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Ellsberg Paradox and Disposition Effect: How the Price Change Can Affect Investment Decisions to Realise Gain or Loss.

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Abstract

The Ellsberg paradox can help us understand how ambiguity can induce asset liquidation, which is reflected by gain or loss realization in the disposition effect. This study investigates the impact of ambiguity (as the Ellsberg Paradox describes) and framing effects on the disposition effect in asset liquidation decisions. By integrating prospect theory with behavioral finance principles, the research seeks to understand how ambiguity connected with emotional biases influences investors' likelihood to liquidate assets under varying conditions of risk and uncertainty. The study uses logistic regression models to analyze data collected from a disposition effect simulation, examining their asset liquidation behaviors concerning the ambiguity and framing effects. The research incorporates subjective targets and tolerances to provide a nuanced understanding of the rationality of asset liquidation decisions in the gain and loss domain. The results indicate that higher ambiguity is associated with a lower probability of asset liquidation, particularly for gains, which aligns with the predictions of the Ellsberg Paradox. The study also finds that the framing effect serves as a quasi-moderator, enhancing investors' decision-making by aligning their actions with personal targets and tolerances. These findings confirm the presence of the disposition effect, with investors more likely to realize gains than losses, but this behavior is moderated by ambiguity and framing considerations. The study offers valuable insights for financial advisors, portfolio managers, and policymakers by highlighting the importance of managing ambiguity and framing in investment strategies. It suggests using decision aids and educational interventions to help investors make more rational decisions, thereby mitigating the negative impacts of behavioral biases. This paper uses logistic regression to unveil the interaction between asset liquidation, ambiguity, and the framing effect in investment decisions. Separate models explain gain and loss realization to understand better how ambiguity differs in winning and losing assets. Furthermore, the additional context of target and tolerance is added to the models, which can prove not all gain realization is irrational based on the bounded rationality of the decision-makers.

Keywords: Disposition Effect, Ellsberg Paradox, Ambiguity, Asset Liquidation, Logistic Regression

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Introduction

Managing the volatility of investment assets is always a challenge for investors. Classical investment theory dictates that investors with highly volatile assets should have high returns to compensate for the risk (Markowitz, 1952). However, the risk and return theory misses the emotional part of investors, which somehow influences final investment decisions. The fear of ambiguity and uncertainty plays a pivotal part in investors' decision to hold or sell an investment asset. The result could be reflected in the disposition effect phenomenon when investors tend to liquidate gains more readily than losses.

The disposition effect is a well-known bias in behavior finance literature (Zahera & Bansal, 2019). Under prospect theory, it was initially considered irrational behavior that moved away from utility maximization (Odean, 1998; Shefrin & Statman, 1985). However, the irrationality of the disposition effect has been debated, as several studies argue that specific contexts must be considered before judging solely based on utility maximization. The latest finding points out that based on the target selling price, the decision to sell the gain is undoubtedly rational as long as the decision is sufficient enough for investors (Kiky et al., 2024).

Ellsberg's paradox illustrated that people choose a prospect with known risk rather than the unknown (Ellsberg, 1961). Investors prefer knowing probability (or uncertainty) over ambiguity (a no-probability situation) in investment decisions. Therefore, investment decisions are not solely based on outcomes but also account for the ambiguity of the process. By understanding the ambiguity, deep machine learning can tackle the problem of creating optimal portfolio management by balancing the risk and reward spectrum (Novykov et al., 2023). The research trend in computer science emphasized creating robust predictions in portfolio management (Alzaman, 2024). Despite the sophisticated artificial intelligence, it remains crucial to understand the emotional challenges investors face. Behavior finance offers a consolidation to cover a gap that has yet to be explored in understanding the actors behind every investment decision.

This paper aims to bridge the gap between the disposition effect and the Ellsberg Paradox. In the volatile world of investment, uncertainty is a constant. Investors must constantly update their information and make swift decisions based on their judgment. This necessitates high emotional management, as investors must be competent in managing their emotions to make sound investment decisions (Kiky, 2022). Achieving a certain level of sophistication gives investors better control over the disposition effect, primarily when liquidating assets (Ahn, 2022; Misra et al., 2022). The urgency of this need cannot be overstated in the fast-paced world of finance.

The action of liquidating the assets can represent the connection between the disposition effect and the Ellsberg Paradox. Based on the Ellsberg Paradox, investors tend to evade ambiguity, which, in the disposition effect, will hold the assets if there is a high level of ambiguity. The tendency to liquidate the assets

will increase as the ambiguity level decreases, specifically when the price increases. Sudden price increases induced trading behavior, and investors liquidated more assets (Gao et al., 2021). Some individuals perceive the irregular price movement as more volatile; in this case, volatility perception is not synonymous (Duxbury & Summers, 2018). Improper handling of ambiguity can drive irrational disposition effects by liquidating winning assets before reaching the target.

The framing effect can influence the decisions. The same information framed differently will result in different choices (Tversky & Kahneman, 1981). Realizing the gain will make investors more willing to exercise the loss (Brettschneider et al., 2021). The framing effect can help mitigate the disposition effect in simulation games (Fenton-O'Creavy et al., 2015). Specifically, the framing effect mitigates the disposition effect of gaining a position with several limitations in loss (Kiky et al., 2024). The mechanism of framing effect in influencing asset liquidation remains open to be explored, especially in moderating the role of reducing ambiguity in the investment decision process.

This paper offers a novel understanding of the decision process of selling win-or-loss assets. Ambiguity aversion can affect investment decisions (Ju & Miao, 2012). The role of price change can be understood as the ambiguous change during the investment. As the price moves, ambiguity decreases because more information is revealed. No such research explores the connection between the disposition effect and the Ellsberg Paradox in the context of asset liquidation decisions. A less ambiguous situation will result in high liquidation action. The effect can be even more substantial if enhanced with the framing effect as a moderating variable. This research set an experimental approach to understanding the unique relationship between ambiguity, framing effect, and asset liquidation decisions that can be very useful in understanding the disposition effect phenomenon.

It is essential to evaluate the liquidation of gains and losses separately. The prospect theory suggests that the utility derived from gains and losses is different due to the concave and convex nature of the utility function, respectively. In the winning assets, the liquidation is more frequent and at relatively small levels above the break-even point. Losses are less frequently realized and tend to be more significant when they are realized (Henderson, 2012). This article will analyze the gain and loss realization separately using logistic regression. It aims to prove that the winning asset liquidation is above the targeted price if moderated by the framing effect.

Literature Review

Disposition effect

The disposition effect can be defined as the difference between gain realized and loss realized (Weber & Camerer, 1998). The original explanations for this phenomenon derived from prospect theory by Kahneman and Tversky (1979), which emphasizes loss and regret aversion problems in human decisions. It can also be

explained by the mental accounting theory, which suggests that investors have separate mental accounts for gain and loss (Thaler, 1980). In the behavior finance theory and state of the art, prospect theory and regret aversion are the dominant theories in explaining the disposition effect.

Gain realization is more likely to occur than loss realization. From the perspective of the disposition effect, investors act irrationally to exercise minor gains while holding a significant loss in the portfolio. This behavior does not maximize their portfolio value. However, the latest finding pointed out that this behavior is not entirely irrational when considering human limitations in investment decisions (Kiky et al., 2024). The framing effect can help remind investors of their target in the decision evaluation process, and most of them tend to sell their assets after reaching upper boundaries. Investors are bound by their subjective target and tolerance that makes the decision rational subjectively. This finding supports bounded rationality introduced by Simon (1972) as a competing theory to explain the irrationality of the disposition effect.

Risk understanding and emotional handling can reflect the difference between professionals and beginner investors in mitigating the disposition effect. The result was that less disposition effect was detected (Guenther & Lordan, 2023; Locke & Mann, 2009). The investment decisions were emotion-dependent (regret and rejoicing). These emotions are tied to personal judgment for investment outcomes and cause irrationality in holding losing stocks or selling winning stocks prematurely (Summers & Duxbury, 2012). Professional investors and traders are usually disciplined in exercising their assets and have a framework for navigating the market dynamic (Gärting et al., 2017). The challenge is even more problematic when facing a bearish market (Chernobai & Hossain, 2017; Lee et al., 2013). To mitigate the disposition effect during the market downtrend, investors need to have a set of competencies, both information processing and emotion management (Richards et al., 2017). Based on these findings, there is a gap that has not yet been explored in the relationship between ambiguity level and the tendency of investors to liquidate their assets, which is eventually reflected by the disposition effect.

The finding from Kiky et al. (2024) pointed out that to evaluate the rationality of the disposition effect, it must be linked with the subjective target and tolerance. If the selling and holding decisions are connected with investors' targets and tolerance levels, we can better understand discrepancies in liquidating gain and loss. The experimental approach can capture the subjectivity of the decisions compared with market aggregate research. In this case, the decision to liquidate gain or loss also must be connected with the subjective target and tolerance to evaluate the rationality of its decisions.

Ellsberg's paradox and ambiguity aversion

Ellsberg's paradox and investment decision-making are connected through ambiguity. The paradox refers to people's tendency to avoid making decisions

when facing an ambiguous situation (Ellsberg, 1961). An ambiguous condition is when the decision-makers have no information about the odds of the event. While in uncertain conditions, the decision-makers can estimate the odds of the event with the given information. For instance, ambiguity is when subjects must choose a ball inside the unknown urn, while uncertainty is when the subjects know the urn has 50:50 blue and red balls.

Due to market volatility, investors will face uncertainty in their investment decisions. As uncertainty increases and the situation shifts into ambiguity, investors tend to do nothing and remain indecisive about their choices. Ambiguity aversion is even more vital in losing assets, as the loss realization will be lower than the gain realization, reflected in the disposition effect. Therefore, if the level of ambiguity is decreased, investors will likely exercise their assets and sell the winning ones. The ambiguity might be a good predictor for estimating the occurrence of asset liquidation.

Ambiguity can make investors reluctant to make decisions, eventually impacting their portfolio performances (Bihari et al., 2022). To handle the ambiguity, investors need emotional intelligence to face their feelings about the uncertainty of the investment outcomes. Managing ambiguity and behavioral bias can lead to rational investment decisions (Raheja & Dhiman, 2020). This research can provide a fundamental understanding of human mechanisms in facing ambiguity in investment practices. The trend of machine learning to create optimum are immanent in the current digital era (Alzaman, 2024; Novykov et al., 2023). How ambiguity and bias in investment decision-making, especially in the disposition effect, allow further exploration.

Liquidating the win and loss

Mitigating the disposition effect and handling risk requires a certain level of sophistication (Eom, 2018; Fenner et al., 2020). This can be started by implementing a simple framework of target and tolerance in the holding and selling decisions (Kiky et al., 2024). Traders usually achieve a certain level of sophistication by practicing discipline in liquidating their assets (Abinzano et al., 2010; Hur et al., 2010). Irrationality begins with unrealistic targets and tolerance in asset transactions (Kiky et al., 2024). It is crucial to evaluate the liquidation decision with the context of the target and tolerance of investors.

The prospect theory can be used to understand the process of liquidating assets. Due to the different utility functions between gain and loss, investors are likely to realize the gain at a small profit but are reluctant to sell the losing assets (Henderson, 2012). It was further explored how investors tend to overestimate the likelihood of extreme gain and loss, known as probability weighting (Henderson et al., 2018). The result was that investors prefer assets with the potential for significant gains (overweighed small probabilities of high returns) and a solid aversion to assets that might incur substantial losses. This probability weighting can be influenced by ambiguity in a dynamic market. It may be mitigated by framing the effect of liquidating the winning assets until the target is reached.

This experiment uses the framing effect based on a subjective target and tolerance price inputted before the simulation to mitigate the disposition effect. The treatment group will receive a message to hold the assets if they exercise the price below the targeted price or hold the asset beyond the tolerance level. The message will be stated:

“The system recommends [Hold]: There is an 80% chance that prices will continue to rise, meaning you will miss out on additional profits (Target – P_t) based on your target.” (Kiky, 2024)

The framing effect induces liquidation on loss and helps the subject navigate the winning assets until the desirable target. The authors hypothesize that there might be a moderating framing effect in the relationship between ambiguity and asset liquidation. Based on the previous model of asset liquidation, it is crucial to analyze gain and loss separately, considering the utility function's concave and convexity (Henderson, 2012). In this case, as the price is revealed over time, the level of ambiguity also decreases. If the Ellsberg Paradox holds, the author suspects a negative relationship between ambiguity and asset liquidation.

This paper investigates the relationship between ambiguity, framing effect, and asset liquidation in gain and loss. This article applied logistic regression to predict the oddity of asset liquidation influenced by ambiguity and moderated by the framing effect. The model should predict a higher probability of exercising gain than loss. The investigation also compares the classic liquidation model and target-tolerance liquidation model as further analysis to understand the rationality of asset liquidation. Details of the research models can be described as follows:

Classic liquidation model:

$$CLG_t = a_t - b_1 Amb_t + b_2 F_t + b_3 F_t * Amb_t + \varepsilon_t \quad (1)$$

$$CLL_t = a_t - b_1 Amb_t + b_2 F_t + b_3 F_t * Amb_t + \varepsilon_t \quad (2)$$

CLG_t = Classic liquidation on gain (or realized gain)

CLL_t = Classic liquidation on loss (or realized loss)

Amb_t = Ambiguity level at time t

F_t = Framing effect at time t

Amb_t * F_t = Moderating effect at time t

a_t = Constant

b_{1,2,3} = Slope coefficient

Target-tolerance liquidation model:

$$TLG_t = a_t - b_1 Amb_t + b_2 F_t + b_3 F_t * Amb_t + \varepsilon_t \quad (3)$$

$$TLL_t = a_t - b_1 Amb_t + b_2 F_t + b_3 F_t * Amb_t + \varepsilon_t \quad (4)$$

TLG_t = Gain realized | P_t >= Target

TLL_t = Loss realized | P_t <= Tolerance

Amb_t = Ambiguity level at time t

F_t = Framing effect at time t

Amb_t * F_t = Moderating effect at time t

a_t = Constant

b_{1,2,3} = Slope coefficient

Research Method

Quantitative and experimental methods are used to test the influence of ambiguity and the moderating effect of a framing effect on asset liquidation. The laboratory experiment is designed to record participants' decisions on liquidating and holding assets. The team developed a dedicated website to mimic the movement of four blue-chip stocks in the Indonesian capital Market, accessed at <https://efekdisposisi.com>.

The stock simulation consists of anonymous stocks that participants can trade within 14 sessions. Two stocks will move upward, and two will move downward. Before the simulation, participants fill in demographic information such as age and gender, then answer risk profiling questions and ten questions about investment literacy. Subjects will input their target and tolerance before the simulation begins. Based on the responses, the participants will be grouped into the control group without system aid in navigating market ambiguity.

In contrast, the manipulated group received system aid based on their input target and tolerance level. The system reminded them to hold the winning stock if they decided to sell it before meeting the target. For losing stocks, the system notified the participant to exercise the assets below the tolerance level. The author hypothesizes that the ambiguity can affect the liquidation of the assets, while the framing effect (system aid) might moderate the ambiguity in asset liquidation decisions.

The assets' prices are Rp 1,000; participants receive 1,400 lots each. The names of the stocks remain anonymous to avoid familiarity bias in the process (Bulipopova et al., 2014; Zhdanov & Simonov, 2021). This paper is a further extension of previous research of Kiky et al. (2024), which has not answered the mechanism of the liquidation process that might be related to the disposition effect. Understanding the proposed model in this paper could answer why mitigation of the disposition effect only works to a certain extent (Talpssepp & Vaarmets, 2019).

The dependent variable in this paper is dichotomous, which requires logistic regression to analyze the model. The details of variable measurement are in the next section and presented in Table 1. The multivariate analysis of the main and moderating effects is tested using SPSS and PROCESS MACRO. The PROCESS MACRO and conditional analysis offer a better analysis of running ordinary least squares to capture the variables' interaction (Hayes, 2022). The odds of asset liquidation might differ between gain and loss conditions, as the disposition effect is empirically found.

Variable and measurement

The dependent variable in this article is the liquidation of the assets. The gain and loss are analyzed separately, considering that the participants might be more ready to realize the gain than the loss, as the disposition effect posits. The independent variable is the ambiguity level, which is reflected by the session change in the experiment. As the session changes, the ambiguity decreases due to more information the price movement reveals. The ambiguity is very high at the beginning of the session and reaches the lowest point at the end of the simulation. The system aid, the framing effect, will act as the moderating variable to enhance the negative relationship between ambiguity and asset liquidation.

It is essential to differentiate asset liquidation between classical and contextual measurement. Classical liquidation decisions only measure the gain and loss realization without considering participants' targets and tolerance, which is reflected in models (1) and (2). This experiment can extract the subjective target and tolerance represented in models (3) and (4). Analyzing the model into contextual targets and tolerance can capture the missing nuance in classical models.

Logistic regression result

Several basic assumptions are checked before logistic regression is applied. Since the dependent variable in this paper is binary, the first assumption is fulfilled. Each observation must be independent and linear. In the simulation, there is no repeated measurement for every participant. Therefore, the data should be independent as the participant experimenting without the influence of another participant. Lastly, each independent variable must not have a multicollinearity problem. The result of the multicollinearity check for each model is 1.00, which indicates no multicollinearity problem.

The logistic regression result proves that ambiguity influences asset liquidation decisions. In the analysis, the author separates the gain and loss by considering the effect of ambiguity might differ in each condition, as suggested in previous research (Henderson, 2012; Henderson et al., 2018). The p-value of the independent variable in the four models is consistent below 0.05, which indicates that ambiguity affects liquidation decisions. Models 1, 2, and 3 show a negative relationship between ambiguity and liquidation, while in model 4, the relationship is positive. This result will be discussed further in the discussion section.

The moderating effect of framing is detected, except in model (1). The finding also indicates that the framing effect can be considered the independent variable influencing asset liquidation decisions. The framing effect is a direct predictor and moderating variable affecting the relationship between ambiguity and asset liquidation, also known as a quasi-moderator. Based on this finding, we can understand the complexity of asset liquidation, the dynamic process of ambiguity, and framed information that is eventually reflected in gain and loss realization. Furthermore, gain and loss realization are perceived differently based on our model due to the nature of loss

and regret aversion. Our model suggests that investors are more likely to realize their gain as the price increases. The details of the logistic regression result are presented in Table 1.

Table 1-Logistic Regression Result

Indicators	Coefficient	SE (HC4)	Z	p-value
Classic Liquidation				
Model (1) / Gain				
Constant	0.4275	0.0581	7.3621	0.000*
Ambiguity	-0.1914	0.0151	-12.642	0.000*
Framing Effect	-0.5185	0.0829	-6.2520	0.000*
Amb*F (Moderating)	0.0128	0.0216	0.5927	0.553
Model (2) / Loss				
Constant	-1.1978	0.0633	-18.929	0.000*
Ambiguity	-0.0595	0.0157	-3.7855	0.000*
Framing Effect	0.3953	0.0888	4.4504	0.000*
Amb*F (Moderating)	-0.0644	0.0222	-2.8998	0.003*
Target-Tolerance Liquidation				
Model (3) / Gain				
Constant	-1.6822	0.0905	-18.595	0.000*
Ambiguity	-0.3377	0.0226	-14.960	0.000*
Framing Effect	-0.3783	0.1521	-2.4878	0.013*
Amb*F (Moderating)	-0.1420	0.0379	-3.7426	0.000*
Model (4) / Loss				
Constant	-1.9433	0.0813	-23.912	0.000*
Ambiguity	0.0733	0.0201	3.6554	0.000*
Framing Effect	-0.5391	0.1406	-3.8347	0.000*
Amb*F (Moderating)	0.1073	0.0338	3.1748	0.001*

* p-value is less than 0.05

Source: Author's work

Figure 5 in the Appendix describes the visualization of the model (1). As the ambiguity decreases, participants are more likely to realize their gain over the observed time. However, the framing effect does not moderate overall gain realization (without considering the subjective target), represented in the dotted interpolation line. Without the framing effect, the odds of asset liquidation on the gain are close to 80% when the ambiguity level is low. The odds are approximately 68% when the system reminders assist the participants, lower than the control group. The result is consistent with the statement that investors are more ready to realize the gain.

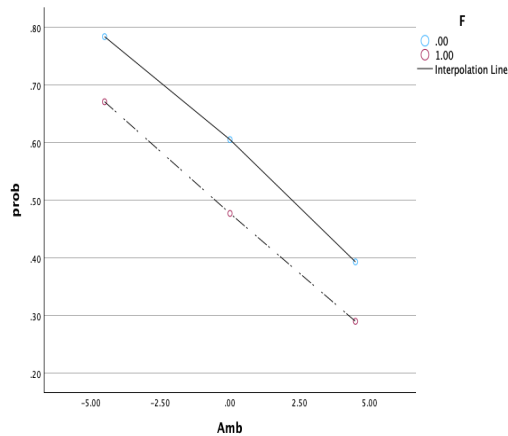


Figure 1- Logistic Regression Model 1 Visualization, Authors work

Figure 6 in the Appendix also represents the visualization of the model (2) that predicts the likelihood of loss realization. The model still predicts a greater chance of finding loss realization as the ambiguity decreases. However, the probability is lower than in model (1), in which participants only have approximately 44% at the lowest ambiguity level in realizing the loss moderated by the framing effect. The odds are even decreased if the participants are not assisted by system aid in navigating the market volatility. The result is reflected by the steeper interpolation dotted line.

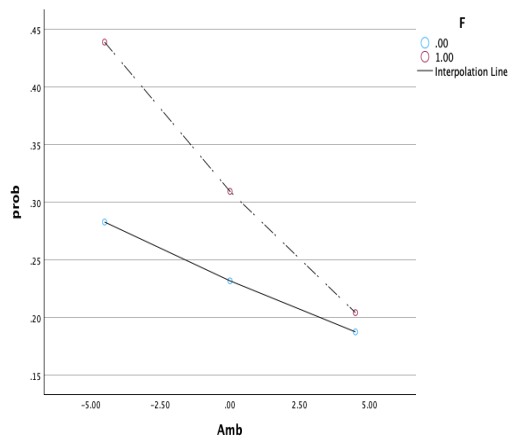


Figure 2- Logistic Regression Model 2 Visualization, Author's work

Model (3) will focus on gaining a realization that meets or exceeds the inputted target. Figure 3 describes the visualization of the model (3). When the ambiguity is high, it is expected to gain realization, even if the framing effect doesn't moderate this relationship. However, as the ambiguity decreases, the moderator takes effect and makes the probability of asset liquidation approximately 52%. The likelihood of gaining realization in the non-system aid group is lower than in the moderated group, which is below 50%. During a highly ambiguous situation, system reminders cannot moderate gain realization. However, as the price reveals more

information and decreases the ambiguity, the system can start to take effect and make the participants hold the target until they reach their target.

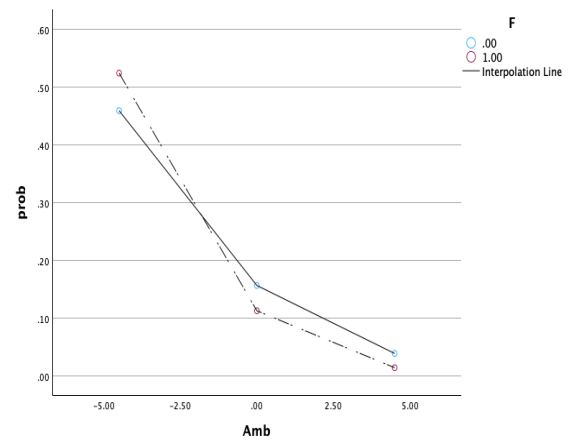


Figure 3- Logistic Regression Model 3 Visualization, Author's work

Asset liquidation is more likely to occur when the ambiguity is high or early experiment rather than late simulation. If the price keeps decreasing, participants tend to hold the loss despite it reaching below their subjective tolerance level. In model (4), as the price reveals more information and the trend is down, we can unlikely see the asset liquidation decisions. The downtrend price pattern has increased their ambiguity and stuck to the asset. Participants perceived the loss very differently than the gain, as was posited by the prospect theory. The framing effect cannot even increase the loss realization in the process, which in the model (4) predicts the probability is below 5%. The highest probability of realizing the loss is only approximately 10% in loss, which is consistent with the disposition effect theory. The visualization can be seen in Figure 4.

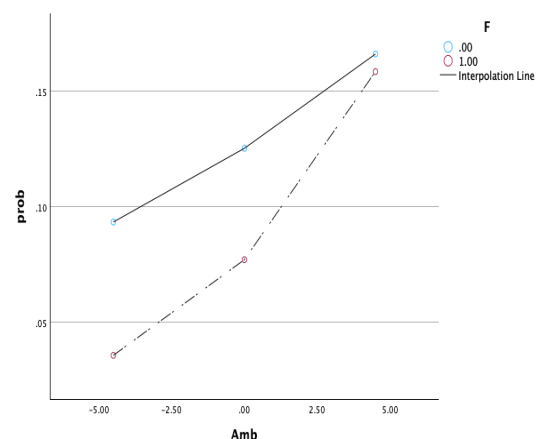


Figure 4- Logistic Regression Model 4 Visualization, Author's Work

The model is quite robust in predicting gain realization compared with loss realization. In the classic gain realization (model 1), the Nagel K score is 16.81%, and it improves significantly when the gain realization is connected with the subjective target (model 3), where the score is 37.58%. In the gain realization scenario, as the price reveals more information and increases, the ambiguity level decreases, and participants are indeed more likely to liquidate their assets and make a profit. The moderating effect fits only with the model (3), which accounts for liquidating decisions that already meet their subjective target.

The loss realization is more complicated than the gain condition. Our models (2) and (4) indicate that more variables are needed to explain the mechanism behind loss realization. Nagel K's scores in both models are very low: 5.47% and 5.25%, respectively. This finding will be elaborated further in the discussion section. Table 2 presents further details of the model summary.

Table 2- Model Summary Result

Model	-2LL	Model LL	df	P value	Cox Snell	Nagel K
Model 1	3,383.50	365.11	3.00	0.00	0.126	0.168
Model 2	3,088.46	104.73	3.00	0.00	0.038	0.055
Model 3	2,141.76	771.35	3.00	0.00	0.265	0.376
Model 4	1,831.28	72.80	3.00	0.00	0.026	0.053

Source: Author's work

Discussion

Ambiguity and disposition effect

The empirical result confirmed the relationship between ambiguity and asset liquidation decisions. The result is very robust in gain realization compared with loss realization. Ellsberg's paradox dictated that people avoid ambiguity and be indecisive about situations (Ellsberg, 1961). Our finding found a similar pattern occurred in asset liquidation, specifically in the gain domain. As the price progresses and moves upward, the ambiguity decreases, and the odds of gain realization increase. It can explain the nature of the disposition effect in the gain domain and why investors are more ready to exercise their gain in anticipating the reversal pattern. Investors perceive gain as a less ambiguous situation; when analyzed in the context of their subjective target, the liquidation is even stronger when the price exceeds the inputted target. This result also opens a room to explore the effect of price patterns and whether uptrend movement reduces ambiguity and increases the chances of asset liquidation. People perceive volatility differently between regular and irregular price changes (Duxbury & Summers, 2018). However, the result of this experiment points out that with regular price changes, people perceive very different risks, such as gain and loss. The investigation could enhance the results of Frieder (2008) and explain the mechanism behind the investors' response to dynamic information change.

The result has several limitations in understanding the loss situation. The general model of loss

liquidation (model 2) indicates a negative relationship exists between ambiguity and loss realization. However, the model shows a positive relationship after the dependent variable (loss liquidation) is remeasured with subjective tolerance (model 4). The result is inconsistent between models 2 and 4, which reveals rumination in the loss domain. The complexity and different nature of people's perceived loss are consistent with prospect theory (Kahneman & Tversky, 1979). Loss realization can occur if investors have voluntarily given up their lost assets or reached the low Sharpe ratio, as Henderson (2012) suggested, which is worth investigating in future research. The ambiguity level seems to increase as investors perceive more uncertainty in a loss situation.

Framing effect as quasi-moderator

The framing effect works as the moderator in the three tested models. As the dependent variable is remeasured with the context target and tolerance, the moderating effect is consistent in the gain and loss domain (models 3 and 4). The result also confirmed that the framing effect also acts as an independent variable, similar to previous research findings (Kiky et al., 2024). Therefore, based on this finding, the framing effect can be considered a quasi-moderator open for further exploration to investigate its role as a mediating variable. The system reminder mitigates the gain realization up to the subjective target, which makes investors realize more gain than the non-system group. The odds of gain realization are very high when ambiguity is very low in the later simulation.

Despite being empirically significant as a moderating and independent variable in the loss domain, our logistic model demonstrates a very low likelihood of exercising loss compared with the gain liquidation. The result is consistent with the disposition effect theory, realizing the loss costs emotional damage in the process, which is unbearable to exercise in most cases (Odean, 1998; Shefrin & Statman, 1985; Weber & Camerer, 1998). It remains a promising avenue in future research on how to make a stop loss effective in mitigating the disposition effect, specifically in the loss domain (Talpepp & Vaarmets, 2019).

Difference in gain and loss

This article analyses the data using logistic regression on gain and loss liquidation decisions. The result can be understood by comparing the different nuances in both situations by analyzing the gain and loss domain separately rather than using the disposition effect ratio (PGR — PLR). There was indeed a different probability weighting between gain and loss, as Henderson et al. (2018) suggested, which caused a very complex situation when facing a downtrend price.

The ambiguity between gain and loss is very different, which is the limitation of this research. In this experiment, the author treats price change (both uptrend and downtrend) as the same as

ambiguity change. As the price reveals more information, the ambiguity should decrease. However, the mechanics do not apply in the loss domain, which can be improved in future investigations. This finding opens our understanding of the complexity of investment decisions regarding cognitive ability and emotional intelligence in handling loss and ambiguity. Learning and rationality of disposition effect can be future topics that connect the behavioral finance theory with the practicability in computer science study (Dai et al., 2023; Vaarmets et al., 2019).

Practical implication

The digital era has moved into a sophisticated artificial intelligence era. Understanding the ambiguity helps us predict the chance of asset liquidation occurring. This finding can be implemented to set a deep machine learning to manage investment assets based on subjective preference (Novykov et al., 2023). Computer science can experiment with two domains (gain and loss) to make a suggestion based on the degree of ambiguity of the current market situation. The suggestion can benefit beginner investors who need more competency or a certain level of sophistication in navigating market volatility (Kuo et al., 2013; Raheja & Dhiman, 2020; Vaarmets et al., 2019).

Behavioral finance is essential for developing a suitable learning environment for beginner investors, especially college students. Beginner investors tend to oversimplify the market risk and trade carelessly without any fundamental framework. Ambiguity can be crucial in understanding how investors process price changes and perceive market volatility. Market states can affect how investors liquidate their assets, which is reflected in the disposition effect (Lee et al., 2013). The finding is ready to be implemented in various experimental ambiguity sets to develop a bounded rationality investor who can navigate market uncertainty wisely and with discipline and self-control.

Conclusion

This study explores the nuanced relationship between ambiguity, framing effects, and the disposition effect in the context of asset liquidation decisions. By employing logistic regression models, we have demonstrated that ambiguity significantly influences investors' tendencies to liquidate assets, with a clear differentiation between gains and losses. Our findings indicate that higher ambiguity correlates with a lower likelihood of asset liquidation, particularly in the case of gains, aligning with the principles of the Ellsberg Paradox. The study further reveals that when implemented as a system aid, the framing effect serves as a quasi-moderator, enhancing investors' decision-making processes by aligning their actions with personal targets and tolerances.

The empirical evidence this research provides offers valuable insights into behavioral finance,

highlighting the importance of understanding emotional and cognitive biases in investment decisions. The distinct patterns observed in gain and loss realizations underscore the need for personalized investment strategies that account for individual risk preferences and tolerance levels. Future research should expand on these findings by exploring the impact of dynamic market conditions and diverse investor profiles on the disposition effect and ambiguity aversion. Additionally, further investigation into the role of educational and technological interventions in mitigating these biases could lead to more effective investment decision-making frameworks.

Limitations and future research

While providing significant insights into the interplay between ambiguity, framing effects, and the disposition effect in asset liquidation decisions, this study has its limitations. Firstly, the sample size and diversity may limit the generalizability of the findings. The data was collected from a specific demographic and geographic region, which may only partially represent the broader population of investors. Future research should consider incorporating a more diverse and extensive sample to enhance the robustness and applicability of the results across different investor profiles and market conditions.

Secondly, the study's reliance on a controlled experimental design may not fully capture the complexities and dynamics of real-world financial markets. While necessary for isolating specific effects, the experimental conditions may not reflect the myriad factors influencing investor behavior in actual trading environments. Additionally, the use of logistic regression, while appropriate for the analysis, may not account for potential nonlinear relationships and interactions between variables. Future research could benefit from more sophisticated modeling techniques and longitudinal studies to better understand the temporal dynamics and causal relationships in investor decision-making processes.

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Appendix - Visualisation of Measurements

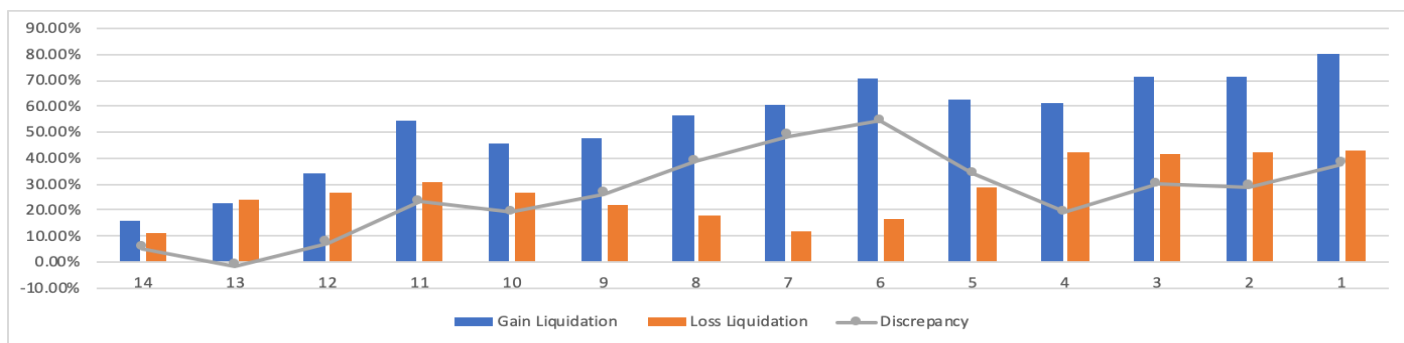


Figure 5- Asset Liquidation, Classic Measurement

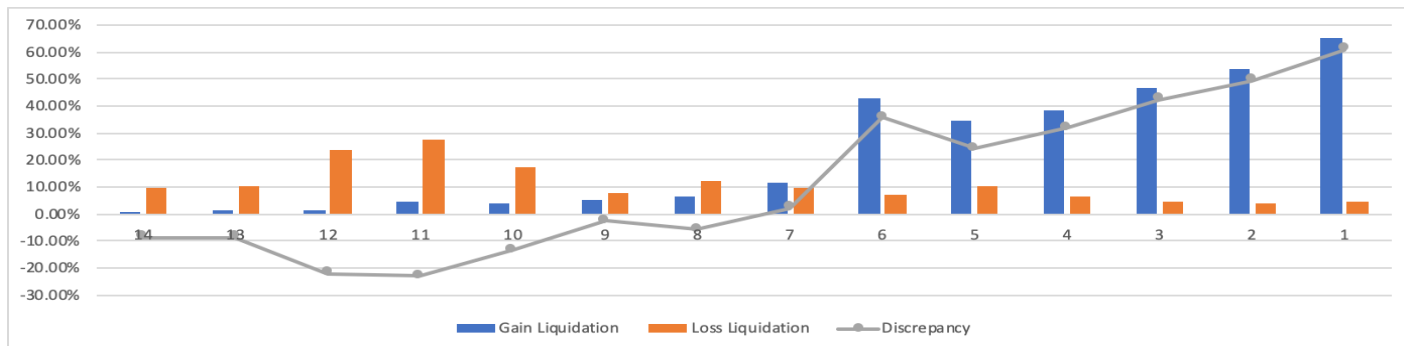


Figure 6- Asset Liquidation, Target-Tolerance Measurement