in an asymmetric way, reducing the tendency of liquidating winners while enforcing that of riding losers. Thus our model accounts for some relevant empirical facts and provides an explanation of why trading experience may alleviate, but cannot eliminate the disposition effect.

2 Model Setup

There are two types of assets in the economy: cash which earns zero interest rate; and a stock whose return r is independently and identically distributed across periods. Assume r 's cumulative distribution function in each period is $F(r) = F_X(r \mid X > -1)$ where $X \sim \mathcal{N}(\mu, \sigma^2)$. This assumption guarantees that investors cannot lose more than the amount they invest. Both assets are of perfect elastic supply. Denote stock price in period t as P_t which evolves according to $P_t = P_{t-1}(1 + r_{t-1,t})$.

There is one representative agent in the economy who holds wealth W_t in period t. his wealth evolves according to:

$$W_t = B_{t-1} + x_{t-1}P_t = B_{t-1} + x_{t-1}P_{t-1}(1 + r_{t-1,t}) = W_{t-1} + x_{t-1}P_{t-1}r_{t-1,t} \tag{1}$$

where B_t denotes the period t cash holding and x_t the period t stock share holding. The second equality follows from stock price drifting behavior. To see the first and last equality, one only needs to see the wealth equivalence before and after period t portfolio adjustment.

Suppose that the agent has been holding the stock for n periods up to period t ($n \le t$) and is going to liquidate the stock in period *t+1* for consumption. Let us consider his period t portfolio choice problem: by choosing an optimal stock holding position $x_t^n *$, the agent maximizes his expected prospect utility of period *t+1*:

$$\max_{x_t^n} E_{t,n}(U(W_{t+1} - W_{rp})) \tag{2}$$

$$U(x)=\begin{cases} x^{\alpha} & for\ x\geq 0 \\ -\lambda(-x)^{\alpha} & for\ x<0 \end{cases} \tag{3}$$

where $E_{t,n}(.)$ is the subjective expectation operator of the investor who has been holding stock for *n* periods up to period *t*. W_{rp} denotes the reference level of wealth. Parameter $0<\alpha\leq 1$ governs diminishing sensitivity of the value function, while parameter $\lambda>1$ governs degree of loss aversion.

We specify W_{rp} as follows: Motivated by Köszegi and Rabin's idea that past events and future expectations jointly determine the current reference point, I make the assumption that an agent who has been holding the stock for *n* periods up to period *t* has reference level:

$$W_{rp}=B_{t-1}+x_{t-1}^{n-1}P_{t-1}(1+r_{rp}^{n}) \tag{4}$$

where

$$r_{rp}^{n}=\eta\frac{(n-1)\overline{r}_{n-1}+r_{t-1,t}}{n}+(1-\eta)E_{t,n}(r_{t,t+1}) \\ \eta\in[0,1] \tag{5}$$

where $\overline{r}_{n-1}$ is the mean of stock returns of the *n-1* periods prior period *t-1*.

Note that r_{rp}^{n} is the weighted sum of the arithmetic mean of past *n* periods stock returns and expectation of future period stock returns. This specification captures two reference point drifting features documented in the literature. First, more imminent events are more saliently felt than more distant events and "too" distant historical performance is thought to be irrelevant to current reference point dynamics (Chan, Jegadeesh, Lakonishok, 1996; Chae, 2005; Barberis and Thaler, 2002). In particular, I assume the "cutting point" to be when the investor bought the stock and started to hold it, after which he observed its returns which serve as basis on which the current reference point is formed. Second, people immediately but incompletely adjust their reference point in response to newly arrived information (Barberis, Huang, Santos, 2001; Chen and Rao, 2002). It is obvious that with the present of term $\overline{r}_{n-1}$, r_{rp}^{n} tend to react sluggishly to $r_{t-1,t}$.

3 Assumptions, Results and Economics Intuitions

We model investors' trading experience as their consecutive stock holding periods up to period *t*. This idea is consistent with Nicolosi, Peng and Zhu (2009). We compare decisions of two investors with different holding periods, *m* and *n*. Three assumptions are made as follows:

1. $\alpha = 1$; This means that the value function's diminishing sensitivity component vanishes. This allows us to give a closed-form solution to the problem and is also consistent with the experiment results of Tversky and Kahneman (1992) that the value function is only mildly concave and convex in the gain and loss regions respectively.
2. $\overline{r}_{n-1} = \overline{r}_{m-1} \triangleq \overline{r}$; $x_{t-1}^{n-1} = x_{t-1}^{m-1} \triangleq x_{t-1}$; these two restrictions guarantee that the two investors are *ex ante* identical except for their trading experience, thus helping to isolate the differential effect of $r_{t,t-1}$ on x_t^n* and x_t^m* respectively. Moreover, it is also realistic in that it is consistent with the law of large numbers.
3. $E_{t,n}(r_{t,t+1}) = E_{t,m}(r_{t,t+1}) = \mu$; That is, both investors have rational expectations over future stock returns.

Results are summarized in the following proposition.

Proposition: Given that $[\int_{-1}^{0} e^{-\frac{r^2}{2}} dr]\mu - [1-e^{-\frac{1}{2}}]\sigma < \frac{\sqrt{2\pi}}{1-\lambda}[1-F_X(-1)]$:

$\forall m, n \in \mathbb{N}$ s.t. $m > n$

1; $x_t^m * > x_t^n *$ if $r_{t-1,t} > \bar{r}$;

2; $x_t^n * < x_t^m *$ if $r_{t-1,t} < \bar{r}$;

3; $|x_t^m * - x_t^n *|$ is strictly increasing in $|r_{t-1,t} - \bar{r}|$; in addition, $|x_t^m * - x_t^n *| \to 0$ as $|r_{t-1,t} - \bar{r}| \to 0$.

Proof: The optimal interior solution of x_t^n *is given by:*

$$x_t^n * = \begin{cases} \frac{x_{t-1}}{K_1}\left(\frac{r_{rf}^n - r_{t-1,t}}{1+r_{t-1,t}}\right), \text{when } r_{t-1,t} < r_{rf}^n \\ \frac{x_{t-1}}{K_2}\left(\frac{r_{rf}^n - r_{t-1,t}}{1+r_{t-1,t}}\right), \text{when } r_{t-1,t} > r_{rf}^n \\ 0, \text{when } r_{t-1,t} = r_{rf}^n \end{cases} \tag{6}$$

Where $K_1 > 0$ *and* $K_2 < 0$ *are the two roots of:*

$$\frac{\partial E_{t,n}(U(W_{t+1} - W_{rp}))}{\partial x_t^n} = (\lambda - 1)[-\sigma(e^{-\frac{K^2}{2}} - e^{-\frac{1}{2}}) + \mu\int_{-1}^{K} e^{-\frac{r^2}{2}} dr] + \sqrt{2\pi}[1-F_X(-1)] = 0 \tag{7}$$

whose existence is guaranteed by:

1; $\mu > 0$.

2; $[\int_{-1}^{0} e^{-\frac{r^2}{2}} dr]\mu - [1-e^{-\frac{1}{2}}]\sigma < \frac{\sqrt{2\pi}}{1-\lambda}[1-F_X(-1)]$ *; i.e.* $[\frac{\partial E_{t,n}(U(W_{t+1} - W_{rp}))}{\partial x_t^n}]\Big|_{K=0} < 0$

Hence:

$$x_t^m * - x_t^n * = \frac{x_{t-1}}{K_i}\left(\frac{r_{rf}^m - r_{t-1,t}}{1+r_{t-1,t}}\right) - \frac{x_{t-1}}{K_i}\left(\frac{r_{rf}^n - r_{t-1,t}}{1+r_{t-1,t}}\right) = \frac{x_{t-1}}{K_i}\left(\frac{r_{rf}^m - r_{rf}^n}{1+r_{t-1,t}}\right) = \eta \frac{n-m}{mn} \frac{x_{t-1}}{1+r_{t-1,t}} \frac{r_{t-1,t} - \bar{r}}{K_i} \quad (8)$$

Where i=1 if $r_{t-1,t} < \bar{r}$ *, i=2 if* $r_{t-1,t} > \bar{r}$ *. The third equality follows by plugging in equation*(5) with parameter *m* and *n*. *With equation*(8) and the fact that $K_1 > 0$ *and* $K_2 < 0$, *it is trivial to verify that the proposition holds.* Q.E.D.

The proposition states that trading experience reduces the tendency to sell winners but enforces the impulse to ride losers. The discrepancy due to trading experience vanishes as recent stock performance matches its historical average.

The intuition is as follows: Compared to an inexperienced investor, a more experienced investor tends to have a more stable reference point, in the sense that he reacts less to recent stock performance. Therefore, given historical performance up to period *t-1*, in period *t* the more experienced forms a relatively lower (higher) reference point facing a high (low) realization of stock price. Being in the gain (loss) region, both the more experienced and the inexperienced investors gambol to the respective lowest (highest) possible wealth level. With a lower (higher) reference wealth level, the more experienced investor has to purchase more stocks in order to gambol to the edge, alleviating (exaggerating) the disposition effect. To understand the third point in the proposition, note that the more the stock's recent performance deviates from historical performance, the larger the gap between the inexperienced and more experienced investors' reference points, hence the sharper the discrepancy between their stock holding positions.

4 Conclusion and Future Research Plan

This paper presents a static portfolio choice model to illustrate why trading experience may alleviate, but cannot eliminate the disposition effect. We show that more experienced investors with more trading experience who therefore have more stable reference points have less propensity to liquidate winners but greater propensity to ride losers. The discrepancy due to trading experience vanishes as recent stock performance matches its historical average.

I acknowledge Dr. Chun Xia from The University of Hong Kong for his helpful comments and firm support in my preparation for this writing sample. This paper is part of a project by Dr. Xia for whom I have been a research assistant. Possible further extensions include: first, conduct mean-variance analysis with equation(7). Though it is difficult to find a closed-form solution of K as a function of μ and σ, we may conduct numerical analysis and compare different values of K when experiencing capital gain and capital loss; second, extend the static portfolio choice problem into dynamic settings in which the investor takes into account the effect on future reference points when making current investment decisions. The extension is necessary if we wish to examine how reference point endogeneity affects the investor's portfolio decisions. The static model described above is inadequate in this aspect because investors when making decisions understand that their choices won't affect the current reference point which, according to equation(4) and(5), is only determined by previous investment decisions.

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