Liquidation Decisions under Prospect Theory *

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Abstract

This paper examines the trading behavior with respect to prospect theory from an intraday analysis. The holding time of losers is longer than that of losers. In terms of holding time and profit, investors have the disposition effect. Using the Cox proportional hazards model, we find that the propensity to liquidate is not always positively related to the amount of the capital gain. Investors are more likely to hold longer losers than winners under a critical point, but to hold longer winners than losers over the critical point. From the perspective of an S-shaped utility function in prospect theory, our finding suggests that the disposition effect and the break-even effect play an important role in liquidation decisions.

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Keywords: Disposition effect; Prospect theory; Trade Disposition; Holding time; Cox proportional hazards model

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1. Introduction

The general tendency to hold losers too long and to sell winners too soon, which Shefrin and Statman (1985) termed the 'disposition effect,' has been found in a variety of data sets and time periods.[1] The theoretical framework they employ is an extension of prospect theory (Kahneman and Tversky (1979)). Kahneman and Tvesky (1979), in the original presentation of prospect theory, suggest an S-shaped value function, which is defined on gains and losses relative to a reference point, rather than an absolute wealth.[2] In this setting, an investor will be risk averse in the domain of gains but he will be risk seeking in the domain of losses. Thus, the investor is more likely to sell winners because he is more likely to be risk averse. On the other hand, he becomes risk-loving and will hold on to losers. In this paper, we search for empirical evidence of the differential holding time of winners and losers. We examine how the liquidation decisions of investors are influenced by their trading gains and losses. Specifically, we investigate the effect of trading performances on the holding time of their positions.

Motivation for this analysis is also derived from Kyle, Ou-Yang, and Xiong (2006), who provide a formal framework to analyze the liquidation decisions of economic agents under prospect theory. The convexity in the agent's direct value function of losses can induce the agent to delay liquidation. Loss aversion induces the agent to be more risk averse near the reference point, and can induce liquidation near this point. Their model suggests that prospect theory preferences induce the agent to delay liquidation of a relatively inferior project if it is in losses and to accelerate liquidation of a relatively superior project if it is in gains. This explanation suggests that the liquidation decisions can be varied across the magnitude of trading performance, because the sensitivity to losses is higher than to gains around the reference point.

[1] See, for example, Odean (1998), Grinblatt and Keloharju (2001), Shapira and Venezia (2001), Coval and Shumway (2005), Locke and Mann (2005), and Frazzini (2006).

[2] A number of papers have proposed behavioral theories. For example, see the model of loss aversion (Benartzi and Thaler (1995), Baberis and Huang (2001), Barberis, Huang, and Santos (2001)) and the house-money effect (Thaler and Johnson(1990)). Grinblatt and Han (2005) suggest that the disposition effect creates a spread between a stock's fundamental value and its equilibrium price, as well as price underreaction to information.

In our further analysis, we examine the relationship between the liquidation decision and the magnitude of trading performance. In this paper we try to find empirical evidence of loss aversion near the reference point, which would support a liquidation problem for an agent with preferences consistent with prospect theory.

We use the Korean stock index futures transactions data on the Korea Stock Price Index (KOSPI) 200. Using a unique data set of all trades on the Korean stock index futures market from January 2, 2003, to March 31, 2005, we examine the trading behavior with respect to the disposition effect from an intraday analysis. The holding time of losers is longer than that of losers. In terms of holding time and profit, investors have the disposition effect. Using the Cox proportional hazards model, we find that the propensity to liquidate is not always positively related to the amount of the capital gain. Investors are more likely to hold longer losers than winners under a critical point, but to hold longer winners than losers over the critical point. From the perspective of an S-shaped utility function in prospect theory, our finding suggests that the disposition effect (risk aversion) and the break-even effect (loss aversion) play an important role in liquidation decisions. This result is consistent with the implication of Kyle, Ou-Yang, and Xiong (2006).

The remainder of this paper is organized as follows. Section 2 describes the hypotheses of the trade disposition measured by holding time. Section 3 presents data and the methodology to calculate holding time and trading profit. Section 4 shows empirical results of the Cox proportional hazards model, and present extensions and robustness. Section 5 concludes.

2. Hypotheses

The disposition effect is also measured by holding time of each contract. We are able to calculate holding time of each contract because we have the information of a trader's account information, and time for each transaction. Using the Cox proportional hazards model, we analyze which factor affects the trade decision. To test the relationship between holding time and trade disposition, we set the following two hypotheses.

Hypothesis 1: *Disposition prone investors have a tendency to hold losers longer than winners.*

By definition, the disposition effect is the tendency to hold losers too long and sell winners too soon, because the risk aversion varies with paper gains and losses. If a specific investor has the disposition effect, he is likely to hold losers longer than winners. To test the above hypothesis, we investigate holding time of winners and losers.

Hypothesis 2: *The propensity to liquidate is not always positively related to the amount of the capital gain.*

The disposition prone investors maximize an S-shaped utility function, which is convex in a loss domain and concave in a gain domain. This reflects risk aversion in the domain of gains and risk seeking in the domain of losses. If an asset appreciates in price, the investor's wealth will be in a risk-averse domain, making a sale more likely. In contrast, if the asset is trading below its reference price, the investor becomes risk loving and will hold on to the asset for a chance to break even. In addition, the loss aversion is an important factor in liquidation decisions. Higher sensitivity to losses than to gains near the reference point accelerates investors to liquidate around the break-even point. We want to test whether investors are more loss averse around the reference point or not. To test the above hypothesis, we investigate hazard rate of contracts in gains.

3. Data and Analytical Method

3.1 Data

In this paper, we analyze the entire history of transactions of the Korean stock index futures from January 2003 to March 2005. The Korean stock index futures market and data are more described in Choe and Eom (2009). The data include each trader's account information, identifiers for the buying trader and the selling trader, the price, and the time of each transaction. They also provide information on the country of residence of investors, and whether they are individuals or institutions. There are 69,391 different traders in the data. The numbers of individuals, institutions, and foreign investors are 59,081, 9,742, and 568, respectively. The percentage of individual investors is approximately 85%, which is strikingly higher than that of institutions (14%) and foreign investors (1%). However, on the basis of trading volume, the percentage of individual investors is lower. In 2004, 48.6% of the gross volume of trade was by individual investors, 29.1% of the gross volume of trade was by institutional investors, and 22.3% by foreign investors.

3.2. Calculating Method of Holding Time and Profit

We follow the Locke and Mann (2005) methodology to calculate trading profit and holding time using high frequency transaction data. *Trade* is categorized into buy or sell. More specifically, open buy, open sell, close buy, close sell, netting open buy, netting open sell, netting close buy, netting close sell, position out buy, and position out sell are the types of trade. *Position* is categorized into the long and the short positions. *Trade price* is the transaction price and *end* *price* is the price of each minute. *Average cost* is the volume weighted buy (or sell) price. *Holding time* is the volume weighted holding time of the position. *Realized profit* is calculated when the trade reduces positions or buy and sell (or sell and buy) happen during one minute. It is categorized into realized gain, realized zero, and realized loss. *Unrealized profit* is calculated using the average cost and end price. It is also categorized into paper gain, paper zero, and paper loss. We calculate holding time and profit every minute for all traders (69,391 traders) in the Korean stock index futures market for the sample period.

3.3. Analytical Example of Calculating Holding Time and Profit

Table I presents an example of the methodology calculating profit and holding time. Trader A opens a long position at 10:00 by buying one contract at $100, which is an open buy trade. At 10:01, Trader A adds to the position by buying one contract at $99. The average cost is $99.5, which are the volume weighted price of $100 and $99. The holding time is 0.5 minutes, which are the average of one minute for the first contract at 10:00 and zero minute for the second contract at 10:01. Trader A has a paper loss (PL), -$0.5 per contract, at 10:01. As Trader A buys one contract at $98 at 10:02, the average cost becomes $99, which is the average price of $100, $99, and $98, and the holding time becomes one minute which is the average of two minutes for the first contract at 10:00, one minute for the second contract at 10:01, and zero minutes for the third contract at 10:02.

At 10:03, Trader A reduces the position by selling one contract at $96, which is a close sell trade. As Trader A sells one contract at $96, he has a realized loss (RL), -$3.00 per contract, and a paper loss (PL), -$3.00 per contract. The average cost of the remaining position is unchanged because position reduction does not affect the cost of the remaining position. As time passes, the holding time continues to increase because position reduction does not affect the time of the remaining positions.

At 10:04, Trader A buys one contract at $95 and sells one at $96, which is a netting trade. We consider the intraminute trade as distinct from the existing position. As a result, the offsetting trade does not change the existing position and average cost. Trader A generates a realized gain (RG) from an intraminute trade. While Trader A does not trade until 10:08, the value of the position changes as the market price fluctuates. Trader A liquidates one position at 10:08 by selling one contract at $93 and has a realized loss (RL), -$6.00 per contract.

At 10:09, Trader A liquidates a long position and opens a short position by selling two contracts at $96, which is called a position out sell trade. Trader A has a realized loss (RL) in the long position and has a paper gain (PG) in the short position. We consider this trade as combination of a close sell and an open sell trade. Trader A liquidates the position by buying one contract at 10:11, which is called a close buy.

At 10:14, Trader A opens a short position by selling two contracts at $93, which is an open sell trade. At 10:15, Trader A buys one contract at $91 and sells three at $92, which is a netting open sell trade. When the intraminute trade happens with a position change, we consider the minimum of intraminute buy and sell quantities as the intraminute offset trade. In this case, Trader A buys one contract at $91, sells one at $92, and sells two at $92, which is a combination of an intraminute trade and open sell trade. Finally, Trade A liquidates a short position by buying four contracts at 10:18.

3.4. Summary Statistics of Holding Time and Profit

Table II reports the mean and median of holding time, realized profit, realized profit per contract, and round for all trades of 69,391 traders in the Korean stock index futures market over 553 trading days from January 2003 to March 2005. Loss means that the trade ends with negative profit, zero means that the trade ends with zero profit, and gain means that the trade ends with positive profit.

Panel A presents the result of all disposition trades from approximately 13 million observations. As we expected, the average holding time is very short (177 minutes) because futures contracts have a lot of risk such as unlimited liability and margin call. Since profit in the futures market is zero-sum, we confirm that the mean of realized profit equals to zero. The average round is 8.33 contracts. Although futures contracts are riskier than stocks, investors show the disposition effect that utility function is S-shaped, which is convex in a loss domain and concave in a gain domain. The average holding time of a loss is 221 minutes, which is much larger than that of a gain, 164 minutes. This result supports the hypothesis 1 that investors have a tendency to hold losers longer than winners. The absolute magnitude of profit per contract in loss is KRW 0.27 million (approximately 270 U.S. dollars), which is much greater than that in gain, KRW 0.19 million. The round of a loss is 9.4 contracts, which is larger than that of a gain, 8.33 contracts. In addition, the number of a realized loss is about 5 million, which is much smaller than that of a realized gain, roughly 7 million. These results also support behavioral bias that investors are likely to realize small gain more frequently. From the perspective of holding time, magnitude of profit, and frequency, investors display the disposition effect. The median value also shows a similar pattern, but the value is much smaller than the mean value.

Panel B presents the result of long position trades. The average holding time, realized profit per contract, and round of the long position is 176 minutes, KRW 0.02 million, and 8.54 contracts, respectively. Since the sample period is in an upward moving market, realized profit per contract for long position holders shows a positive value. The average holding time of a gain is longer than that of a loss, but the median of holding time in gain is shorter than that in loss. Since the holding time has no upper limit, the mean of holding time may be biased by a few large values, and this interpretation is supported by the median value. Clearly, long position holders also show the disposition effect. Panel C presents the result of short position trades, which is much similar to long position trades.

Table III reports the mean and median of holding time, realized profit, realized profit per contract, and round across realized profit groups. The average holding time of realized profit per contract between -0.025 (KRW -25,000, approximately -25 U.S. dollars) and 0 is 48 minutes, which is much longer than that of realized profit per contract between 0 and 0.025, 32 minutes. This result supports evidence that investors have a tendency to hold losers longer than winners. However, the average holding time of realized profit per contract between -0.100 and -0.200 is 89 minutes, which is much shorter than that of realized profit per contract between 0.100 and 0.200, 97 minutes. This pattern does not change over (under) 0.100 (-0.100) of realized profit per contract range. This is most strikingly evident in individual investors. In Figure 2, the holding time of gains is shorter than that of gains to a critical point, but is longer over the critical point. This result supports the hypothesis 2 that the propensity to liquidate is not always positively related to the amount of the capital gain. This result implies that higher sensitivity to losses than to gains near the reference point accelerates investors to liquidate around the break-even point. Investors are likely to hold longer gains than losses over the critical point, because gains are high enough to compensate for the risk aversion and loss aversion. Overall, investors will hold longer losses than gains around the break-even point, but will hold longer gains than losses over the critical point.

Table IV reports the mean and median of holding time, realized profit, realized profit per contract, and round by an investor type. Panel A is the result of individuals, Panel B is the result of institutions, and Panel C is the result of foreigners. The mean (median) holding time of individuals, institutions, and foreigners are 110 (14), 369 (28), and 532 (196) minutes, respectively. This result indicates that individual investors hold futures contracts shorter than institutional and foreign investors. In particular, foreign investors hold futures contracts longer than two other investor groups. There are several reasons for this phenomenon. First, since individual investors do not want to be exposed to position risk, they are inclined to clear their position quickly. This implies that individual investors are short-term traders in the Korean stock index futures market. Second, the purpose of trade is different across an investor type. Most individuals trade futures contracts for speculative purposes, but institutions and foreigners usually trade futures contracts for an arbitrage or hedging.

On average, individuals and institutions lose money, but foreigners earn money from the Korean stock index futures market. For example, the mean of realized profit for individual investors is KRW -0.01 million, that of institutions is KRW -0.15 million, and that of foreigners is KRW 0.30 million. The mean (median) of round for individuals, institutions, and foreigners are 5.55 (1), 23.96 (8), and 26.80 (10) contracts, respectively. This result indicates that individuals are small traders, but institutions and foreigners are large traders. While individuals and institutions have a tendency to hold winners shorter and losers longer, foreigners show no difference in holding time between winners and losers. In sum, this table supports the previous result that individual and institutional investors, especially individuals, display the disposition effect, but foreign investors do not have the bias. Clearly, there appears to be substantial heterogeneity in the magnitude of the disposition effect across the investor types.

4. Trade Disposition Decision

4.1. Cox Proportional Hazards Model

Survival analysis focuses on the distribution of survival times. Although there are well known methods for estimating unconditional survival distributions, most interesting survival modeling examines the relationship between survival and one or more predictors, usually termed covariates in the survival-analysis literature. The Cox proportional hazards regression model, introduced by Cox (1972), is a broadly applicable and the most widely used method of survival analysis.

The Cox proportional hazards model is the most popular model for the analysis of survival data. It makes no assumption regarding the nature of the hazard function *h(t)* itself, which makes the Cox proportional hazards model more robust. We can estimate the coefficients without having to specify the baseline hazard function $h_0(t)$. That is why it is called a semi-parametric model.

Another advantage of using the Cox proportional hazards model is that it's relatively easy to incorporate time dependent covariates due to its use of the partial likelihood function. Even though the baseline hazard is unspecified, the Cox proportional hazards model can still be estimated by the method of partial likelihood, developed by Cox (1972). Although the resulting estimates are not as efficient as maximum-likelihood estimates for a correctly specified parametric hazard regression model, not having to make arbitrary, and possibly incorrect, assumptions about the form of the baseline hazard is a compensating virtue of Cox's specification.

The Cox proportional hazard model is represented as:

$$h_i(t) = h_0(t)\exp\{\beta_1 x_{i1} + \ldots + \beta_k x_{ik}\} \tag{1}$$

where $h_i(t)$ is the hazard function for the *i*th subject, $h_0(t)$ is the baseline hazard function, x_{i1} ,…, x_{ik} are covariate values corresponding to the *i*th subject, and β_1 ,…, β_k are parameters to be estimated.

The above equation gives us a couple of features. First, if $x_{i1}, \ldots, x_{ik}$ =0, the hazard function of *i*th subject is the baseline hazard function, which is the hazard function in the absence of covariates. Second, consider two observations i and j that differ in their x-values, with the corresponding linear predictors $\eta_i = \beta_1 x_{i1} + \ldots + \beta_k x_{ik}$ and $\eta_j = \beta_1 x_{j1} + \ldots + \beta_k x_{jk}$. The hazard ratio for these two observations,

$$\frac{h_i(t)}{h_j(t)} = \frac{h_0(t)e^{\eta_i}}{h_0(t)e^{\eta_j}} = \frac{e^{\eta_i}}{e^{\eta_j}} \tag{2}$$

is independent of time t. Consequently, the Cox model is a proportional hazards model.

4.2. Cox Proportional Hazards Model Estimation

The Cox proportional hazards model employs a non-parametric estimate of the baseline hazard. This means that there is no assumption about the probability of closing positions at time t after the open position.

The form of the Cox proportional hazards model is as follows.

Model 1:

$$h(t) = h_0(t)\exp\{\beta_g I(profit_{i,t} > 0)\} \tag{3}$$

Model 2:

$$\begin{aligned} h(t) = h_0(t)\exp\{&\beta_{g1} I(0 < profit_{i,t} < 0.1) + \beta_{g2} I(0.1 \le profit_{i,t} < 0.2) + \\ &\beta_{g3} I(0.2 \le profit_{i,t} < 0.5) + \beta_{g4} I(0.5 \le profit_{i,t} < 1) + \beta_{g5} I(profit_{i,t} \ge 1)\} \end{aligned} \tag{4}$$

Model 3:

$$h(t) = h_0(t)\exp\{\beta_{g1} profit_{i,t} I(0 < profit_{i,t} < 0.1) + \beta_{g2} profit_{i,t} I(0.1 \le profit_{i,t} < 0.2) + \beta_{g3} profit_{i,t} I(0.2 \le profit_{i,t} < 0.5) + \beta_{g4} profit_{i,t} I(0.5 \le profit_{i,t} < 1) + \beta_{g5} profit_{i,t} I(profit_{i,t} \ge 1)\} \quad (5)$$

Model 4:

$$h(t) = h_0(t)\exp\{\beta_{g1} profit_{i,t} I(0 < profit_{i,t} < 0.1) + \beta_{g2} profit_{i,t} I(0.1 \le profit_{i,t}) + \beta_{l1} \left|profit_{i,t}\right| I(0 > profit_{i,t} > -0.1) + \beta_{l2} \left|profit_{i,t}\right| I(profit_{i,t} \le -0.1)\} \quad (6)$$

where t is the time to position liquidation, $h(t)$ is the hazard rate for liquidation, $h_0(t)$ is the baseline hazard rate, and $profit_{i,t}$ is the profit per contract by liquidation for account i at time t. $profit_{i,t}$ is measured at KRW one million. Hazard rate is estimated allowing for a common baseline hazard for all accounts and account-specific baseline hazards.

4.3. Cox Proportional Hazards Model Estimation Results

Figure 1 depicts the baseline survival function of the Cox proportional hazard using equation (10). Hazard rate is estimated allowing for a common baseline hazard for all accounts. Panel A depicts the results of all accounts. The baseline survival function drops quickly in the first 100 minutes after the time of purchase. The survival rate at 100 (300) minutes after the time of purchase is 24.4% (11.1%), which means that less than 25% (12%) of the position is held for more than 100 minutes. Panel B depicts the results by an investor type. The survival rate of foreign investors is much higher than that of individual and institutional investors. The survival rate at 100 minutes after the time of purchase for individual, institutional, and foreign investors is 19.7%, 39.1%, and 68.9%, respectively. This result implies that foreign investors in the Korean stock index futures market show a different pattern from domestic investors, and individual investors seem to hold futures contracts for short-term periods.

Table V reports coefficient estimates, standard error, and hazard rate of the Cox proportional hazards model 1 – 4 for all accounts during the sample period. The left-side column is the results allowing for a common baseline hazard $h_0(t)$ and the right-side column is the results allowing for account-specific baseline hazards $h_i(t)$.

Model 1 estimates the Cox proportional hazards model with an indicator variable for the gain per contract. A positive coefficient (β_g) for the indicator variable $I(profit_{i,t} > 0)$ implies that investors have the disposition effect. The value of β_g using a common baseline hazard is 0.10, which means that the investor's conditional probability of liquidating a contract is exp(0.10) = 1.11 times higher for a contract with a gain than for a contract with a loss. The value of β_g using account-specific baseline hazards is 0.16, and the probability of liquidating a contract 1.17 times higher for a contract with a gain than for a contract with a loss. All estimated coefficients are statistically significant at the one percent level. This result suggests that investors are likely to liquidate winners more rapidly than losers.

Model 2 estimates the Cox proportional hazards model with several indicator variables for the range of gains per contract. We find that the coefficients are decreasing with increasing profit per contract. This result indicates that investors are more likely to realize small gains than small losses. For example, the coefficient β_{g1} for the indicator variable $I(0 < profit_{i,t} < 0.1)$ using a common baseline hazard is 0.71, which means the investor's conditional probability of liquidating a contract is 2.04 times higher for a contract with a gain than for a contract with a loss. The coefficient β_{g2} for the indicator variable $I(0.1 \le profit_{i,t} < 0.2)$ is 0.21, and hazard rate is 1.23. On the contrary, the coefficients β_{g3}, β_{g4}, β_{g5} for the indicator variable $I(0.2 \le profit_{i,t} < 0.5)$, $I(0.5 \le profit_{i,t} < 1)$, $I(profit_{i,t} \ge 1)$ have negative values -0.33, -0.81, -1.34, respectively. The negative coefficients suggest that a larger gain is associated with a reduced probability of liquidation. This result implies that the propensity to liquidate is not always positively related to the amount of the capital gain, but is positively related to a critical point and negatively related over the critical point. This result implies that higher sensitivity to losses than to gains near the reference point accelerates investors to liquidate around the break-even point. The risk aversion and the loss aversion induce investors to hold longer losses than gains around the break-even point. However, investors are likely to hold longer gains than losses over the critical point, because gains are high enough to compensate for the risk aversion and loss aversion.

Model 3 estimates the Cox proportional hazards model with several indicator variables for the range of gains per contract times profit per contract. The sign of coefficients is very similar to the result of Model 2, which verifies the previous result. Interestingly, the coefficient β_{g1} for the indicator variable times profit $profit_{i,t} I(0 < profit_{i,t} < 0.1)$ using an account-specific baseline hazard is 6.41, which means that the investor's conditional probability of liquidating a contract is 610 times higher for a contract with a gain than for a contract with a loss. This result suggests that an increased gain between zero and KRW 0.1 million is associated with an increased probability of liquidation.

Model 4 estimates the Cox proportional hazards model with several indicator variables for the range of gains per contract times profit per contract and several indicator variables for the range of losses per contract times profit per contract. As we expected, investors are more likely to realize small gains and hold onto large gains, small losses, and large losses. For example, the coefficient β_{g1} for the indicator variable times profit $profit_{i,t} I(0 < profit_{i,t} < 0.1)$ using account-specific baseline hazards is 2.88. However, the coefficients β_{g2}, β_{l1}, β_{l2} for $profit_{i,t} I(0.1 \le profit_{i,t})$, $profit_{i,t} I(0 > profit_{i,t} > -0.1)$, $profit_{i,t} I(profit_{i,t} \le -0.1)$ have negative values -1.29, -0.28, -1.30, respectively.

4.4. Robustness Check

To reinforce our empirical evidence, we estimate the Cox proportional hazards model with more refined data. Table VI reports coefficient estimates of the Cox proportional hazard model 1 - 4 for the accounts which trade at least 20 times during the sample period. Among the 69,391 traders, 42,716 accounts trade at least 20 times and are considered active traders. Furthermore, we test with the censored holding time data. Table VII reports coefficient estimates of the Cox proportional hazard model 1 - 4 for the accounts which trade at least 20 times during the sample period. In this table, holding time over 1,000 minutes is censored to 1,000 minutes. Overall, the two additional test results are consistent with the previous analysis in that the sign of coefficients are not changed.

5. Conclusion

This paper examines the trading behavior with respect to prospect theory from an intraday analysis. We examine how the liquidation decisions of investors are influenced by their trading gains and losses. In addition, we examine the relationship between the liquidation decision and the magnitude of trading performance. We try to find empirical evidence of loss aversion near the reference point, which would support a liquidation problem for an agent with preferences consistent with prospect theory.

We use the Korean stock index futures transactions data on the KOSPI 200. Using a unique data set of all trades on the Korean stock index futures market from January 2, 2003, to March 31, 2005, we examine the trading behavior with respect to the disposition effect from an intraday analysis. The holding time of losers is longer than that of losers. In terms of holding time and profit, investors have the disposition effect. Using the Cox proportional hazards model, we find that the propensity to liquidate is not always positively related to the amount of the capital gain. Investors are more likely to sell winners under a critical point, but to hold winners over the critical point. From the perspective of an S-shaped utility function in prospect theory, our finding suggests that the disposition effect (risk aversion) and the break-even effect (loss aversion) play an important role in liquidation decisions. This result is consistent with the implication of Kyle, Ou-Yang, and Xiong (2006).

References

Barberis, Nicholas, and Ming Huang, 2001, Mental accounting, loss aversion, and individual stock returns, *Journal of Finance* 56, 1247-1292.

Barberis, Nicholas, Ming Huang, and Tano Santos, 2001, Prospect theory and asset prices, *Quarterly Journal of Economics* 116, 1-54.

Benartzi, Shlomo, and Richard H. Thaler, 1995, Myopic loss aversion and the equity premium puzzle, *Quarterly Journal of Economics* 110, 73-92.

Choe, Hyuk, and Yunsung Eom, 2009, The Disposition Effect and Investment Performance in the Futures Market, *Journal of Futures Markets* 29, 496-522.

Coval, Joshua D., and Tyler Shumway, 2005, Do behavioral biases affect prices?, *Journal of Finance* 60, 1-34.

Cox, D. R., 1997, Regression models and life tables, *Journal of the Royal Statistical Society Series B* 34, 187-220.

Frazzini, Andrea, 2006, The disposition effect and underreaction to news, *Journal of Finance* 61, 2017-2046.

Grinblatt, Marchk, and Bing Han, 2005, Prospect theory, mental accounting, and momentum, *Journal of Financial Economics* 78, 311-339.

Grinblatt, Marchk, and Matti Keloharju, 2001, What makes investors trade?, *Journal of Finance* 56, 589-616.

Kahneman, Daniel, and Amos Tversky, 1979, Prospect theory: An analysis of decision under risk, *Econometrica* 47, 263-291.

Kyle, Albert S., Hui Ou-Yang, and Wei Xiong, 2006, Prospect theory and liquidation decisions, *Journal of Economic Theory* 129, 273-288.

Locke, Peter R., and Steven C. Mann, 2005, Professional trader discipline and trade disposition, *Journal of Financial Economics* 76, 401-444.

Odean, Terrance, 1998, Are investors reluctant to realize their losses?, *Journal of Finance* 53, 1775-1798.

Shapira, Zur, and Itzhak Venezia, 2001, Patterns of behavior of professionally managed and independent investors, *Journal of Banking and Finance* 25, 1573-1587.

Shefrin, Hersh, and Meir Statman, 1985, The disposition to sell winners too early and ride losers too long: Theory and evidence, *Journal of Finance* 40, 777-790.

Shumway, Tyler and Guojun Wu, 2005, Does disposition drive momentum?, working paper, University of Michigan

Thaler, Richard H., and Eric J. Johnson, 1990, Gambling with the house money and trying to break even: The effects of prior outcomes on risky choice, *Management Science* 36, 643-660.

Table I
Example of Calculating Holding Time and Profit

This table reports the example of calculating holding time and profit for a specific investor. The trade is categorized by buy or sell, the number of trade, and trade type. Open buy, open sell, close buy, close sell, netting open buy, netting open sell, netting close buy, netting close sell, position out buy, and position out buy are the types of trade. Position is categorized into long and short. Trade price is the transaction price and end price is the price of each minute. Average cost is the volume weighted buy (or sell) price. Holding time is the volume weighted holding time of the position. Realized profit is calculated whenever the trade realize his position or buy and sell (or sell and buy) during one minute. RG, R0, RL are realized gain, realized zero, and realized loss, respectively. Unrealized profit is calculated based on the average cost and end price. PG, P0, PL are paper gain, paper zero, and paper loss respectively. I calculate holding time and profit every minute for all traders (69,391 traders) in the Korean stock index futures market over 553 trading days from January 2003 to March 2005.

Time	Trade			Position		Price		Average Cost		Holding Time		Realized Profit				Unrealized Profit			
	B/S	#	Type	L/S	#	Trade	End	Start	End	Start	End	Total	#	Per	Type	Total	#	Per	Type
10:00	Buy	1	Open Buy	Long	1	$100	$100		$100.00		0					0	1	0	P0
10:01	Buy	1	Open Buy	Long	2	99	99	$100.00	99.50	1.0	0.5					-$1	2	-$0.50	PL
10:02	Buy	1	Open Buy	Long	3	98	98	99.50	99.00	1.5	1.0					-3.00	3	-1.00	PL
10:03	Sell	1	Close Sell	Long	2	96	96	99.00	99.00	2.0	2.0	-$3.00	1	-$3.00	RL	-6.00	2	-3.00	PL
10:04	Buy	1	Netting	Long	2	95	96	99.00	99.00	3.0	3.0	1.00	1	1.00	RG	-6.00	2	-3.00	PL
	Sell	1				96													
10:05				Long	2		95	99.00	99.00	4.0	4.0					-8.00	2	-4.00	PL
10:06				Long	2		92	99.00	99.00	5.0	5.0					-14.00	2	-7.00	PL
10:07				Long	2		94	99.00	99.00	6.0	6.0					-10.00	2	-5.00	PL
10:08	Sell	1	Close Sell	Long	1	93	95	99.00	99.00	7.0	7.0	-6.00	1	-6.00	RL	-4.00	1	-4.00	PL
10:09	Sell	2	Position out Sell	Short	1	96	95	99.00	96.00	8.0	0.0	-3.00	1	-3.00	RL	1.00	1	1.00	PG
10:10				Short	1		94	96.00	96.00	1.0	1.0					2.00	1	2.00	PG
10:11	Buy	1	Close Buy	Short	0	95	95	96.00	96.00	2.0		1.00	1	1.00	RG				
10:12							93												
10:13							94												
10:14	Sell	2	Open Sell	Short	2	93	93		93.00		0.0					0.00	2	0.00	P0
10:15	Buy	1	Netting Open Sell	Short	4	91	92	93.00	92.50	1.0	0.5	1.00	1	1.00	RG	2.00	4	0.50	PG
	Sell	3				92													
10:16				Short	4		91	92.50	92.50	1.5	1.5					6.00	4	1.50	PG
10:17				Short	4		90	92.50	92.50	2.5	2.5					10.00	4	2.50	PG
10:18	Buy	4	Close Buy	Short	0	91	91	92.50	92.50	3.5		6.00	4	1.50	RG				

Table II
Holding Time and Realized Profit

This table reports the mean and median of holding time, realized profit, realized profit per contract, and round for all trades of 69,391 traders in the Korean stock index futures market over 553 trading days from January 2003 to March 2005. Loss means that the trade ends with negative profit, zero means that the trade ends with zero profit, and gain means that the trade ends with positive profit. Panel A is the results of all trades, Panel B is the result of long position traders, and Panel C is the result of short position traders. Realized profits are KRW one million.

		Mean				Median			
	Observations	Holding time	Realized profit	Realized profit per contract	Round	Holding time	Realized profit	Realized profit per contract	Round
Panel A. All disposition trades									
All	13,796,750	177	0.00	0.00	8.95	17	0.03	0.03	1
Loss	5,544,065	219	-2.61	-0.26	9.66	23	-0.24	-0.12	2
Zero	884,496	33	0.00	0.00	6.91	4	0.00	0.00	1
Gain	7,368,189	163	1.96	0.19	8.66	16	0.15	0.08	1
Panel B. Long positions									
All	6,775,280	176	0.27	0.02	9.22	17	0.03	0.03	1
Long Loss	2,614,480	171	-2.40	-0.25	9.94	21	-0.23	-0.11	2
Long Zero	433,617	35	0.00	0.00	7.14	4	0.00	0.00	1
Long Gain	3,727,183	196	2.17	0.20	8.95	18	0.15	0.08	1
Panel C. Short positions									
All	7,021,470	178	-0.26	-0.02	8.69	17	0.03	0.01	1
Short Loss	2,929,585	261	-2.79	-0.27	9.41	25	-0.25	-0.13	2
Short Zero	450,879	32	0.00	0.00	6.69	4	0.00	0.00	1
Short Gain	3,641,006	129	1.74	0.17	8.36	15	0.14	0.08	1

Table III
Holding Time and Realized Profit across Realized Profit Groups

This table reports the mean and median of holding time, realized profit, realized profit per contract, and round for all trades of 69,391 traders in the Korean stock index futures market over 553 trading days from January 2003 to March 2005. Loss means that the trade ends with negative profit, zero means that the trade ends with zero profit, and gain means that the trade ends with positive profit. Realized profits are KRW one million.

Realized profit per contract		Observations	Mean				Median			
			Holding time	Realized profit	Realized profit per contract	Round	Holding time	Realized profit	Realized profit per contract	Round
	<-1.000	261,960	2,136	-22.98	-1.94	11.52	997	-3.80	-1.52	2
-1.000<=	<-0.500	400,165	512	-7.25	-0.70	10.36	264	-1.33	-0.68	2
-0.500<=	<-0.200	1,074,288	197	-2.84	-0.32	8.88	74	-0.50	-0.30	2
-0.200<=	<-0.100	1,139,173	89	-1.18	-0.15	7.96	23	-0.20	-0.15	2
-0.100<=	<-0.075	490,163	60	-0.71	-0.10	7.76	13	-0.10	-0.10	1
-0.075<=	<-0.050	573,864	52	-0.57	-0.07	8.51	10	-0.08	-0.08	1
-0.050<=	<-0.025	723,712	46	-0.40	-0.05	9.74	8	-0.05	-0.05	1
-0.025<=	<0	877,054	48	-0.20	-0.02	13.39	7	-0.03	-0.03	2
0		892,173	34	0.00	0.00	7.59	4	0.00	0.00	1
0.000<	<=0.025	1,842,636	32	0.16	0.02	9.26	5	0.03	0.03	1
0.025<	<=0.050	1,330,577	36	0.32	0.05	7.55	7	0.05	0.05	1
0.050<	<=0.075	786,860	48	0.51	0.07	7.71	11	0.08	0.08	1
0.075<	<=0.100	606,295	59	0.66	0.10	7.25	15	0.10	0.10	1
0.100<	<=0.200	1,173,361	97	1.18	0.15	8.02	29	0.20	0.15	1
0.200<	<=0.500	1,007,444	224	2.94	0.32	9.22	95	0.50	0.30	2
0.500<	<=1.000	397,531	550	7.67	0.70	10.95	290	1.41	0.68	2
1.000<		219,494	2,106	25.18	1.79	12.96	1,008	4.04	1.43	2

Table IV
Holding Time and Realized Profit across Investor Types

This table reports the mean and median of holding time, realized profit, realized profit per contract, and round by investor type for all trades of 69,391 traders in the Korean stock index futures market over 553 trading days from January 2003 to March 2005. Loss means that the trade ends with negative profit, zero means that the trade ends with zero profit, and gain means that the trade ends with positive profit. Panel A is the results of individuals, Panel B is the result of institutions, and Panel C is the result of foreigners. Realized profits are KRW one million.

		Mean				Median			
	Observations	Holding time	Realized profit	Realized profit per contract	Round	Holding time	Realized profit	Realized profit per contract	Round
Panel A. Individual									
All	11,438,027	110	-0.01	0.00	5.55	14	0.03	0.03	1
Loss	4,490,451	138	-1.25	-0.23	5.89	18	-0.19	-0.11	1
Zero	729,643	19	0.00	0.00	4.69	4	0.00	0.00	1
Gain	6,217,933	101	0.89	0.16	5.41	13	0.12	0.08	1
Long	5,646,093	114	0.05	0.01	5.65	14	0.03	0.03	1
Long Loss	2,150,008	120	-1.27	-0.23	5.99	17	-0.18	-0.10	1
Long Zero	357,370	20	0.00	0.00	4.88	4	0.00	0.00	1
Long Gain	3,138,715	120	0.96	0.17	5.50	15	0.13	0.08	1
Short	5,791,934	106	-0.07	-0.01	5.46	13	0.03	0.03	1
Short Loss	2,340,443	154	-1.24	-0.23	5.79	19	-0.20	-0.11	1
Short Zero	372,273	19	0.00	0.00	4.51	4	0.00	0.00	1
Short Gain	3,079,218	81	0.81	0.15	5.32	12	0.10	0.08	1

				Panel B. Institution					
All	1,431,867	369	-0.15	0.00	23.96	28	0.00	0.00	8
Loss	617,367	438	-5.16	-0.35	24.44	38	-0.89	-0.12	8
Zero	111,538	34	0.00	0.00	18.96	2	0.00	0.00	5
Gain	702,962	363	4.23	0.30	24.33	33	0.73	0.09	8
Long	655,287	329	0.56	0.05	24.99	23	0.03	0.01	8
Long Loss	262,509	289	-4.09	-0.28	26.58	26	-0.75	-0.10	8
Long Zero	53,596	27	0.00	0.00	18.93	2	0.00	0.00	5
Long Gain	339,182	407	4.25	0.32	24.72	31	0.71	0.09	7
Short	776,580	403	-0.75	-0.05	23.08	34	0.00	0.00	8
Short Loss	354,858	547	-5.95	-0.40	22.85	51	-1.00	-0.13	8
Short Zero	57,942	39	0.00	0.00	18.98	2	0.00	0.00	5
Short Gain	363,780	321	4.20	0.29	23.96	35	0.74	0.09	9
				Panel C. Foreigner					
All	896,572	532	0.30	0.00	26.80	196	0.00	0.00	10
Loss	420,063	549	-10.01	-0.41	26.69	205	-1.61	-0.20	10
Zero	43,312	267	0.00	0.00	13.29	107	0.00	0.00	5
Gain	433,197	542	10.32	0.39	28.25	199	1.51	0.17	10
Long	460,240	553	1.76	0.06	29.03	211	0.05	0.01	10
Long Loss	195,692	458	-9.66	-0.38	29.31	198	-1.57	-0.18	10
Long Zero	22,650	296	0.00	0.00	14.98	125	0.00	0.00	5
Long Gain	241,898	653	11.16	0.43	30.12	235	1.75	0.19	10
Short	436,332	510	-1.24	-0.08	24.44	182	-0.03	-0.01	10
Short Loss	224,371	628	-10.32	-0.45	24.41	212	-1.64	-0.22	9
Short Zero	20,662	236	0.00	0.00	11.45	91	0.00	0.00	4
Short Gain	191,299	402	9.27	0.35	25.88	165	1.25	0.15	10

Table V
Cox Proportional Hazards Model Estimation

This table reports coefficient estimates of the Cox proportional hazards model. The form of the Cox proportional hazards model is as follows.

Model 1: $h(t) = h_0(t)\exp\{\beta_g I(profit_{i,t} > 0)\}$

Model 2: $h(t) = h_0(t)\exp\{\beta_{g1} I(0 < profit_{i,t} < 0.1) + \beta_{g2} I(0.1 \le profit_{i,t} < 0.2) + \beta_{g3} I(0.2 \le profit_{i,t} < 0.5) + \beta_{g4} I(0.5 \le profit_{i,t} < 1) + \beta_{g5} I(profit_{i,t} \ge 1)\}$

Model 3: $h(t) = h_0(t)\exp\{\beta_{g1} profit_{i,t} I(0 < profit_{i,t} < 0.1) + \beta_{g2} profit_{i,t} I(0.1 \le profit_{i,t} < 0.2) + \beta_{g3} profit_{i,t} I(0.2 \le profit_{i,t} < 0.5) + \beta_{g4} profit_{i,t} I(0.5 \le profit_{i,t} < 1) + \beta_{g5} profit_{i,t} I(profit_{i,t} \ge 1)\}$

Model 4: $h(t) = h_0(t)\exp\{\beta_{g1} profit_{i,t} I(0 < profit_{i,t} < 0.1) + \beta_{g2} profit_{i,t} I(0.1 \le profit_{i,t}) + \beta_{l1} |profit_{i,t}| I(0 > profit_{i,t} > -0.1) + \beta_{l2} |profit_{i,t}| I(profit_{i,t} \le -0.1)\}$

where t is the time to position liquidation, $h(t)$ is the hazard rate for liquidation, $h_0(t)$ is the baseline hazard rate, and $profit_{i,t}$ is the profit per contract by liquidation for account i at time t. The left side reports the results allowing for a common baseline hazard $h_0(t)$ and the right side reports the results allowing for account-specific baseline hazards $h_i(t)$. The sample consists of all accounts (69,391 traders) in the Korean stock index futures market over 553 trading days from January 2003 to March 2005. All estimated coefficients are statistically significant at the one percent level.

Model	Coefficient	Common Baseline			Account-Specific Baseline		
		Estimate	Standard Error	Hazard Rate	Estimate	Standard Error	Hazard Rate
Model 1	β_g	0.10	(0.0006)	1.11	0.16	(0.0006)	1.17
Model 2	β_{g1}	0.71	(0.0007)	2.04	0.50	(0.0007)	1.65
	β_{g2}	0.21	(0.0009)	1.23	0.18	(0.0010)	1.20
	β_{g3}	-0.33	(0.0011)	0.72	-0.21	(0.0011)	0.81
	β_{g4}	-0.81	(0.0016)	0.45	-0.58	(0.0017)	0.56
	β_{g5}	-1.34	(0.0023)	0.26	-0.98	(0.0025)	0.37
Model 3	β_{g1}	8.34	(0.0117)	4203.17	6.41	(0.0124)	610.92
	β_{g2}	0.29	(0.0066)	1.33	0.51	(0.0069)	1.67
	β_{g3}	-1.44	(0.0033)	0.24	-0.94	(0.0034)	0.39
	β_{g4}	-1.29	(0.0023)	0.28	-0.91	(0.0025)	0.40
	β_{g5}	-0.76	(0.0013)	0.47	-0.60	(0.0015)	0.55
Model 4	β_{g1}	3.46	(0.0126)	31.78	2.88	(0.0132)	17.89
	β_{g2}	-1.69	(0.0016)	0.19	-1.29	(0.0016)	0.27
	β_{l1}	0.68	(0.0151)	1.97	-0.28	(0.0157)	0.76
	β_{l2}	-1.51	(0.0014)	0.22	-1.30	(0.0015)	0.27

Table VI
Cox Proportional Hazards Model Estimation over 20 Times Trade

This table reports coefficient estimates of the Cox proportional hazards model. The form of the Cox proportional hazards model is as follows.

Model 1: $h(t) = h_0(t)\exp\{\beta_g I(profit_{i,t} > 0)\}$

Model 2: $$h(t) = h_0(t)\exp\{\beta_{g1} I(0 < profit_{i,t} < 0.1) + \beta_{g2} I(0.1 \le profit_{i,t} < 0.2) + \beta_{g3} I(0.2 \le profit_{i,t} < 0.5) + \beta_{g4} I(0.5 \le profit_{i,t} < 1) + \beta_{g5} I(profit_{i,t} \ge 1)\}$$

Model 3: $$h(t) = h_0(t)\exp\{\beta_{g1} profit_{i,t} I(0 < profit_{i,t} < 0.1) + \beta_{g2} profit_{i,t} I(0.1 \le profit_{i,t} < 0.2) + \beta_{g3} profit_{i,t} I(0.2 \le profit_{i,t} < 0.5) + \beta_{g4} profit_{i,t} I(0.5 \le profit_{i,t} < 1) + \beta_{g5} profit_{i,t} I(profit_{i,t} \ge 1)\}$$

Model 4: $$h(t) = h_0(t)\exp\{\beta_{g1} profit_{i,t} I(0 < profit_{i,t} < 0.1) + \beta_{g2} profit_{i,t} I(0.1 \le profit_{i,t}) + \beta_{l1} \left|profit_{i,t}\right| I(0 > profit_{i,t} > -0.1) + \beta_{l2} \left|profit_{i,t}\right| I(profit_{i,t} \le -0.1)\}$$

where t is the time to position liquidation, $h(t)$ is the hazard rate for liquidation, $h_0(t)$ is the baseline hazard rate, and $profit_{i,t}$ is the profit per contract by liquidation for account i at time t. The left side reports the results allowing for a common baseline hazard $h_0(t)$ and the right side reports the results allowing for account-specific baseline hazards $h_i(t)$. The sample consists of the account (42,716 traders), at least 20 times trade for the sample period, in the Korean stock index futures market over 553 trading days from January 2003 to March 2005. All estimated coefficients are statistically significant at the one percent level.

		Common Baseline			Account-Specific Baseline		
Model	Variable	Estimate	Standard Error	Hazard Rate	Estimate	Standard Error	Hazard Rate
Model 1	β_g	0.10	(0.0006)	1.10	0.16	(0.0006)	1.17
Model 2	β_{g1}	0.70	(0.0007)	2.02	0.50	(0.0007)	1.65
	β_{g2}	0.20	(0.0010)	1.22	0.18	(0.0010)	1.19
	β_{g3}	-0.34	(0.0011)	0.71	-0.21	(0.0011)	0.81
	β_{g4}	-0.82	(0.0017)	0.44	-0.59	(0.0017)	0.56
	β_{g5}	-1.34	(0.0023)	0.26	-0.99	(0.0026)	0.37
Model 3	β_{g1}	8.20	(0.0117)	3648.27	6.38	(0.0125)	591.52
	β_{g2}	0.22	(0.0067)	1.25	0.49	(0.0069)	1.63
	β_{g3}	-1.47	(0.0033)	0.23	-0.95	(0.0034)	0.39
	β_{g4}	-1.30	(0.0024)	0.27	-0.92	(0.0025)	0.40
	β_{g5}	-0.78	(0.0014)	0.46	-0.61	(0.0015)	0.55
Model 4	β_{g1}	3.25	(0.0127)	25.69	2.84	(0.0133)	17.19
	β_{g2}	-1.73	(0.0016)	0.18	-1.30	(0.0017)	0.27
	β_{l1}	0.47	(0.0152)	1.59	-0.31	(0.0157)	0.73
	β_{l2}	-1.56	(0.0015)	0.21	-1.31	(0.0016)	0.27

Table VII

Cox Proportional Hazards Model Estimation over 20 Times Trade Censored

This table reports coefficient estimates of the Cox proportional hazards model. The form of the Cox proportional hazards model is as follows.

Model 1: $h(t) = h_0(t)\exp\{\beta_g I(profit_{i,t} > 0)\}$

Model 2: $h(t) = h_0(t)\exp\{\beta_{g1} I(0 < profit_{i,t} < 0.1) + \beta_{g2} I(0.1 \le profit_{i,t} < 0.2) + \beta_{g3} I(0.2 \le profit_{i,t} < 0.5) + \beta_{g4} I(0.5 \le profit_{i,t} < 1) + \beta_{g5} I(profit_{i,t} \ge 1)\}$

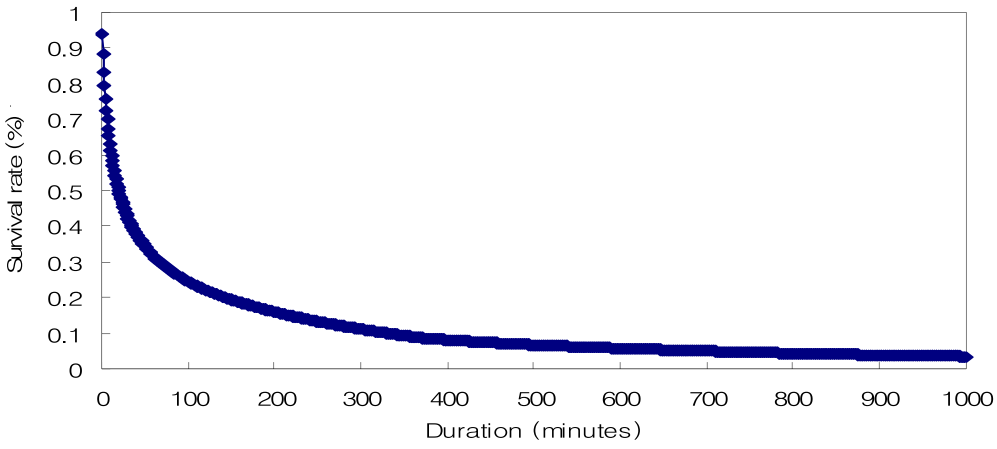
Model 3: $h(t) = h_0(t)\exp\{\beta_{g1} profit_{i,t} I(0 < profit_{i,t} < 0.1) + \beta_{g2} profit_{i,t} I(0.1 \le profit_{i,t} < 0.2) + \beta_{g3} profit_{i,t} I(0.2 \le profit_{i,t} < 0.5) + \beta_{g4} profit_{i,t} I(0.5 \le profit_{i,t} < 1) + \beta_{g5} profit_{i,t} I(profit_{i,t} \ge 1)\}$

Model 4: $h(t) = h_0(t)\exp\{\beta_{g1} profit_{i,t} I(0 < profit_{i,t} < 0.1) + \beta_{g2} profit_{i,t} I(0.1 \le profit_{i,t}) + \beta_{l1} |profit_{i,t}| I(0 > profit_{i,t} > -0.1) + \beta_{l2} |profit_{i,t}| I(profit_{i,t} \le -0.1)\}$

where t is the time to position liquidation, $h(t)$ is the hazard rate for liquidation, $h_0(t)$ is the baseline hazard rate, and $profit_{i,t}$ is the profit per contract by liquidation for account i at time t. The left side reports the results allowing for a common baseline hazard $h_0(t)$ and the right side reports the results allowing for account-specific baseline hazards $h_i(t)$. The sample consists of the account (42,716 traders), at least 20 times trade for the sample period, in the Korean stock index futures market over 553 trading days from January 2003 to March 2005. The holding time over 1,000 minutes is censored. All estimated coefficients are statistically significant at the one percent level.

		Common Baseline			Account-Specific Baseline		
Model	Variable	Estimate	Standard Error	Hazard Rate	Estimate	Standard Error	Hazard Rate
Model 1	β_g	0.10	(0.0006)	1.11	0.16	(0.0006)	1.17
Model 2	β_{g1}	0.69	(0.0007)	2.00	0.50	(0.0007)	1.64
	β_{g2}	0.18	(0.0010)	1.20	0.17	(0.0010)	1.18
	β_{g3}	-0.36	(0.0011)	0.70	-0.23	(0.0011)	0.79
	β_{g4}	-0.92	(0.0018)	0.40	-0.65	(0.0018)	0.52
	β_{g5}	-1.78	(0.0032)	0.17	-1.25	(0.0033)	0.29
Model 3	β_{g1}	7.99	(0.0118)	2944.01	6.28	(0.0125)	534.03
	β_{g2}	0.10	(0.0067)	1.11	0.42	(0.0069)	1.52
	β_{g3}	-1.58	(0.0034)	0.21	-1.02	(0.0035)	0.36
	β_{g4}	-1.47	(0.0026)	0.23	-1.04	(0.0027)	0.35
	β_{g5}	-1.25	(0.0023)	0.29	-0.91	(0.0023)	0.40
Model 4	β_{g1}	0.73	(0.0132)	2.07	1.51	(0.0137)	4.55
	β_{g2}	-2.48	(0.0021)	0.08	-1.73	(0.0021)	0.18
	β_{l1}	-2.05	(0.0157)	0.13	-1.61	(0.0160)	0.20
	β_{l2}	-2.35	(0.0020)	0.10	-1.77	(0.0020)	0.17

Panel A. All accounts



Panel B. By Investor Type

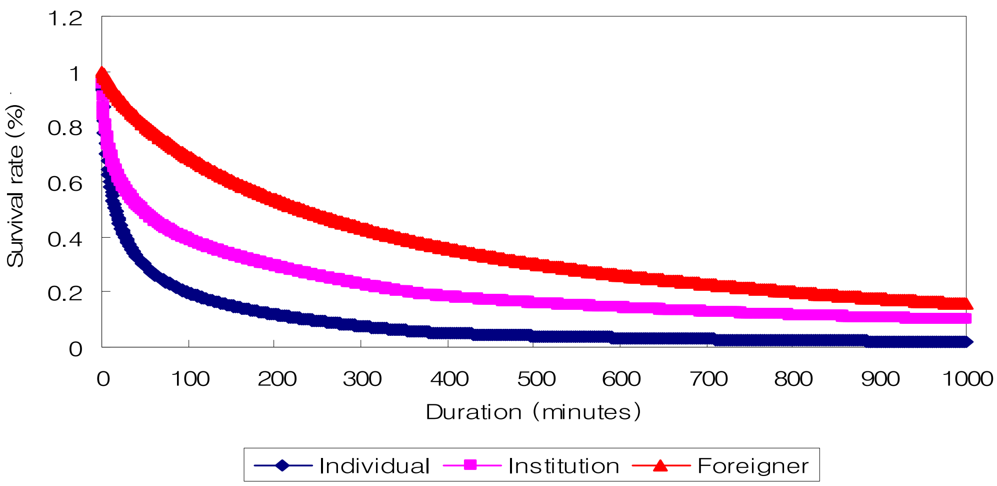


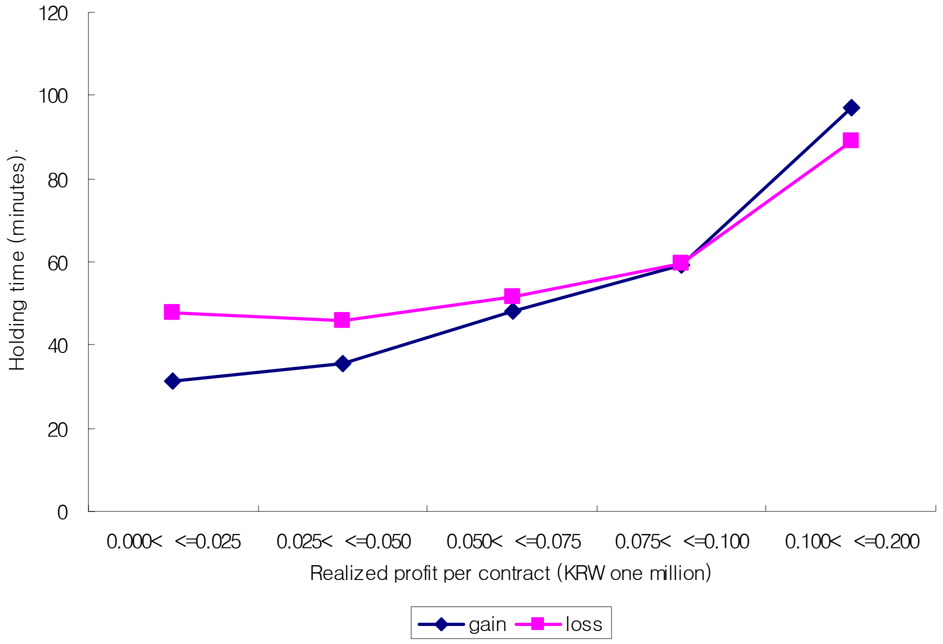
Figure 1. Baseline Survival Function.

This figure depicts baseline survival function of the Cox proportional hazard model. The form of the Cox proportional hazards model is as follows.

$$h(t) = h_0(t)\exp\{\beta_g I(profit_{i,t} > 0)\}$$

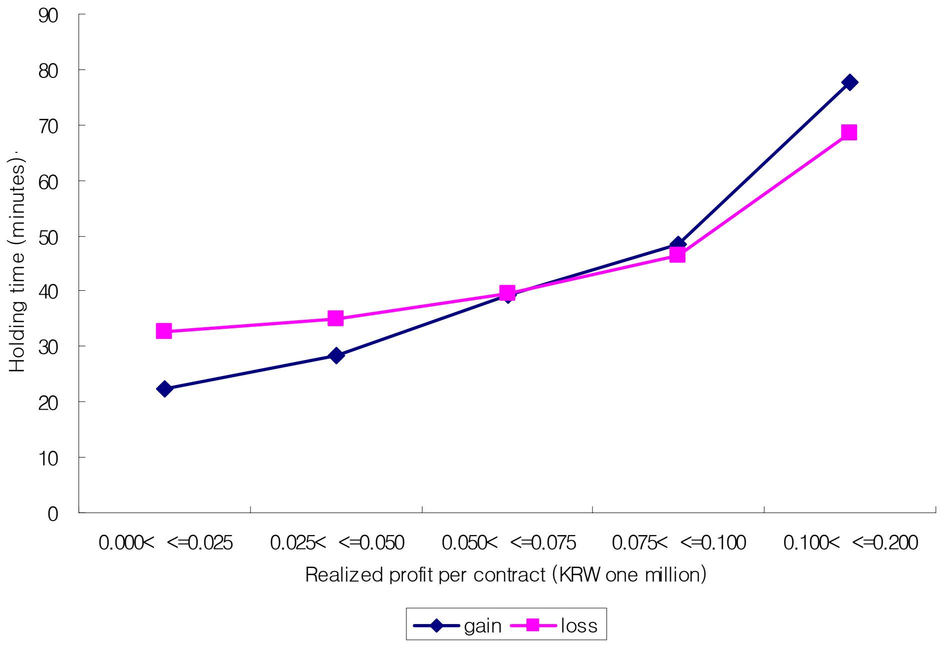
where t is the time to position liquidation, $h(t)$ is the hazard rate for liquidation, $h_0(t)$ is the baseline hazard rate, and $profit_{i,t}$ is the profit per contract by liquidation for account i at time t. Hazard rate is estimated allowing for a common baseline hazard for all accounts. Panel A depicts the results of all accounts and Panel B depicts the results across investor types. The sample consists of all accounts (69,391 traders) in the Korean stock index futures market over 553 trading days from January 2003 to March 2005

Panel A. All accounts

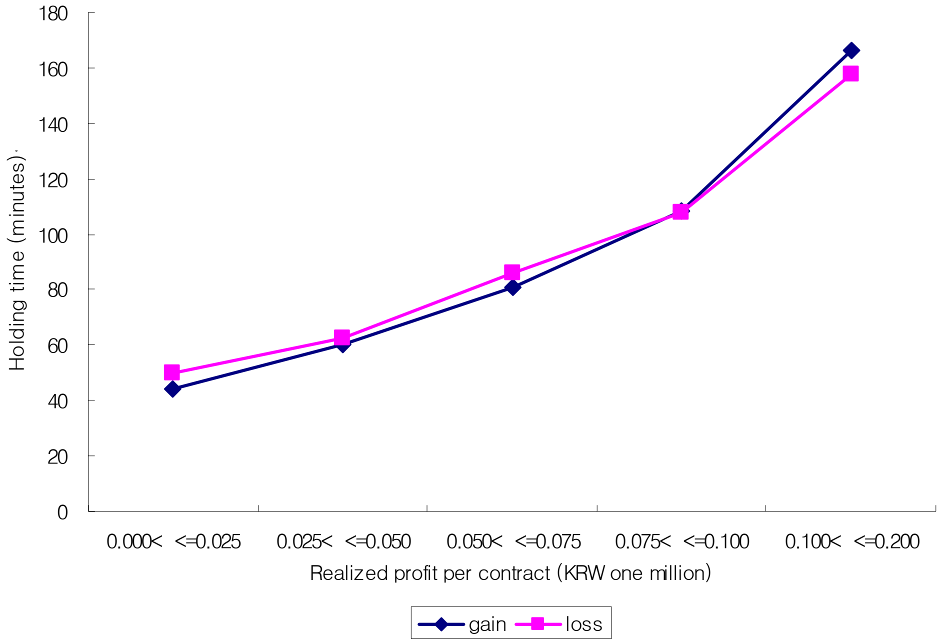


Panel B. By Investor Type

Individuals



Institutions



Foreigners

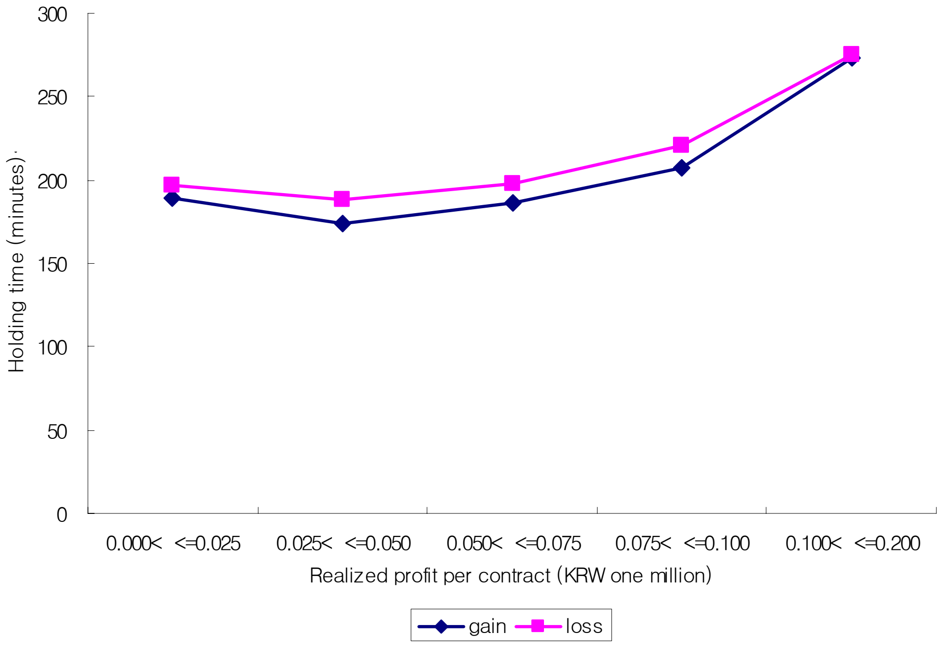


Figure 2. Holding time across Investor Types.

This figure depicts the holding time of realized profit per contract across investor types. Panel A depicts the results of all accounts and Panel B depicts the results across investor types. The sample consists of all accounts (69,391 traders) in the Korean stock index futures market over 553 trading days from January 2003 to March 2005