TI 2008-112/2
Tinbergen Institute Discussion Paper

A Dynamic Model of Investor Decision-Making

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A Dynamic Model of Investment Decision Making:
How Adaptation to Losses Affects Future Selling Decisions

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Abstract

We conduct an experiment to test whether the size of a loss and the time in a losing position affect investors' adaptation to the loss situation and, subsequently, whether this adaptation affects future investment decisions. As investors adapt to losses, their neutral reference point shifts downwards causing losses to become psychologically less painful. This shift in reference point is a dynamic process that is updated every time new information is received about the stock's performance. The dynamically changing reference point, together with changing perceptions on the stock's expected future performance, together influence the decision to hold on to or to capitulate on an investment. We study the relative contribution of each of these components as well as their inter-relationships in a dynamic experimental design. Our results indicated that a larger loss size and a longer time in a losing position are related to higher adaptation levels. These higher adaptation levels relate to less positive emotions and less optimistic expectations about future price changes. The actual decision to capitulate an investment, however, only depends directly on the expectation about the stock's future performance. The adaptation level, by contrast, affects the actual investment decision indirectly via its impact on expectations.

Keywords: adaptation, capitulation, selling decisions, investment.

I. Introduction

[Generally, we now start with capitulation, and then bring in adaptation. Why not link up to adaptation of reference points, but the missed link to actual subsequent decision making in a dynamic context given adaptation and possibly changing expectations. This links up to more recent literature I think.]

Shefrin and Statman (1985), Weber and Camerer (1998) found evidence that investors have a tendency to hold their losers (depreciated investment) too long and sell their winners (appreciated investment) too soon, this phenomenon is known as the disposition effect. Odean (1998) analyzed individual trading accounts from a large discount brokerage house and found the disposition effect to be robust, investors sell winners 1.6 times more than losers. It is evident that investors prefer avoiding rather than realizing losses, nevertheless, there are times that investors choose to sell their depreciated equities and convert them into cash or other less risky assets, this phenomenon is known as "capitulation" in financial markets. A question remains unanswered is: since investors generally avoid realizing losses, what leads to capitulation? Does it depend on the size of loss and/ or the time in losing position? What roles do reference dependence (prospect theory), expectations (expected utility framework) and emotions play in the decision making process? In this paper, we aims to test a comprehensive model which takes the above mentioned factors into account, we examine how adaptation to losses affect one's neutral reference point, hence influence his or her expectation and emotions, eventually leads to the decision to hold or to capitulate a losing investment.

Much effort from standard finance has contributed to the understanding of investors' portfolio choice and trading behavior. The majority of models assume that investors evaluate investment options according to the expected utility framework, that when faced with uncertainty, people make decisions based on the utility of the outcomes and their respective probability. This theoretical motivation, first developed by von

Neumann and Morgenstern (1944), formed the basis of portfolio theory (Markowitz 1952), and was later extended by Sharpe (1964), Fama (1971) and Black (1972), among others. However, empirical evidence in recent decades shows that people systematically violate the expected utility framework. For example, Shefrin and Statman, (1985) coined the disposition effect, Thaler and Johnson (1990) found the "house money" effect, that when facing subsequent gambles, people's decisions to take or skip the gambles depends not only on their expected utility, but they are more willing to take risks if they have won in prior gambles than if they have lost.

On the other hand, prospect theory (Kahneman and Tversky 1979) has been gaining prominence in psychology and behavioral economics literature. In prospect theory, gains and losses are not measured in absolute terms of overall wealth. Instead, it is a reference dependence model in which each stimulus' value depends on its difference in value compared to a neutral reference point. A vast amount of studies based on market data have found evidence inline with the prospect theory, for example, Lichtenstein and Bearden (1989) showed that merchant–supplied reference prices influence consumer's perception on prices; Urbany, Beardan and Weilbaker (1988) found that reference prices affect consumer perception and price search; Winer (1986) showed that reference price influence the brand choice for frequently purchased products. It appears that prospect theory provide a better framework to investigate decision making in real life situations. Although prospect theory has been applied in various studies to investigate human behaviors, not until recently the role of adaptation of reference point plays in decision making process has received some attention. Researchers have proposed various ways to measure or model adaptation of reference point.

Koszegi and Rabin (2006) and Yogo (2008) recently proposed that adaptation is one's expected value of the future outcome. While not opposing to one's rational expectation may play a role in decision making and such a reference point may be

adaptable, the focus of our study is the adaptation of neutral reference point and we are interested in how one adapts to the current state may influence his or her future decisions. Along the same logic, although Odean (1998) suggested that initial purchase price of stock is a reference point use in decision making, and Gneezy's (2005) experimental results suggested that investors are most likely to use historical peak of the price of stock as reference point, their results are not conflicting to our model since it is possible to have multiple reference points in a decision making process. However, we argue that since the value of each stimuli (e.g. historical peak, initial purchase price) are dependent on the value of the neutral reference, it is of utmost importance to first get a clearer picture of adaptation of the neutral reference point.

Chen and Rao (2002) suggested that people immediately but incompletely update their reference point after experiencing an event. They found that holding economic outcome constant, the sequence of events (either loss-follow-by-gain or gain-followed-by-loss) affect one's psychological appraisal of the outcome. Nonetheless, their study did not account for the dynamics and uncertainties in decision making since outcomes are presented explicitly and evaluated retrospectively.

A recent study by Arkes *et al.* (2008) presented evidence that people adapt to gain faster than to loss of the same magnitude. However, there are limitations to their findings. Arkes *et al.'s* experimental design consists of short time frame (2-3 time points) and they controlled for expectations (that there is a fair chance of upside or downside movement of the same magnitude in the future), with this method, the authors minimized the possible effect of expositional biases. However, compare to the financial markets, this set up is unrealistic and not dynamic as only 2 possible outcomes of the security were presented synthetically, thus it does not allow researches to test the relationship between expectation and adaptation, which is the contribution of our study. Instead of controlling for

expectation, we will measure investors' expectations of the price change of their security and test how that is affected by adaptation to losses.

Moreover, in several experiments, Arkes *et al* asked participants to estimate the price change that would induce the same magnitude of happiness (sadness) due to a previous gain (loss), the limitation of such measure is that people may not estimate their emotions accurately. Affective forecasting studies **(**Gilbert, Pinel, Wilson, Blumberg & Wheatley, 1998; Wilson, Wheatley, Meyers, Gilbert & Axsom, 2000; Gilbert, Driver-Linn & Wilson, 2002) demonstrated that although people often predict the valence of their emotional reaction (good vs. bad), or even the specific emotions (e.g. joy) correctly, they overestimate the intensity and duration of the emotional reactions. To overcome these issues, we conduct an experiment consists of realistic settings, extended time frame, and multiple measures of adaptation of neutral reference point, details will be discussed in the method section.

The present study contributes to the existing literature by proposing a dynamic model of investment decision-making. We test whether size of losses and time in losing position affect investors' adaptation of neutral reference point, then we systematically examine how the neutral reference affects investors' emotions and expectations, which then influence their decision to hold or to capitulate a losing investment. We focus on examining investors' hold/ capitulate decisions subsequent to initial purchase and losses because this type of downside selling decision is of high importance in understanding trading behaviors in the financial market, e.g. we may provide new insights in understanding disposition effect.

Our model is first motivated by the implication of prospect theory (Kahneman and Tversky 1979) and adaptation level theory (Helson 1964), that the adaptation of neutral reference point can be modeled as changes in adaptation level. Second, we adopt the framework of cognitive-experiential self-theory (Epstein 1994), which suggest there are

two systems in decision making: experiential and rational. This framework is chosen because not only it allows us to examine investors' decision-making process from the rational point of view, but it also let us take emotional input into account.

The remainder of this paper is organized as follow. Section II reviews prospect theory, adaptation level theory and cognitive-experiential self-theory, then we synthesize these three theories and postulate a dynamic model of investment decision making. Section III conveys the experimental design and Section IV discusses the empirical results. Finally Section V concludes the findings from the experiment and provides implications for future research in adaptation of reference point.

II. Theoretical Background

II. 1 Reference Dependence and Adaptation Level

The two theories that underlie our model for adaptation are prospect theory as developed by Kahneman and Tversky (1979), and dynamic adaptation theory as developed by Helson (1964).

According to prospect theory, outcomes are evaluated relative to a neutral reference point. If the outcome is above (below) the neutral reference point, it is considered a gain (loss). The hedonic principle suggests it is human nature to seek pleasure and to avoid losses and punishment. Although selling a losing investment can prevent one from incurring further losses, actually realizing the loss may be nonetheless psychologically painful if the reference point is higher than the current stock price. Kahneman and Tversky (1979) show that losses impose approximately double the psychological effect of gains. Therefore, when investors face the choice to realize a financial loss now or not, they tend to take the risky action (in our case, holding on to the losing investment) in order to retain the possibility of avoiding the loss. This is known as loss aversion.

Weber and Camerer (1998) and Odean (1998) among many others use experimental and empirical data to show that investors in the financial markets actually have a tendency

to hold on to their losing positions. Investors' reluctance to sell at a loss is also found outside the stock market. For example, Case and Shiller (1988), Genesove and Mayer (2001) conclude that in the property market, owners are more likely to sell at a profit than at a loss.

The empirical evidence that investors tend to avoid the realization of losses combined with the phenomenon that in the end many investors do capitulate on losing positions, leads to the question what are precisely the determinants of this decision to capitulate. This is particularly of interest in a dynamic setting, where investors can opt to capitulate or not every time they receive new information about the stock's performance. In this paper we argue that a prime candidate determinant of the capitulation decision is the investors' dynamic adaptation to losses. Adaptation is a process in which the effect of a constant or repeated stimulus reduces over time. Studies have shown that individuals are able to adapt to various kinds of losses/ unpleasant situations (see Frederick and Loewenstein 1999 for an overview), for example, surgeons can get used to operations although it is sickening for most people (Brickman, Coates and Janoff-Bulman 1978). Adaptation level theory (Helson 1964) suggests that the perceived magnitude of a stimulus depends on its relation to an adapted level which is determined by preceding stimuli. According to Helson's formula (1964), adaptation level (*AL)* is the average of past stimuli levels, while *X* represents the current stimulus level, and *t* represents time (another version of this formula that captures time discounting was proposed by Hardie, Johnson and Fader 1993):

$$AL_t = \frac{1}{t}\sum_{t=0}^{t} X_t \qquad (1)$$

By comparing adaptation level theory (Helson 1964) with prospect theory (Kahneman and Tversky 1979), we can see that adaptation processes is similar to a shift of neutral reference along the value function proposed by prospect theory. Suppose one invests in a stock and then its price drops immediately, the neutral reference and the adaptation level is the initial purchase price; the current change in value is then judged to be

a loss. Over time, if investors adapt to the loss, in the framework of adaptation level theory, the adaptation level is the average of the initial price and the current price; and in the framework of prospect theory, the neutral reference point shifts downwards along the value function towards the loss, position of the neutral reference is not specified. Nonetheless, both theories presume that the neutral reference point shifts downwards towards to loss, this would restore investor' emotional state and they would feel less pain from the loss, thus are more likely to keep holding a loser. Later if the stock price bounces back, investors may even feel happy and perceive the change of price to be a gain, regardless of in terms of overall wealth the raise may only imply a smaller loss.

It is, nonetheless, important to note that adaptation level theory originates from studies of the sensory systems, e.g. how people adapt to weight and pain, and adapting to psychological pain caused by financial loss is not a purely sensory experience. It is unlikely that investors adapt to loss precisely based on the Helson's formula. Adaptation level is difficult, if not impossible to measure, for instance, Lichtenstein and Bearden (1989) found that in price perception research, the basis of internal reference price range remains largely unknown, as each consumer may perceive the prices and form their basis differently. Arkes *et al.* (2008) inferred reference point adaptation based on minimum selling prices and prices that would leads to equivalent feeling of happiness (sadness) due to previous gain (loss). Our study contributes to the understanding of adaptation of reference point by proposing novel ways to estimate investor's adaptation to financial losses. We ask investors to report at what price level they would feel satisfied and at what level they would be willing to sell their security. We assume that investors should not lower their goals unless their neutral reference is lowered. By comparing the reported price levels at multiple time point, we then calculate the difference of the reported prices and infer level of adaptation. (See method section for details).

II.2 Dual processes decision-making models

As each stimulus may be the input of the one's decision making process, it is important to examine the process itself. The growing body of behavioral finance literature has highlighted a limitation of standard finance – economic agents are not as rational as assumed, their behaviors often violate the expected utility framework, for example, people use mental accounting (Thaler 1985); prior outcomes affect people's subsequent risky choices (Thaler and Johnson 1990), myopic loss aversion affect investment behaviors (Benartzi and Thaler 1995), investor psychology causes under- and over reaction in security markets (Daniel, Hirshleifer and Subrahmanyam 1998). Since the rational approach does not seem to fully explain investors' trading behavior, our study adopts the dual process approach. Instead of focusing on rational process, this approach also addresses the importance of the automatic/ emotional process in human's decision making. The idea that decision process can be divided into two parts – namely intuition and reason, has a long history (see Chaiken and Trope 1999 for an overview). Contemporary psychology mainly labels this idea as dual process theories, examples include: hot-cold model (Metcalfe and Mischel 1999), MODE model (Fazio and Towles-Schwen 1999), associative system vs. rule-based system (Sloman 1996), cognitive-experiential self-theory (Epstein 1994), among others. All these models differ in details, but in general they all distinguish the two operating systems as one is quick and emotionally driven, the other is slow and governed by rules.

Among all, cognitive-experiential self-theory (Epstein 1994) seems to be the best fit in our model. Epstein (1994) suggests that there are two systems in decision-making, namely the experiential system and the rational system. The experiential system can automatically and effortlessly process information, it also interacts with the rational system as a source of intuitive wisdom and creativity. On the other hand, the rational system is a deliberative and effortful system; it processes at a high level of abstraction and is able to handle long term delay of gratification, but it is not an efficient system to process the vast

amount of information one comes across in everyday life. Since conventional way of examining investors trading behavior adopted by standard finance is based on rationality, i.e. rely on the rational system, this approach may only account for half of what is going on in investors' mind. This may be the reason why expected utility framework sometime fails to describe or predict trading behavior. In order to get thorough understand of investors' decision making process, it is necessary to take the emotion-driven experiential system into consideration.

By synthesizing prospect theory, adaptation level theory and cognitive-experiential self-theory, we argue that when investors experience a loss, a new adaptation level is created and it value lies between the original neutral reference and the value of the loss. This adaptation level can be seen as an updated neutral reference point as in the framework of prospect theory. By providing comparison to any other stimuli, this updated neutral reference point creates input values to both the rational and experiential systems, and eventually affects investors' decision to hold or to capitulate the losing investment.

In all, our model employs the dual processes framework of the cognitive-experiential self theory, and extends it by adding a dynamic component – adaptation level as reference point. Next we propose hypotheses related to investors' adaptation and decision making process.

II.3 Research model

Our model is presented in Figure 1. A number of the effects presented in the figure have also been studied in previous literature, for example, the relations between the loss since the previous period, the experiential system, the rational system, and behavior. See the overview by Loewenstein and Ted O'Donoghue (2007). Our main contribution lies in testing the effects of loss size and time on adaptation, and the effect of adaptation on the experiential and rational systems, and hence on the actual decision to capitulate or not. We explain these effects and the ensuing hypotheses in more detail below.

1. The effect of loss size and time in losing position on adaptation

As stated by the formula of adaptation level theory, the adaptation level is determined as a recursive average of all preceding stimuli. This implies the adaptation level is updated at every point in time. In our settting, the simuli are given by the realized changes in stock prices over a specific period. We do not expect that the adaptation process follows the precise dynamics of (1), but we do expect a significant relationship from the total sum of past stimuli and the elapsed time to the final adaptation level. In particular, we expect the adaptation level to be positively related to the sum of all previous changes in the stock price ($X_t = P_t - P_{t-1}$), and negatively to the number of time points (t). The sum of past stimuli in our setting thus collapses to the size of the total loss since $t = 0$, i.e., $(P_0 - P_t)$. To state it formally, we hypothesize that

H1: Size of total loss and time in losing position are positively related to adaptation.

We model this in a linear way as

$$A_t = \alpha + \beta_1 \cdot t + \beta_2 \cdot (P_0 - P_t) + \varepsilon_{1t}, \tag{2}$$

where A_t is the adaptation level, t is the time in the losing position, and $(P_0 - P_t)$ is the size of the total loss.

2. *Adaptation affects rational and experiential systems and the decision to capitulate or not.*

Following cognitive-experiential self-theory, we hypothesize that investors' adaptation to losses affects their subsequent investment decisions. In particular, their (adapted) new neutral reference point is an input for the dual processes decision-making model, as the reference point is processed by both the rational and experiential systems. [NOTE this implies a direct effect]Based on the hedonic principle, investors feel worse when they

suffer larger losses. Although loss adaptation reduces the psychological pain, in absolute terms we still expect adaptation is negatively related to positive emotions. On the other hand, we also expect investors to process the stock prices with the rational system. As total loss accumulates, investors may consider the market to have pessimistic expectation towards the stock, thus may adjust their own expectation accordingly. To sum up and state formally:

H2: Adaptation is negatively related to one's positive feelings and optimistic expectations towards the losing investment.

Effect of adaptation on feelings and expectations are modelled respectively as follow:

$$E = \alpha + A \cdot \beta_1 + \varepsilon \quad (3)$$

$$EX = \alpha + A \cdot \beta_2 + \varepsilon \quad (4)$$

where E = emotion, EX = expectation, A = adaptation.

It is also expected that when investors feel bad about the losses to a certain extent, they no longer hold on to the losing investment. It is because loss aversion is a mechanism to protect one's psychological well being, if the present loss causes sufficient negative feelings, one is expected to be more likely to capitulate the stock. Also, as it is only rational to hold a currently losing investment if one expect a bounce back in price in the future, it is anticipated that if investors' expectation of the stock price become excessively pessimistic, they are likely to capitulate the losing investment. Thus, the effect of adaptation on the decision to hold or to capitulate, through the emotional and experiential systems is stated formally as follow:

H3: Adaptation is positively related to one's tendency to capitulate the losing investment.

Effect of adaptation, feelings and expectation on the hold or capitulate decision is modelled as follow:

$$(H/C) = \alpha + A \cdot \beta_1 (E \cdot \beta_3) + A \cdot \beta_2 (EX \cdot \beta_4) + \varepsilon \quad (5)$$

where H = hold, C = capitulation, E = emotion, EX = expectation, A = adaptation.

Since the aim of this study is not to validate the dual process model but to add a dynamic component to it, we do not test how the rational and experiential systems interact, and the validity of cognitive-experiential self-theory relies in a significant body of previous research (for example, see Finucane, Alhakami, Slovic and Johnson 2000; Haidt 2001; Kahneman and Frederick 2002) Nonetheless, we include one measure for each of the two systems in order to check for consistency with previous findings.

III. Experimental design and research methodology

There were 111 participants (72 male, 39 female) in this study, they took part in the experiment with a chance to win a €100 prize by enrolling in a fair lottery. Participants arrived at the lab and were assigned to individual cubicles. Participants were presented with the scenario that they had recently started investing and had a single stock – Stock X, in their portfolio. Their task was to decide whether to hold or to sell the stock and convert to cash for up to 10 times. There were up to 10 investment months in the experiment. After each period, participants received information of the stock's performance. Before deciding to hold or to capitulate, they answered a short questionnaire. The amount invested in stock X was predetermined, and participants could only choose to sell or to hold the whole invested amount.

Loss amounts at each period are predetermined but their order of being presented to participants was randomized. All participants incurred losses with Stock X, and there were 2 series of losses. With random assignment, participants first received 5%, 10%, 20% or 40% maximum losses, and these losses were incurred during a losing period of 1, 3 or 5 months. After the assigned losses were incurred, the participants who were still holding the stock, had a flat price period (around up or down 1%) of either 2 or 4 months. The purpose of having variations in the number of investment months was to achieve a more natural set-up. After that, a second loss of 5% or 10% took place, after which the experiment ended.

Finally, participants were debriefed and dismissed.

To sum up, this is a 4 (Loss size: 5%, 10%, 20% or 40%) x 3 (Losing period: 1 vs. 3 vs. 5 months) x 2 (Flat period: 2 vs. 4 months) x 3 (Second loss: 5% vs. 10% vs. 15%) design. We used this design because it consists of larger variations of price change for each participant, which may appeal to be a more natural setting, and the study's external validity can then be enhanced.

Dependent Measures

Five dependent measures were employed. The first two measures were designed to reflect investors' adaptation level. We measure investors' adaptation to losses in an indirect measure – their investment goal. Investors want to attain certain investment goal with their investment; for example, one may expect the price of a stock to increase from $30 to $35, this $5 increase in price provides a positive psychological value to the investor and he or she thus feels satisfied with the investment. We assume the size of this psychological value required depends on one's neutral reference point. For example, if the stock price drops to $25 and investors adapt to the loss, then they may only require the stock price to bounce back to, e.g. $28 to be able to feel equally satisfied. In all, if ones' neutral reference is lower due to adaptation, then their investment goal should be lowered accordingly. Investment goal is reflected by two measures, the first measure assesses the satisfy price of investors: "In the next month, what is the price of Stock X that would make you feel satisfied?" (mean = 32.75, *s.d.* = 5.35). The second measure is an estimate of the selling price: "In the next month, if the stock price increases, what is the price you would sell at?" (mean = 35.64, *s.d.* = 6.26). The last reported answers to these two questions at each time point are averaged to form the measures of adaptation level. The third measure assessed participants' feelings for the experiential system: "How does the performance of Stock X make you feel?" Answers are reported in a 9-point scale (1= very bad, 9 = very good), (mean = 3.84, *s.d.* = 1.87). The fourth measure assesses their expectation for the rational

system: “How do you think the price of Stock X will change in the next month?” Answers are also reported in a 9-point scale (1= surely decrease, 9 = surely increase), (mean = 5.68, *s.d.* = 1.66). Finally, the fifth measure indicates whether participants chose to hold or to capitulate: “Do you want to Hold or Sell Stock X now?” (frequency of hold = 497, frequency of capitulate = 54).

IV. Results

The partial least squares (PLS) approach was applied to estimate the proposed model (SmartPLS was used, Hansmann and Ringel 2004). As there is only one measure for each variable, reliability and validity tests of measures are not applicable in this study. Structural coefficients were computed (see Figure 2), their standard errors and significance were estimated based on the bootstrapping method (Efron and Gong 1983) with 500 bootstrapping runs.

An analysis of PLS was run, the main effects of time in losing position and size of total loss on adaptation was observed. When total loss and time increase, investors report lowered satisfy price and selling price, that is, investor’ adaptation to losses increases (beta = 0.366, p <. 001, beta = 0.124, p <.001). These results give support to Hypothesis 1, i.e. that size of total loss and time in losing position are positively related to adaptation.

Moreover, the main effect of adaptation on investors’ feeling (measure for experiential system) and expectation (measure for rational system) were also found. As investors’ adaptation to losses increases, their feelings and expectations towards Stock X becomes less positive and less optimistic respectively (beta = -0.085, p <. 05, beta = -0.162, p <.001). These results give support to Hypothesis 2, i.e. that adaptation is negatively related to one’s positive feelings and optimistic expectations towards the losing investment.

We also found the main effect of investors’ feelings and expectations on their decision to hold or to capitulate. As investors report better (worse) feelings and more (less)

optimistic expectation towards stock X, their tendency to hold increases (decreases), however, only the effect of expectation on the hold or capitulate decision is significant (beta = -0.271, p <.001). A possible reason why feelings do not predict the hold/ capitulate decision directly may be due to the nature of the experiment – as it is common to believe that one should make rational decisions in the financial market, participants may incline to base their decision on the rational system. It is possible that participants may in fact rely on the rational system and are pessimistic about the stock performance, hence chooses to sell. Another possibility is that participants felt bad about their losses, this emotion interacts with the rational system, thus expectation becomes less optimistic and tendency to capitulate increases. Nonetheless, the observed effect of expectation on the decision to hold or to capitulate may be initiated or affected by negative feelings, as more positive feelings predicts more optimistic expectations (beta = 0.279, p < .001) That is, the effect of feelings on the hold/capitulate decision is indirect in this study. In all, these results support Hypothesis 3, i.e. that adaptation is positively related to one's tendency to capitulate the losing investment.

In addition, as total loss accumulates, participants report significantly less optimistic expectations. Participants may believe that there is a decreasing trend of Stock X's price, therefore they adjust their expectation in the same direction. A Sobel test was performed to examine if adaptation level mediates the effect of total loss on expectation, results indicate that the mediation effect is significant, t= -3.06, p<.001.

According to cognitive-experiential self-theory, each stimulus (i.e. previous loss) is processed by both the experiential and rational systems then influences one's decision. However our findings indicate that larger previous loss significantly predicts less positive feelings (beta = -0.435, p< .001), but it does not affect investors' expectation of the stock's future performance. Nevertheless, as the rational and experiential systems interact, less

positive feeling leads to less optimistic expectation, the size of previous loss is still able to affect investors' decision to capitulate.

In sum, the PLS results support hypothesis 1 that investors adapt to loss, and their adaptation level is influenced by the amount of total loss and time; the structural model also support hypotheses 2 and 3 that adaptation level affect investors' experiential and rational systems, hence affect their hold/ capitulate decisions.

V. Conclusion and Discussion

Consistent with adaptation level theory, the hypothesized positive relationship between adaptation and total loss size and time has been confirmed empirically. Also consistent with previous findings, results of this study show that information is processed by both the rational (expectation) and experiential (affect) systems to produce a decision. We contribute to the existing literature by showing that adaptation is a valid input in the dual process model and has a negative relationship with positive feelings and optimistic expectations, hence positively related to investors' tendency to capitulate.

Adaptation level theory considers that the adaptation level can be summarized in a single value, and other values are judged in correspondence to it, nevertheless, the use of multiple reference points is more likely in the financial market, e.g. the initial purchase price and price in previous time (Weber and Camerer 1998, Odean, 1998). In addition, Doyle, Green and Cook (1995) argue that there are three natural reference points which people use in daily lives to make comparison with: the norm, the best of the rest, and the worst of the rest. Our findings add to Weber and Camerer (1998) and Doyle et al (1995) that not only there are multiple reference points influencing one's decision process, but also some reference points may be combined together to form a new reference point, i.e. adaptation level to affect one's decision. In correspondence to Koszegi and Rabin (2006) and Yogo (2008)'s model that one's expected value of the future outcome are to be

modeled as reference points, our findings is inline with their models that expectation does play a role in decisions making and expectations are adaptable as well. Our findings are also consistent with those from Chen and Rao (2002) that people immediately but incompletely update their reference point after experiencing an event, as we demonstrate that adaptation depends on time in losing position, that is, it takes time for investors to fully or at least mostly adapt to a loss.

In addition, range theory (Volkmann 1951) proposes that the range of value of stimuli determines the perceived value of stimuli in the range. That is, whether a change of price is perceived as gain or loss will depend on its relative location in this range. Then naturally a follow up question is: how do investors create the range? Norm theory (Kahneman and Miller 1986) suggests that a different degree of normality is assigned to the stimuli in the range of the norm; thus, the investors' memory of the stimuli may or may not be accurate because of availability bias. Besides, range frequency theory (Parducci 1968) suggests that judgement of a stimulus is influenced by the rank of the stimulus within a group of stimuli. Therefore, it is possible for one single dramatic stimulus to exert a strong influence on adaptation level. For example, after experiencing a stock market crash, some investors may never be willing to invest in equities again. Investors' dependency on their memory of past stimuli to make judgment may be a reason why they still prefer receiving information about the past performance of a financial product. Empirical evidence, however, suggests that historical prices of a financial product do not predict its future performance. Our study shows that adaptation reflected by satisfy price and selling price, is influential to investors' decision to capitulate a losing investment or not; further research should investigate how adaptation can be better estimated in order to better reveal its effects on investors' decision-making.

Limitations and Future Directions

This experiment was done within a short time frame, in reality, investors may have

more time in-between receiving each piece of information, thus the effect of time was not fully examined in this study. Further studies should try to replicate these findings with larger samples and adopt more natural settings. Moreover, finding meaning (learn a lesson) from a loss help people to adapt (Taylor 1983) future studies should test if there is better adaptation when investors have a sufficient time frame to “learn” from the loss.In addition, recruiting participants outside the population of undergraduates will also increase the validity of the findings.

Figure 1

Proposed dynamic model of investment decision-making

[make all arrows solid rather than dashed!!]

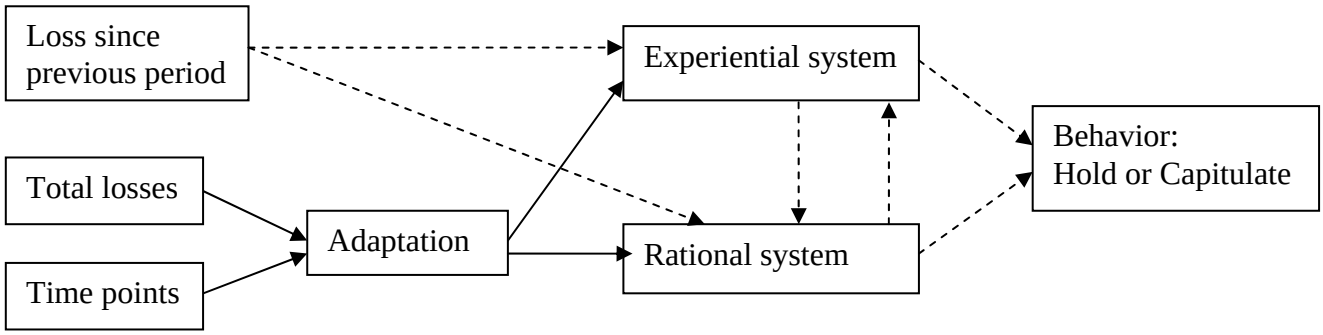
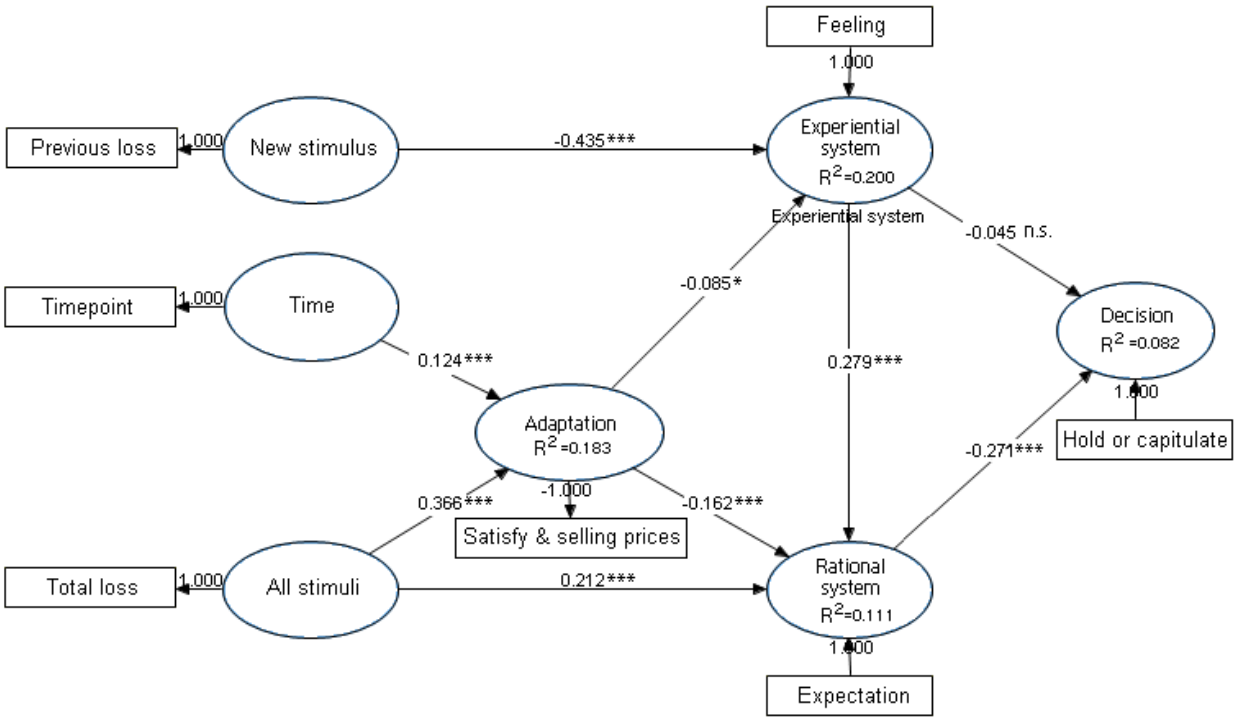


Figure 2

PLS results



Note: * $p < .05$; *** $p < .001$; n.s. = not significant; hold = 0, capitulate = 1. Also add some details about measurements and estimation method. This figure is not yet stand-alone.

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