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Mirjam Lehenkari

ESSAYS ON THE EFFECTS OF GAINS AND LOSSES ON THE TRADING BEHAVIOR OF INDIVIDUAL INVESTORS IN THE FINNISH STOCK MARKET

FACULTY OF ECONOMICS AND BUSINESS ADMINISTRATION,
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Abstract

The behavior of investors is often at odds with the assumptions of traditional finance theory. Research conducted over the past half-century or so abounds with examples in which the central axioms of traditional theory are systematically violated. One of the most well-established behavioral patterns in this context is the disproportionate tendency of investors to sell stocks that have appreciated in value since purchase ('winners') rather than stocks that have declined in value ('losers'); this phenomenon is known as the disposition effect and most commonly attributed to Kahneman and Tversky's (1979) prospect theory. The overall aim of this doctoral thesis is to investigate the robustness of this phenomenon, its underlying mechanisms, and its potential implications for individual investors.

The four independent but related essays of this thesis were designed to answer the following research questions: (1) Does the disposition effect 'survive' bear markets, in which investors may not be able to realize gains even if they wish to do so? (2) Is there any supporting evidence for prospect theory-based explanation of the disposition effect in the form of other observed behavior consistent with the theory? (3) Is prospect theory the most feasible explanation for the disposition effect? (4) What are the implications of the disposition effect from the point of view of individual investors?

Using comprehensive data covering virtually all trades executed in the Finnish stock market during 1995–2003, this thesis demonstrates the following: (1) As robust as the disposition effect appears to be in light of previous studies, the phenomenon is only partially detected in bear markets. (2) The relationship between prospect theoretic preferences and investor behavior is not easily generalizable to other behavioral patterns besides the disposition effect. (3) In fact, even the relationship between prospect theory and the disposition effect is not as strong as is generally believed. Our results instead suggest an explanation based on escalation of commitment, according to which the disposition effect is caused above all by self-justificatory concerns. (4) Finally, although the disposition effect is generally inconsistent with economic rationality, it does not appear to be detrimental to investment performance.

Keywords: behavioral finance, investor behavior, prospect theory

To the memory of my father, Esko Lehenkari

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Oulu, February 2009

Mirjam Lehenkari

List of the essays

The thesis is comprised of an introductory chapter and the following four essays:

I Lehenkari, M. & Perttunen, J. (2004) Holding on to the Losers: Finnish Evidence. Journal of Behavioral Finance 5: 116–126.

II Lehenkari, M. (2008) The Hedonic Editing Hypothesis: Evidence from the Finnish Stock Market. Accepted for publication in the Journal of Behavioral Finance.

III Lehenkari, M. (2008) In Search of the Underlying Mechanism of the Disposition Effect. Manuscript.

IV Lehenkari, M. (2008) The Disposition Effect: Underlying Mechanisms and Implications for Individual Investors. Manuscript.

The thesis contains one article that is co-authored with Professor Perttunen, the supervisor of this dissertation. The collaboration was carried out in such a way that Lehenkari's contribution to the co-authored paper is substantial as well as clearly identifiable. Specifically, both authors were involved in planning and designing the study, and both authors participated in the statistical analyses. Perttunen was primarily responsible for managing and preparing the data. Lehenkari contributed to the study by analyzing and interpreting the results and was responsible for drafting and revising the manuscript.

Contents

1 Introduction

Why is a bird in the hand worth two in the bush? That is, why do people often prefer a certain outcome to a risky outcome? Answering such questions is of fundamental importance for our understanding of how people make real-life decisions, such as starting a family, choosing a career, selecting a place to live, and deciding when to retire. Understanding the principles that guide individual decision-making, in turn, is central to increasing our grasp of investor behavior, including how investors choose their portfolios, why they trade, how they perform and so forth.

It is now a widely-acknowledged fact that the behavior of investors is often at odds with traditional expected utility theory (EUT). More importantly, the recent literature abounds with empirical examples in which the central tenets of this theory are systematically violated. This evidence has motivated the development of alternative theoretical models, which now number well into the double digits. Among the most well-known and accepted of these is prospect theory, which was developed by two psychologists named Kahneman and Tversky (1979). The overall aim of this doctoral thesis is to evaluate the applicability of prospect theory as a general framework for modeling investor behavior.

One of the most well-established behavioral patterns arising from recent research on stock markets is the disproportionate tendency of investors to sell stocks that have appreciated in value since purchase (‘winners’) rather than stocks that have declined in value (‘losers’). This phenomenon was originally detected by Shefrin and Statman (1985) and labeled the disposition effect. From a normative point of view, selling winners rather than losers is irrational. EUT posits that investors should make their investment decisions based on expected returns and their associated probabilities – not on past returns. The unwillingness of investors to realize their losses is also inconsistent with optimal tax planning; tax considerations should induce investors to defer capital gains and realize capital losses instead.

To explain the disposition effect, much empirical work has emphasized prospect theory and, in particular, its assumption of asymmetric risk preferences as the main driving force behind the phenomenon. According to this view, people are risk-averse in the domain of positive outcomes and risk seeking in the domain of negative outcomes. One implication of this assumption in the context of stock markets is that when faced with a gain, an investor seeks to reduce her exposure to risk and, consequently, sells the stock. Conversely, when faced with a loss, an investor is willing to assume more risk and thus holds onto the stock.

Since the work of Shefrin and Statman (1985), the disposition effect has been the subject of several empirical studies. The phenomenon has been tested in a variety of different economic settings such as stock markets (Lakonishok & Smidt 1986, Ferris, Haugen & Makhija 1988, Odean 1998), housing markets (Case & Shiller 1988, Genesove & Mayer 2001), and experimental markets (Weber & Camerer 1998). In addition to individual investors, evidence of the disposition effect has also been found among professional traders (Locke & Mann 1999, Frazzini 2006). Outside of the U.S. stock market, the effect has been observed, for example, in Japan (Bremer & Kato 1996), Finland (Grinblatt & Keloharju 2001), Israel (Shapira & Venezia 2001), and Australia (Brown, Chappel, Da Silva Rosa & Walter 2006), China (Shumway & Wu 2006), and Taiwan (Barber, Lee, Liu & Odean 2007).

While the disposition effect appears to be a rather pervasive and widely-recognized phenomenon, there are some issues that have not yet been addressed in the existing literature. For example, does the disposition effect 'survive' market conditions under which the phenomenon is least expected to occur? This question is the basic motivation behind the first essay of this thesis. In a downturn, investors have fewer winners in their portfolios, and so they may not be able to realize gains even if they wish to do so. At the same time, if they have liquidity needs, they may be forced to sell losers. Consequently, we expect to find weak evidence of the disposition effect in bear markets.

Prospect theory has entered the literature on investor behavior mainly due to its supposed connection with the disposition effect. As robust as the disposition effect is, there is little supporting evidence for prospect theory-based explanations with regard to other observed investment behaviors that are consistent with the theory. In an attempt to fill this gap, the second essay of this thesis focuses on another behavioral pattern derived from prospect theory termed 'hedonic editing.' The hedonic editing hypothesis, as introduced by Thaler (1985), is based on the assumption that over the course of performing mental accounting, people tend to frame multiple outcomes in ways that yield the highest perceived value. Because of the nonlinearity and asymmetry assumed by prospect theory, the hedonic editing hypothesis suggests that in some situations, the integration of outcomes into a single mental account will maximize the perceived value, whereas in other situations, the highest value can be achieved by segregating outcomes into separate mental accounts. In particular, perceived value is maximized if a gain is segregated from another gain and if a loss is integrated with another loss. The highest value is also achieved if a small loss is integrated with a larger gain and if a small gain is

segregated from a larger loss. Within the context of stock markets, this framework was first used by Shefrin and Statman (1984) in their behavioral theory of dividends.

Despite its intuitive and theoretical appeal, relatively little empirical research has been undertaken to test the hedonic editing hypothesis. More importantly, most evidence is based on questionnaire results involving hypothetical scenarios of negligible financial consequence to the subjects, and the findings of the few studies that have been conducted are mixed (Thaler 1985, Thaler & Johnson 1990, Linville & Fischer 1991). To the best of our knowledge, the only study to date testing the hedonic editing hypothesis outside of an experimental setting is Lim (2006). The aim of the second essay of this thesis is very similar to that of Lim; namely, to analyze investor preferences for segregating or integrating multiple outcomes in a real market setting. Specifically, we investigate how individual investors in a stock market time their stock sales when realizing gains and losses. If the principles that guide investor behavior are those suggested by the hedonic editing hypothesis, we should observe investors integrating losses more frequently than gains as well as integrating smaller losses with larger gains, rather than the other way around.

As noted earlier, prospect theory is generally regarded as the single most important, if not the sole, driving force behind the disposition effect. It appears, however, premature to assume such a significant explanatory role for the preferences predicted by prospect theory, given the hitherto virtual absence of formal modeling or theoretical justification for this explanation. Only recently have there been some efforts to address this issue from a theoretical perspective, and the linkage between prospect theory and the disposition effect has been called under serious question, most notably by Hens and Vlcek (2005) and Barberis and Xiong (2006). In light of these recent findings, it is worth raising the question of just what role should be assigned to prospect theory in explaining the disposition effect. Is it the primary explanation for the unwillingness of investors to realize losses, as most studies to date have suggested? Or, does it explain only a small portion of this tendency, as more recent research seems to imply? This is the central question the third essay of this thesis seeks to answer. A related question is, if not prospect theory, what then is the underlying mechanism behind the disposition effect? In our study, the discussion is organized around two alternative explanations that have received the most attention in existing literature, namely, the belief in mean reversion and escalation of commitment. The relative importance of the alternative explanations of the disposition effect has been previously evaluated by Zuchel

(2001) and Kaustia (2003); however, we are the first to test the three theories simultaneously.

Besides understanding why investors sell their winners and keep their losers, there is an equally important issue regarding the implications (if any) of this kind of behavior. Given the widespread and systematic nature of the disposition effect, an assessment of its consequences from the point of view of individual investors indeed is in order. While a good deal of existing research at least implicitly suggests that selling winners and keeping losers is detrimental to investment performance, virtually none of these studies provide evidence to validate this claim (a notable exception is Odean, 1998). With this lack of direct evidence, the (sub-)optimality of the behavior in question remains largely an open issue, and it is this gap in knowledge that the fourth essay of this thesis is designed to fill.

Throughout the thesis, we employ an extensive database consisting of all shareholdings registered in the paperless Finnish stock ownership system. The data are maintained and provided by the Finnish Central Securities Depository (FCSD), and the register covers virtually all stocks listed in the Helsinki Exchanges (HEX). The data include the initial share ownership records of the FCSD on January 3, 1995, and the daily changes in these records up to December 30, 2003. Studies similar to the one at hand, examining the trading behavior of all individual investors in a stock market, are uncommon in existing literature (exceptions include Grinblatt and Keloharju, 2001, and Kaustia, 2003). There is a reasonable explanation for this. The FCSD database is extremely large, yet the Finnish stock market is small relative to other stock markets. Consequently, it would be computationally infeasible to conduct a comprehensive study using market data from, say, the major U.S. exchanges.

The remainder of this introductory chapter is organized as follows. In Sections 2 and 3, we provide a concise overview of the literature on decision-making under risk and EUT, respectively. Section 4 discusses the evidence that has led theorists to look for alternatives to EUT. Section 5 provides a description of how individuals respond to risky choices under prospect theory and discusses the general implications of this theory. The material presented in Sections 2 through 5 is necessarily general in nature, and readers familiar with the theoretical perspectives on decision-making under risk or those interested primarily in the empirical results of the present work may want to skip to Section 6, where the main findings of the four essays of this thesis are summarized.

2 Decision-making under risk

The prescriptive or normative approach to decision-making has a long history. Beginning with Pierre de Fermat and Blaise Pascal, the 17th-century founding fathers of modern probability theory assumed that individuals evaluate gambles on the basis of their expected values, so that people will be indifferent between gamble payoffs $(x_1,...,x_n)$ with probabilities $(p_1,...,p_n)$ and a certain payoff equal to the gamble's expected value $x = \sum x_i p_i$. The idea seems perfectly reasonable, provided that the gamble is repeated several times. According to the law of large numbers, the average payoff of n independent gambles converges to the expected value of the gamble as n increases to infinity.

In the case of a one-shot gamble, however, people may not base their decisions solely on the expected values of their prospects. This point was ingeniously demonstrated by Daniel Bernoulli in 1738 in his resolution of the so-called St. Petersburg paradox. In the St. Petersburg game, a coin is flipped repeatedly until a head is produced; if you participate in the game, you receive a payoff of, say, $\$2^n$, where n is the number of the throw producing the first head. It is easy to see that the expected monetary payoff of the game is infinite, yet most people will only be willing to pay a relatively small amount to participate in it. In other words, people do not in general evaluate a gamble in terms of its expected monetary value. In response to this finding, Bernoulli proposed a theory in which (i) an individual's utility from wealth is not linearly related to wealth but rather increases at a decreasing rate, and (ii) people evaluate a gamble in terms of the utility of its monetary outcomes, with the value of the gamble equal to the expectation of these utilities. While Bernoulli's theory, which was the first instantiation of EUT, appeared to resolve the St. Petersburg paradox, it was never really picked up until two centuries later.

Interest in the theory was revived when von Neumann and Morgenstern (1944) provided a formal axiomatization of expected utility. Dubbed the 'von Neumann-Morgenstern EUT,' the simplicity and intuitive appeal of its axioms, the elegance of its representation of people's attitudes towards risk, and the vast body of theoretical results it has produced have led the framework to become the dominant paradigm for the analysis of decision-making under risk in economics in general and finance in particular.

In spite of its attractiveness, EUT has refutable implications, and beginning in the 1950s, psychologists and economists have provided a substantial body of empirical evidence suggesting that people do not necessarily conform to many of

the theory's key axioms or predictions. What makes these findings significant is that in many cases, individuals seem to depart from the model in systematic and predictable ways. This evidence has motivated the development of alternative models that aim to address the lack of descriptive validity of EUT. One of the most well-regarded alternatives to EUT is Kahneman and Tversky's (1979) prospect theory. Although EUT still enjoys a position of highest honor within economics at large, prospect theory has gained substantial ground in recent years, and it now even occupies second place in the research agenda of some of its former opponents. Prospect theory is largely responsible for the burgeoning field of behavioral finance, and it has also served as the main motivation for the empirical research presented in this doctoral thesis.

3 Expected utility theory

Although the primary purpose of this introductory chapter is to discuss prospect theory and its relation to the four empirical studies that form the core of the present thesis, EUT provides a sensible starting point in establishing a normative basis for decision-making, which will then serve as a benchmark to compare actual behavior under risk. In what follows, we will briefly review the general concepts in EUT and present a set of axioms from which EUT can be derived.

In EUT, preferences are defined over risky prospects (also called lotteries), where a prospect can be understood as a list of outcomes with associated probabilities. Let $S = (\mathbf{q}, \mathbf{r}, \mathbf{s}, \ldots)$ denote a set of prospects. Any prospect $\mathbf{q}$ can be represented by a probability distribution $\mathbf{q} = (p_1, \ldots, p_n)$ over a fixed set of outcomes $X = (x_1, \ldots, x_n)$, where p_i is the probability of x_i, $p_i \in [0, 1]$, and $\sum p_i = 1$. Since the set of potential outcomes is invariant, it is possible to define a prospect simply by its vector of probabilities (such as $\mathbf{q}$ above), although it is sometimes appropriate explicitly write the outcomes as $\mathbf{q} = (x_1, p_1; \ldots ; x_n, p_n)$. Using this preliminary notation, the expected utility hypothesis can be derived from the following four axioms:

> AXIOM 1. (Completeness): For all $\mathbf{q}, \mathbf{r} \in S$, either $\mathbf{q} \succcurlyeq \mathbf{r}$ or $\mathbf{r} \succcurlyeq \mathbf{q}$ or both, where $\succcurlyeq$ denotes weak preference.
>
> AXIOM 2. (Transitivity): For all $\mathbf{q}, \mathbf{r}, \mathbf{s} \in S$, if $\mathbf{q} \succcurlyeq \mathbf{r}$ and $\mathbf{r} \succcurlyeq \mathbf{s}$, then $\mathbf{q} \succcurlyeq \mathbf{s}$.
>
> AXIOM 3. (Continuity): For all $\mathbf{q}, \mathbf{r}, \mathbf{s} \in S$, where $\mathbf{q} \succcurlyeq \mathbf{r} \succcurlyeq \mathbf{s}$, there exists some $p \in [0, 1]$ such that $p\mathbf{q} + (1 - p)\mathbf{s} \sim \mathbf{r}$, where $\sim$ denotes indifference.
>
> AXIOM 4. (Independence): For all $\mathbf{q}, \mathbf{r}, \mathbf{s} \in S$ and $p \in [0, 1]$, if $\mathbf{q} \succcurlyeq \mathbf{r}$, then $p\mathbf{q} + (1 - p)\mathbf{s} \succcurlyeq p\mathbf{r} + (1 - p)\mathbf{s}$.

Together these axioms of completeness, transitivity and continuity imply that preferences can be represented by a function $U(\cdot)$ such that

> for all $\mathbf{q}, \mathbf{r} \in S$, $U(\mathbf{q}) \geq U(\mathbf{r}) \Leftrightarrow \mathbf{q} \succcurlyeq \mathbf{r}$.

The function $U(\cdot)$ assigns a numerical value to each prospect, ranking them in accordance with an individual's preferences. Notice that $U(\cdot)$ is not unique; take any increasing function g. The function $V(\cdot)$ that is defined as $V(\cdot) = g[U(\cdot)]$ also represents the same preferences. The preference function is ordinal in the sense

that it is invariant to any increasing transformation. In other words, only the ranking of preferences matters.

The first three axioms impose minimal restrictions on the precise form of preferences. It is the fourth axiom that gives EUT most of its content; at the same time, this is the most controversial of the axioms. Without the independence axiom, it would not be possible to invoke the most appealing characteristic of EUT, namely, that preferences can be represented as follows:

$$U(\mathbf{q}) = \sum u(x_i)\, p_{i,}$$

where **q** is any prospect and $u(\cdot)$ is a utility function defined on the set of outcomes.

EUT provides an elegant and simple way to combine probabilities and outcomes into a single measure of 'value' or 'utility' and has a number of appealing properties. One such property is monotonicity, which is defined as follows. Let x_1, … , x_n be outcomes such that $x_1 < \ldots < x_n$. We say that $\mathbf{q} = \left(p_1^q, \ldots, p_n^q\right)$ first-order stochastically dominates $\mathbf{r} = \left(p_1^r, \ldots, p_n^r\right)$ if for all $i = 1, \ldots, n$,

$$\sum_{j=i}^{n} p_j^q \geq \sum_{j=i}^{n} p_j^r ,$$

with a strict inequality for at least one i. Monotonicity is the property that stochastically dominating prospects are preferred to the prospects that they dominate, and it is widely believed that any normatively acceptable theory should satisfy monotonicity.

In EUT, risk attitudes are entirely modeled through the utility function. The shape of the utility function has a simple interpretation. A concave (convex) utility function implies risk aversion (seeking); an individual with concave utility function will always prefer a certain outcome to any risky prospect with an equal expected value, and vice versa for an individual with convex utility function. What is noteworthy is that modeling risk preferences in this way bundles some potentially distinct concepts into a single function: any attitude toward risk (e.g., risk aversion) and any attitude toward outcomes (e.g., the diminishing marginal utility of money) are assumed to be captured by the utility function. Although many have objected that risk attitudes and marginal utility should be separated, combining them need not to be merely seen as a weakness of the theory. Indeed, it is precisely the simplicity and parsimony of the EUT that has made it such a powerful and flexible modeling framework.

Finance in particular provides many opportunities to apply EUT. An example at the most general level is portfolio choice, which consists of selecting an allocation strategy in order to choose among all available stocks in a market, with each strategy yielding an uncertain return. The traditional view is that when selecting several stocks in which to invest, the investor balances the potential gains with the risk of losing part or all of the investment and in effect constructs a portfolio with a risk/return profile that is preferred in an expected utility sense.

4 Descriptive limitations of EUT

Despite the normative appeal of EUT, researchers have discovered several systematic violations of the theory and its underlying assumptions. These are typically grouped under two broad headings: (i) violations of the independence axiom (such as the common consequence and common ratio effects) and (ii) violations of the model's underlying assumptions of procedure and description invariance (such as preference reversal and framing effects).

One of the earliest and probably best-known violations of the independence axiom is the so-called Allais paradox. This problem involves choosing the preferred option from each of the following two pairs of gambles:

A_1: \$100 million with certainty.
\$100 million with probability .89,
\$0 with probability .01.

B_1: \$500 million with probability .10,

and

A_2: \$100 million with probability .11,
\$0 with probability .89.

B_2: \$500 million with probability .10,
\$0 with probability .90.

Note that the second gamble is obtained from the first gamble by making the chance of winning \$100 million 89% less likely for both options. An individual with expected utility preferences should either choose both "A" options or both "B" options across this pair of gambles. Allais (1953), however, predicted and found that when faced with these choices most people prefer A_1 over B_1 in the first gamble but B_2 over A_2 in the second gamble. Although initially dismissed as an isolated example, the Allais paradox has subsequently been replicated by numerous researchers, and it is now regarded as a special case of a more general phenomenon termed the common consequence effect.

The common consequence effect occurs when common outcomes alter an individual's preferences. The commonalities across outcomes should be irrelevant, because they appear in both gambles. Thus, the common consequence effect involves pairs of prospects of the general form:

$$\mathbf{q} = (y, p; c, 1 - p) \qquad \text{and} \qquad \mathbf{r} = (\mathbf{s}, p; c, 1 - p),$$

where $\mathbf{s} = (x, \lambda; 0, 1 - \lambda)$ and $\lambda \in [0, 1]$. The outcomes c, x and y are nonnegative and $x \succ y$. (In the numerical example above, x = \$500 million, y = \$100 million, $p = 0.11$ and $\lambda = 10/11$.) Note that prospects **q** and **r** share a common consequence,

they both yield c with probability 1 - p, and from the independence axiom, we see that choices between **q** and **r** should be independent of the value of c. Yet, numerous studies have shown that individual preferences are significantly affected by the value of c; specifically, people tend to choose **q** when $c = y$ but **r** when $c = 0$.

A second class of systematic violations stems from another early example of Allais (1953) and can be illustrated by the following example from Kahneman and Tversky (1979), in which individuals are again asked to choose between two options:

A_1: \$3000 with certainty. B_1: \$4000 with probability .80, \$0 with probability .20.

and

A_2: \$3000 with probability .25, \$0 with probability .75. B_2: \$4000 with probability .20, \$0 with probability .80.

Existing evidence suggests that many people prefer A_1 to B_1, and B_2 to A_2. However, because the second gamble is derived by multiplying the probabilities of the non-zero outcomes in the first gamble by a common factor of 0.25, such a combination of preferences is inconsistent with EUT and constitutes one example of a phenomenon known as the common ratio effect. More generally, this effect involves pairs of prospects of the form:

$$\mathbf{q} = (y, p; 0, 1 - p) \quad \text{and} \quad \mathbf{r} = (x, \lambda p; 0, 1 - \lambda p),$$

where $x \succ y$ and $\lambda \in [0, 1]$. Assuming that λ is held constant (e.g., at 0.8, as in the above example), then for pairs of gambles of this particular structure, EUT implies that preferences should not depend on the value of p. However, several independent studies have found that people tend to change their choice from **q** to **r** as p decreases.

As evidence against the independence axiom continued to accumulate, it also became clear that EUT's failures extend beyond violations of independence. Two assumptions implicit in EUT (and in any standard theory of decision-making) are procedure invariance and description invariance, which indicate that preferences should be independent of the method used to elicit them and of the way in which the options are described, respectively. There is now a convincing body of evidence to suggest that individual preferences systematically violate these fundamental requirements.

One of the most disturbing findings with regard to the classical view of preferences is the preference reversal effect, originally discovered by Lichtenstein and Slovic (1971). The classic preference reversal experiment has two stages. In the first stage, the subjects are asked to choose between:

p-bet: \$$X$ with probability p, \$0 with probability $1 - p$.	\$-bet: \$$Y$ with probability q, \$0 with probability $1 - q$.

The terms "p-bet" and "\$-bet" come from the greater probability of winning in the first bet (i.e., $p > q$) and the greater possible gain in the second bet (i.e., $Y > X$). In the second stage, using standard elicitation techniques, the subjects are asked for their certainty equivalents of these bets.

EUT predicts that the bet selected in the first stage will also be the one that is assigned the higher certainty equivalent. However, Lichtenstein and Slovic (1971) found that subjects in their study exhibited a systematic departure from this prediction by choosing the p-bet in the first stage and assigning a higher value to the \$-bet. Although this finding initially generated widespread skepticism, it has been subsequently replicated by both psychologists and economists in a variety of settings, and preference reversal is now widely recognized to indicate a failure of procedure invariance.

Researchers have also found that alternative ways of representing or 'framing' prospects may lead to systematic differences in choice. Such a phenomenon is often interpreted as a failure of description invariance, and it is well illustrated by the famous Asian disease problem, as discussed by Tversky and Kahneman (1981). They provided subjects in their study with a dilemma (p. 453):

> *Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the program are as follows:*
>
> *If Program A is adopted, 200 people will be saved.*
>
> *If Program B is adopted, there is 1/3 probability that 600 people will be saved, and 2/3 probability that no people will be saved.*
>
> *Which of the two programs would you favor?*

Another group of subjects were given the same story regarding an Asian disease problem, but they were provided with a different formulation of the alternative programs:

If Program C is adopted 400 people will die.

If Program D is adopted there is 1/3 probability that nobody will die, and 2/3 probability that 600 will die.

Which of the two programs would you favor?

It is easy to see that the two pairs of prospects are stochastically equivalent. The only difference between them is that Programs A and B are phrased in terms of lives saved, whereas Programs C and D are phrased in terms of lives lost. Based on a series of experiments conducted among undergraduate students, university faculty, and practicing physicians, Tversky and Kahneman reported that in general, the majority of subjects preferred Program A to Program B and Program D to Program C.

Departures from EUT are apparent, and the replicability and pervasiveness of the above types of examples are indisputable. In addition to the experimental evidence discussed above, there is now a substantial body of literature documenting patterns of behavior in real market settings that also deviate from the predictions of EUT. Within the context of stock markets, observed behavior characterized by non-expected utility preferences (often combined with biased beliefs) include excessive trading, herding, insufficient diversification, naïve diversification, overinvestment in "familiar" stocks, and extrapolation of trends. Given the overwhelming evidence against EUT, it is no surprise that a considerable amount of theoretical effort has been devoted toward developing alternatives to it. One of the most prominent ones is Kahneman and Tversky's (1979) prospect theory, to which this thesis is most related to, and to which the next section will serve as an introduction.

5 Prospect theory

To accommodate the numerous violations of EUT, Kahneman and Tversky (1979) proposed an alternative account of decision-making under risk called prospect theory. Whereas EUT is more normative in nature, prospect theory is based on an extensive series of experimental observations and is inherently descriptive. In prospect theory, decision-making processes are divided into two phases: editing and evaluation. In the editing phase, a preliminary analysis is conducted with the aim of simplifying subsequent decision-making. In the evaluation phase, choices among edited prospects are determined by the following preference function:

$$V(\mathbf{q}) = \sum \nu(x_i)\pi(p_i),^{1}$$

where $v(\cdot)$ is a value function, and $\pi(\cdot)$ is a weighting function. Prospect theory thus resembles EUT in the sense that individuals are assumed to maximize a weighted sum of 'utilities,' although the weights do not generally coincide with stated probabilities, and a value function is used instead of the utility function. Importantly, the editing phase of prospect theory has no counterpart in EUT.

Another distinguishing element is that in prospect theory, individuals have preferences defined over gains and losses relative to some natural reference point. This is a radical departure from EUT, in which the utility function is defined over final wealth levels. The use of a reference point gives rise to another unique feature of prospect theory, that is, the shape of the value function. The function (sketched in Figure 1) is generally assumed to be

– kinked at the reference point (i.e., at $x = 0$),

– concave for gains ($v''(x) < 0$ for $x > 0$) and convex for losses ($v''(x) > 0$ for $x < 0$), and

– steeper in the domain of losses than in the domain of gains (for all $x > 0$, $v'(x) < v'(-x)$).

1.To be precise, this formulation only applies to simple regular prospects of the form $(x_1, p_1; x_2, p_2)$, where either $p_1 + p_2 < 1$, or $x_1 \geq 0 \geq x_2$, or $x_1 \leq 0 \leq x_2$. A later version of the theory (Tversky and Kahneman, 1992) applies to prospects with any number of outcomes.

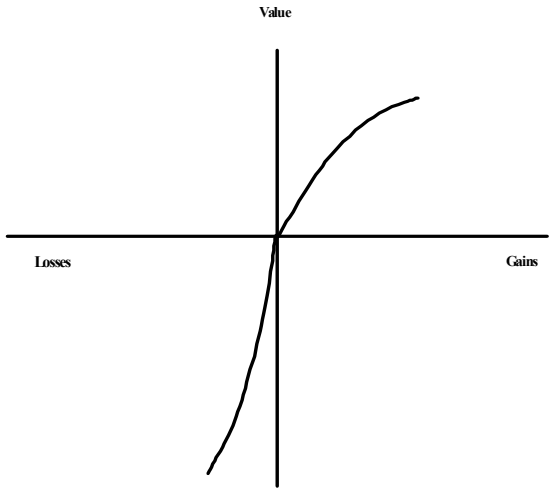

Fig. 1. Prospect theory value function.

In their later paper, Tversky and Kahneman (1992) interpreted these properties as reflecting two more general principles, namely, diminishing sensitivity and loss aversion. According to the principle of diminishing sensitivity, the impact of a marginal change will decrease as one moves farther away from the reference point. This results in an s-shaped value function. The principle of loss aversion states that the impact of a change in the domain of losses is experienced more strongly than an equally sized change in the domain of gains. Loss aversion is implied by the fact that the value function is steeper for losses than for gains.

As mentioned earlier, the evaluation phase involves a weighting function $\pi(\cdot)$, which relates decision weights to stated probabilities. According to Kahneman and Tversky (1979), $\pi(\cdot)$ is an increasing function of p, and it overweights low probabilities while underweighting moderate and high probabilities. Furthermore, the endpoints are such that $\pi(0) = 0$ and $\pi(1) = 1$, but the decision weights are highly unstable when probabilities are close to zero or one; extremely low probabilities are either ignored or overweighted, and extremely high probabilities are either underweighted or assigned a weight of one. Although there are no set criteria for determining what constitutes an extreme probability, between the extremely low and extremely high probabilities, the weighting function has a slope of less than one. Together, these properties of the weighting function allow prospect theory to explain the common consequence and common ratio effects discussed in the previous section.

Besides being able to accommodate the most obvious violations of EUT, prospect theory has other useful properties. One of the more interesting of these properties from the perspective of the present thesis is the reflection effect. From the property that concavity of the value function in the domain of gains is accompanied by convexity in the domain of losses, it follows that attitudes toward risk can be similarly mirrored across the two domains. This implies that an individual displaying risk aversion in a choice among particular prospects with positive outcomes will become risk seeking if the signs of the outcomes are reversed so that the gains are replaced by losses.

The Asian disease problem presented at the end of Section 3 is an illustrative example of the reflection effect. In that example, the choice between options was affected by the wording of the problems. Specifically, in the 'gain frame' in which outcomes were phrased in terms of the probability of living, the majority of subjects chose the sure gain of 200 out of 600 lives. In contrast, in the 'loss frame' in which outcomes were expressed in terms of the probability of dying, the majority of subjects were willing to take the riskier option as opposed to a sure loss of 400 deaths. Consistent with the reflection effect, these choices demonstrate risk aversion in the domain of gains and risk seeking in the domain of losses.

However, before rushing to conclude that the reflection effect solves the Asian disease problem, we must address how outcomes are interpreted. Objectively considered, 200 lives saved out of 600 is exactly the same thing as 400 lives lost. Consequently, a full account would require a theory of how framing affects whether an outcome is interpreted as a gain or a loss. In their 1979 paper, Kahneman and Tversky took a step toward such a theory by suggesting that prior to the second phase of evaluation, there is an early phase of editing that consists of a preliminary analysis of the available prospects.

According to Kahneman and Tversky (1979), six operations are carried out during the editing phase. The first operation involves coding outcomes as gains and losses relative to a reference point. In most choice problems, the natural reference point is the status quo, but in some cases, it corresponds to an outcome that the decision maker had reason to expect or aspired to. In other situations, the reference point is determined by the framing of the problem. It is precisely this possibility of differential coding under the two problem descriptions that must be taken into account in explaining the observed choices in the Asian disease problem.

Several other editing operations within prospect theory involve activities that organize and reformulate prospects so as to simplify subsequent evaluations and choices. One such operation is combination, which reduces the complexity of a

prospect by combining the probabilities associated with identical outcomes. For example, a prospect described as $(x_1, p_1; x_1, p_2; x_3, p_3)$ will be reduced to $(x_1, (p_1 + p_2); x_3, p_3)$ and evaluated in this form. A similar combination operation is consistent with EUT; however, under prospect theory, these two prospects are not equivalent, since $\pi(\cdot)$ is nonlinear. Other editing operations include segregation and simplification. The former entails segregating a riskless component (i.e., an amount that will be obtained regardless of outcome) from the risky component; the latter operation involves the simplification of prospects by rounding probabilities and outcomes. One particularly important form of simplification involves treating extremely unlikely outcomes as if their probabilities were zero.

Whereas the aforementioned operations are applied to each prospect separately, two other operations apply to sets of prospects. The first is cancellation, which eliminates from consideration components that are shared by all prospects. The decision maker thus focuses only on those components that differ. For example, a choice between prospects $\mathbf{q} = (x, p; \mathbf{q}^*, 1 - p)$ and $\mathbf{r} = (x, p; \mathbf{r}^*, 1 - p)$ is evaluated as a choice between $\mathbf{q}^*$ and $\mathbf{r}^*$. The final operation of the editing phase is detection of dominance, which refers to finding stochastically dominated prospects that are then rejected without further evaluation. This operation does not, however, necessarily prevent monotonicity violations. The assumption is that dominated alternatives are eliminated, provided that they are detected. It may well be that the prospects are sufficiently complicated to make it difficult to edit out all dominated options, and so it is possible for some dominated prospects to survive the editing process. Since the preference function under prospect theory is not generally monotonic, stochastically dominated options may ultimately be chosen.

This method for imposing monotonicity has the undesirable side effect that choices may violate transitivity. According to prospect theory, if $\pi(\cdot)$ is nonlinear, then there is some $\mathbf{q}$ and $\mathbf{r}$ so that $\mathbf{q}$ stochastically dominates $\mathbf{r}$ (i.e., $V(\mathbf{r}) > V(\mathbf{q})$). As long as this dominance is detected, the editing phase prevents the direct violation of monotonicity, and $\mathbf{r}$ will not be chosen over $\mathbf{q}$. But indirect violations are nevertheless possible. Suppose there is some other prospect $\mathbf{s}$, such that $V(\mathbf{r}) > V(\mathbf{s}) > V(\mathbf{q})$. If there is no relation of dominance between $\mathbf{s}$ and either $\mathbf{q}$ or $\mathbf{r}$, then the pair-wise choice among these three gambles will result in a cycle whereby $\mathbf{r} \succ \mathbf{s}$ and $\mathbf{s} \succ \mathbf{q}$ and $\mathbf{q} \succ \mathbf{r}$, a clear violation of transitivity.

It is widely believed that any satisfactory theory of choice should satisfy monotonicity and transitivity. The fact that prospect theory admits violations of both has been generally regarded as the major weakness of the theory. To answer these criticisms, Tversky and Kahneman (1992) introduced an updated version of

the theory, called cumulative prospect theory, which satisfies stochastic dominance. By employing cumulative rather than separable decision weights, they were able to construct a preference function that is monotonic and transitive without the need for an initial editing phase.

Having introduced the key elements of prospect theory as well as having addressed some of the concerns raised by the critics, we conclude this section with a brief discussion of this theory's explanatory power with regard to real economic behavior. Prospect theory has proven extremely influential in explaining not just a wide variety of experimental data but also an extensive range of observed behavior in the field. Camerer (2000) has already provided an excellent description of a number of empirical regularities observed in a variety of economic domains that are anomalies for EUT but can all be explained by prospect theory. We will therefore not present in detail what would be a very similar review of the literature. Very briefly, the applied topics encompass (but are not restricted to): savings and consumption decisions (consumption does not adjust downward when people receive bad income news); downward-sloping labor supply (NYC cabdrivers set a daily income target and quit when they reach it); asymmetric price elasticities (consumers are more sensitive to price increases than to price reductions); and favorite-longshot bias (racetrack bettors tend to over-bet longshots and under-bet favorites relative to their chances of winning). In finance, prospect theory has been applied to the study of equity premium puzzle (the exceptionally high return premium of stocks over bonds) and the disposition effect (the tendency of investors to sell winners too soon and hold losers too long), the latter of which is the overriding theme of the essays in this thesis.

6 Overview of the essays

6.1 Essay 1: Holding on to the losers: Finnish evidence

The first essay investigates whether individual investors in the Finnish stock market exhibit the disposition effect, i.e., whether they sell winners rather than losers. The primary aim is to test if the disposition effect 'survives' bear markets in which investors may not be able to realize gains even if they wish to do so. In order to examine whether the phenomenon can be detected in a stock market downturn, we restrict the sample period to the period from March 6, 2000 to September 29, 2000. On the first day of this period, the HEX Portfolio Index reached a new all-time high, after which it decreased by 25% during the subsequent thirty-week time span.

We use the generalized least squares method to analyze the impact of gains and losses on the selling propensity of investors. Our main findings can be summarized as follows. Overall, the results suggest that losses reduce the selling propensity of individual investors in the Finnish stock market. There is, however, no opposite effect identifiable with respect to gains. Thus, consistent with the proposed hypothesis, the disposition effect appears to be less evident (but nonetheless partially present) in a market downturn. The inclusion of a set of control variables that are known to influence the trading behavior of investors does not change this overall conclusion.

6.2 Essay 2: The hedonic editing hypothesis: Evidence from the Finnish stock market

The purpose of the second essay is to examine whether it is possible to find supporting evidence for the prospect theory-based explanation of the disposition effect through observations of other investment behavior consistent with that theory. Of special interest is the hedonic editing hypothesis, according to which investors are inclined to integrate losses rather than gains and prefer to integrate smaller losses with larger gains rather than the other way around.

To see if the principles that guide the behavior of investors are those suggested by the hedonic editing hypothesis, we investigate how individual investors in the Finnish stock market time stock sales when realizing gains, losses, or some mixture of both. Using various methodological approaches, we examine whether investors choose to sell their stocks separately at different times (segregation of

outcomes) or together at the same time (integration of outcomes) and how their decisions are affected by whether they are realizing gains or losses.

Most of the findings contradict the hedonic editing hypothesis. Investors in our sample do not consistently integrate their losses or segregate their gains. In fact, on many occasions, investors integrate their gains at a higher rate than their losses. This observation is even more pronounced after controlling for a wide range of other determinants of investor trading behavior. The evidence regarding mixed outcome cases is also in contrast to the hedonic editing hypothesis. Investors do not integrate smaller losses with larger gains; rather, they appear to do just the opposite. These results lead us to suggest that the relationship between prospect theoretic preferences and investor behavior is not as generalizable as it might seem.

6.3 Essay 3: In search of the underlying mechanism of the disposition effect

The aim of the third essay is to investigate whether investors in the Finnish stock market exhibit the disposition effect (in contrast to the first essay, the entire sample period 1995–2003 is considered), and, provided that such a phenomenon is discovered, examine the explanatory value of prospect theory, belief in mean reversion, and escalation of commitment, in accounting for it.

A key feature that distinguishes our work from previous studies is that we include in our analysis not just the stocks that investors have themselves purchased but also the stocks that they have received through gifts or inheritance. We demonstrate that a distinction between these two groups of stocks provides an ideal basis for analyzing the significance of the three candidate explanations for the disposition effect. Although the implications of prospect theory, belief in mean reversion and escalation of commitment closely parallel each other, they are distinguishable with respect to the level of personal responsibility an investor has regarding the decision to hold the stock in the first place. In other words, whether the stock is purchased by the investor herself or received as a gift or inheritance makes a significant difference. Specifically, if we observe that the propensity of investors to sell winners over losers is amplified, unaffected or attenuated when they are not themselves responsible for the initial investment decision, we would be inclined to suggest that the most likely mechanism behind the disposition effect is prospect theory, a belief in mean reversion or escalation of commitment, respectively.

Results from random effects logistic regression analyses indicate that overall, individual investors in the Finnish stock market show behavior consistent with the disposition effect. That is, they tend to realize their gains rather than losses. More importantly, however, this effect appears to be more pronounced for the stocks that investors have bought themselves than for the stocks that they have inherited or received as a gift. We argue that this novel finding calls into question the explanations for the disposition effect based solely on prospect theory or a belief in mean reversion. Instead, we suggest an interpretation consistent with escalation of commitment, i.e., that investors hold on to their losers, because they are reluctant to admit that the initial decision to buy the stock was a mistake.

6.4 Essay 4: The disposition effect: Underlying mechanisms and implications for individual investors

The primary objective of the fourth essay is to analyze the extent to which the disposition effect influences the investment performance of individual investors in the Finnish stock market. In order to investigate the potential implications of the phenomenon for individual investors, we calculate the cumulative average return differences between the losers that investors keep and the winners that they sell for up to eight years subsequent to the date of sale. Our aim is also to provide previously unreported evidence regarding the actual holding period returns investors earn by holding on to their losers. These returns are then contrasted with those that could have been obtained over the corresponding calendar periods from the winners investors had decided to sell.

The results of the performance analyses indicate that the losers investors keep, on average, consistently underperform the winners they sell for up to at least three years after the date of a sale. As it turns out, however, the actual holding period returns investors earn by holding on to their losers are significantly higher than the returns they could have achieved by instead holding on to their winners. This result appears to be rather robust, as we are not able to detect any investor characteristics that could radically change the result. We therefore conclude that the commonly held view that the disposition effect inherently impairs portfolio performance is not supported by our data.

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