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Striking Out: Biases and Losses of Retail Option Traders

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Abstract

Analyzing over 15 years of account-level trading records from Finland, we show that option features—expiration, moneyness, and the strike price—influence the behavior of retail investors and exacerbate their behavioral biases. Retail investors selectively exploit the expiration feature of options to mitigate the psychological costs associated with selling losing positions, generating a strong disposition effect especially for out-of-the-money options. They also use the strike price of an option as an objective, instrument-specific reference point when making their selling decisions. Behavioral biases contribute to heterogeneity in option trading performance, with the worst performance concentrated among investors with the strongest biases.

JEL Classification: G41, G40, G50, G11

Keywords: options, retail investors, behavioral biases, disposition effect

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"Like complex products, trading in options may pose risks if investors do not have the financial experience to understand options and options trading strategies."

– *FINRA Regulatory Notice 22–08*, 8 March 2022

Option trading by retail investors has increased dramatically in recent years and now accounts for over 60% of U.S. option market volume (Bryzgalova, Pavlova, and Sikorskaya, 2023). This boom in retail option trading has raised concerns among regulators including the Financial Industry Regulatory Authority, which has questioned whether retail investors understand the "*unique characteristics and risks*" associated with options, and the Securities and Exchange Board of India, which now requires brokers to inform their clients about the trading losses and transaction costs incurred by retail option traders.[1] These concerns seem justified in light of recent academic papers which have shown that the aggregate trading performance of retail option traders is poor, particularly around earnings announcements (de Silva, Smith, and So, 2022), in short-term options (Beckmeyer, Branger, and Gayda, 2023), and when using complex option strategies (Naranjo, Nimalendran, and Wu, 2022).

In this paper, we contribute to the debate about retail option trading by studying the behavioral biases of retail option traders, and by linking these biases to heterogeneity in option trading performance. We leverage over fifteen years of account-level trading records from the official registry of stock and option holdings in Finland to provide a comprehensive and granular analysis of the stock and option trading of an entire population of retail investors. Our results show that the "*unique characteristics*" of options, namely expiration, moneyness, and the strike price, influence retail investors' trading decisions and exacerbate behavioral biases. Moreover, we show that stronger behavioral biases are associated with worse option trading performance.

We begin by focusing on the disposition effect, which is the empirical observation that investors are more likely to sell an asset trading at a gain than to sell an asset trading at a loss (Shefrin and Statman, 1985). Despite ongoing debate about its causes

[1] See FINRA (2022) and SEBI (2023). As of July 2023, brokers in India are required to display a notice on their trading platform informing clients that "*9 out of 10*" retail option traders incur net losses, and that "*those making net trading profits incurred between 15% to 50% of such profits as transaction costs.*"

and consequences (e.g., Barberis and Xiong, 2009; Ben-David and Hirshleifer, 2012; Frydman, Barberis, Camerer, Bossaerts, and Rangel, 2014; Jin and Peng, 2023), the disposition effect is widely regarded as one of the most robust and important trading patterns arising from psychological bias (Hirshleifer, 2015).[2] By analyzing the trades of retail investors who trade both stocks and options, we find that the disposition effect is both stronger and more prevalent in options: investors are around 2.39 (1.34) times more likely to sell gains than losses when trading options (stocks), and approximately 96% (81%) of investors exhibit the disposition effect in their option (stock) trades.

We consider several potential explanations for this result. We find that it is not explained by differences in trading styles, investor characteristics, portfolio characteristics, or return distributions between stocks and options.[3] By contrast, we find that it is partly explained by investors selectively exploiting the expiration feature of options in order to mitigate the psychological costs associated with selling an asset at a loss. We argue that this behavior is consistent with disposition effect theories based on realization utility (Barberis and Xiong, 2012) and cognitive dissonance (Chang, Solomon, and Westerfield, 2016). Concretely, since the expiration feature of options allows investors to dispose of their losing positions without having to make a deliberate selling decision, investors can mitigate the negative burst of realization utility or the cognitive dissonance associated with selling an asset at a loss by letting their losses expire.[4] Option expiration thus encourages investors' natural reluctance to realize losses and strengthens the disposition effect.

The propensity to let losses expire more often than gains varies based on an option's moneyness, being particularly pronounced for out-of-the-money options. As a result, the strength of the disposition effect in options also varies with moneyness, being stronger for options that are out of the money. This relation between moneyness and the disposition effect motivates us to examine how investor behavior is influenced by

[2]See Kaustia (2010) and Barber and Odean (2013) for surveys.

[3]The options in our data set are cash-settled, which means that liquidity constraints hindering investors' ability to take physical delivery of the underlying assets cannot explain the result either. See Section 1 for a detailed discussion of our data.

[4]This is particularly true if investors choose to pay less attention to their portfolios on days when their losses expire, as predicted by the ostrich effect of Karlsson, Loewenstein, and Seppi (2009).

moneyness in general and the strike price in particular. Since the strike price is a highly salient feature of any option, we expect that it may influence retail investors' option trading, in line with earlier work showing that salient attributes can influence behavior (e.g., Gabaix, 2019; Bordalo, Gennaioli, and Shleifer, 2022; Vokata, 2023).

Consistent with this intuition, we find that retail investors use the strike price of an option as a reference point when making selling decisions. In particular, investors are more likely to sell an option that is in the money than to sell an option that is out of the money. We refer to this phenomenon as the strike price disposition effect and show that it is both very common—89% of investors exhibit the effect—and distinct from the standard disposition effect. We thus provide novel evidence of investors using an objective, option-specific reference point to subjectively evaluate their investments.

The results discussed so far show that option expiration and the strike price influence investor behavior. These features—together with other features including nonlinear payoffs and embedded leverage—make options more complex assets than stocks. Our results are thus consistent with recent work showing that decision-making processes are influenced by a setting's complexity (e.g., Enke and Zimmermann, 2019; Oprea, 2020) and that complexity can influence trading performance (Naranjo, Nimalendran, and Wu, 2022; Gao, Hu, Kelly, Peng, and Zhu, 2024). In particular, complexity can make investors rely on oversimplified rules of thumb, prevent investors from forming correct beliefs, and lead to suboptimal trading decisions (Simon, 1955; Banovetz and Oprea, 2023; Kendall and Oprea, 2024).

One recent example of a behavioral bias linked to incorrect beliefs is the peak price disposition effect of Quispe-Torreblanca, Hume, Gathergood, Loewenstein, and Stewart (2023). Using data from the UK, the authors find that investors are less likely to sell an asset if its price is lower than the previous peak price obtained by the asset during the investor's holding period, and show that this behavior is related to investors believing that prices will revert to the peak. We find that retail investors in Finland also exhibit the peak price disposition effect when trading stocks. Consistent with complexity influencing behavior, we then show that investors also exhibit the effect when trading options, where the effect is even stronger. Our results thus provide additional evidence consistent with the view that the increased complexity of options influences the trading of retail investors and exacerbates their behavioral biases.

Finally, we take advantage of our ability to follow investors throughout a large part of their investing lives in order to shed light on how behavioral biases contribute to heterogeneity in option trading performance. We split investors into quintiles based on their disposition effect, strike price disposition effect, and peak price disposition effect estimates, and show that investors with stronger behavioral biases experience larger lifetime losses and worse daily returns. For example, the average daily returns of investors are monotonically decreasing with the strength of the disposition effect, with investors in the top quintile of the disposition effect generating average daily returns of -0.54%, compared to returns of -0.15% for investors in the bottom quintile. Similar patterns hold for the strike price disposition effect and the peak price disposition effect.

Related Literature. Our paper contributes to the literature on behavioral biases in options. While a large literature has studied the biases of retail investors trading stocks, considerably fewer papers have studied the biases of option traders. To the best of our knowledge, Han, Lee, and Liu (2009) and Schmitz and Weber (2012) are the only papers to provide direct evidence of a disposition effect in options.[5] Our main focus is to compare investor behavior in stocks and options, and to analyze how the unique characteristics of options influence investor behavior and exacerbate the disposition effect. We also document a novel strike price disposition effect, show that the peak price disposition effect also exists in options, and link each of these effects to heterogeneity in option trading performance.[6]

[5]Papers that have provided indirect evidence of a disposition effect in options are Heath, Huddart, and Lang (1999) and Poteshman and Serbin (2003), who show that investors are more likely to exercise options if the past returns of the underlying stock are positive, and Bergsma, Fodor, and Tedford (2020) and Chiang, Chiu, and Chou (2021), who adapt the capital gains overhang measure of Grinblatt and Han (2005) to options and document patterns in option returns consistent with the disposition effect.

[6]More generally, our finding that option features influence the disposition effect presents a challenge for disposition effect theories based on prospect theory (Shefrin and Statman, 1985), speculative belief updating (Pitkäjärvi, 2022), and the law of small numbers (Jin and Peng, 2023), as well as for rational theories of the disposition effect (Dorn and Strobl, 2023; Dai, Jiang, Liu, and Xu, 2023). Our results provide several new stylized facts for these theories to explain.

Relatedly, our paper adds to a growing literature on the protection of retail investors (e.g., Carlin, 2009; Campbell, Jackson, Madrian, and Tufano, 2011; Zingales, 2015; Gurun, Matvos, and Seru, 2016; Heimer and Simsek, 2019; Vokata, 2023; Gao, Hu, Kelly, Peng, and Zhu, 2024). We focus on option trading by retail investors, following a significant rise in retail investor participation in option markets. We show that option features and complexity are the main drivers of our results on behavioral biases. The fact that investors' decision making is hindered when trading options has potentially important implications for regulators who are interested in the societal effects of retail option trading (e.g., FINRA, 2022; SEBI, 2023).

Our strike price disposition effect results also contribute to the literature on reference points and reference-dependent behavior. As emphasized by Baillon, Bleichrodt, and Spinu (2020), a challenge with empirical studies of reference-dependent behavior is that there is a large pool of potential reference points and not much is known about how people subjectively form reference points. By contrast, the strike price of an option is an objective and unambiguous asset-specific reference point that is the same for all investors. Our results provide the first evidence of this objective reference point influencing investors' decisions.

Finally, our paper contributes to the literature on option trading by retail investors. In addition to the papers cited so far, Bauer, Cosemans, and Eichholtz (2009), Hu, Kirilova, Park, and Ryu (2023), and Bogousslavsky and Muravyev (2024) use account-level trading records to study the trading performance of retail option traders, while Lakonishok, Lee, Pearson, and Poteshman (2007), Choy and Wei (2012), and Choy (2015) use various proxies for retail trading to study similar questions. Eaton, Green, Roseman, and Wu (2022) and Lipson, Tomio, and Zhang (2023) analyze the asset pricing implications of retail option trading, Li, Musto, and Pearson (2022) study how retail investors use complex option strategies, and Ernst and Spatt (2022) and Hendershott, Khan, and Riordan (2022) examine how institutional details related to option trade execution impact retail investors. We contribute to this literature by studying retail investors' behavioral biases and by linking these biases to heterogeneity in option trading performance.

1 Data and Descriptive Statistics

Our data set is from Euroclear Finland, which acts as the official registry of stock and option holdings in Finland. The data include the daily holdings and changes in holdings of all securities registered with Euroclear Finland or its predecessor the Finnish Central Securities Depository from January 1995 to December 2017.[7] Shorter samples of the stock data have previously been analyzed by Grinblatt and Keloharju (2001), Seru, Shumway, and Stoffman (2010), and Vasudevan (2023), while a subset of the option data has been used by Vacca (2023) to study informed derivative trading by employees.

The data include the trades of all investors in Finland, including institutional investors, corporations, and government entities. Because our interest is in the trading behavior of retail investors, we exclude these other investor groups from the sample. Moreover, we limit our sample to those retail investors who traded both stocks and options during our sample period, in order to allow for an apples-to-apples comparison of stock and option trading by retail investors.

Technically, the options in our data set are bank-issued warrants. The term "warrant" can be misleading, because it typically refers to call options issued on the primary market by companies which, if exercised, lead to the issuance of new shares. By contrast, the warrants in our data set are exchange-traded, cash-settled, European-style call or put options issued by banks and marketed specifically to retail investors.[8] They are similar to vanilla call and put options[9] with the one notable difference being that investors cannot write warrants.[10] To avoid this confusion in terminology, throughout

[7] The first option was registered in December 2000.

[8] The issuing banks also act as designated market makers for the warrants, thus guaranteeing liquidity for investors.

[9] Approximately 5% of the option observations in our data set are in options with barrier features. In unreported regressions, we confirm that our results are robust to excluding these observations.

[10] Hu, Kirilova, Park, and Ryu (2023) and Bogousslavsky and Muravyev (2024) find that option writing by retail investors is rare, possibly because of restrictions on option writing imposed by brokers, so we do not expect the fact that investors cannot write warrants to have a large impact on our results.

the paper we refer to the warrants in our data set as options.

The data from Euroclear Finland do not contain information on option characteristics, such as the expiration date, strike price, underlying asset, and whether an option is a call or a put, so we manually collect data on option characteristics from press releases issued by banks. Due to the limited availability of older press releases, our data on option characteristics span the period from August 2007 to December 2017. The proportion of options for which we have data on characteristics starts at 74% in 2008, rises to over 90% in 2010–2013, and reaches 100% in 2014–2017. The data from Euroclear Finland also do not contain transaction prices, so we use the day's closing price as the transaction price.

The data include options written on 39 distinct underlying assets. 26 of the underlyings are Finnish stocks, 7 are stock indices, and the remaining 6 are commodities or exchange rates. Stock options account for 85% of all observations, index options account for 14%, and the remaining options account for 1%.

Summary statistics on investor characteristics, trade characteristics, and the sample are presented in Table 1. Our sample contains 19 635 investors of whom 11% are female. The median investor is 35 years old with 6 years of experience trading stocks and 2.5 months of experience trading options, and places 97 stock trades and 9 option trades in total. The investors in our data set are thus both more experienced and more active in trading stocks than options.

Trading in stocks and options also differs in terms of trade sizes and holding periods. The median trade size and holding period for stocks are €22 339 and 233 trading days, compared to €556 and 28 trading days for options. This option trade size is comparable to Bogousslavsky and Muravyev (2024), who document a median trade size of $425 among users of an online trading journal in the U.S. from 2020 to 2022.

Additional details on option purchases are presented in Table 2. Consistent with Bryzgalova, Pavlova, and Sikorskaya (2023) and Bogousslavsky and Muravyev (2024), we find that retail investors prefer calls over puts, with 66% of all option purchases being in calls. In terms of option moneyness, investors have a preference for out-of-the-money calls, while for puts the proportions of in-the-money and out-of-the-money purchases are roughly equal.

The most notable difference between the options in our data set and the options studied in other recent papers is that the times to expiration of our options are typically longer. For example, Bryzgalova, Pavlova, and Sikorskaya (2023) find that from 2019 to 2021, almost half of all retail option trades in the U.S. were in options with less than a week to expiration. Similarly, Beckmeyer, Branger, and Gayda (2023) find that more than 75% of retail trades in S&P 500 index options are in options that expire on the same day. By contrast, only 4% of the options purchased by our investors expire in less than a week, and only 24% expire in less than a month. The difference is at least partly explained by the fact that our data set ends in 2017, while the rising popularity of short-term options is a more recent phenomenon.

Table 2 also reports details on option purchases for subsamples formed on gender, age, and trading experience. The results are remarkably stable across subsamples, with the exception of inexperienced investors, who are relatively more likely to buy calls, make small trades, and buy options with longer times to expiration.

The literature on option trading by retail investors, starting with Lakonishok, Lee, Pearson, and Poteshman (2007), Bauer, Cosemans, and Eichholtz (2009), and Choy and Wei (2012), has shown that hedging against adverse stock price movements does not seem to be a primary motivation behind retail investors' option trades. For example, Bogousslavsky and Muravyev (2024) find that only 0.1% of the option trades in their sample are protective puts, which can be used to limit the downside risk of a long stock position. Table A1 shows that protective puts are also very uncommon in our sample. Specifically, we split stock option purchases into four categories based on option type and whether an investor owns the underlying stock. We find that when an investor purchases an option while already owning the underlying stock, 90% of the time they purchase a call option. In other words, investors are far more likely to leverage up their long exposure with a call, than to limit their downside risk with a put. In total, protective puts make up only 3% of all stock option purchases. The results are similar if we consider the total euro value of stock option purchases, as opposed to the number of purchases. Overall, these results are consistent with the view that hedging is not a primary concern for retail investors.

2 Results

We begin our analysis of retail option traders' behavioral biases by showing that they exhibit the disposition effect (Shefrin and Statman, 1985), a novel bias that we refer to as the strike price disposition effect, and the peak price disposition effect (Quispe-Torreblanca, Hume, Gathergood, Loewenstein, and Stewart, 2023). Moreover, by comparing investors' stock and option trades, we show that the biases are stronger and more prevalent in options. We then finish by linking the biases to heterogeneity in option trading performance.

2.1 The Disposition Effect

In our baseline analysis, we follow Chang, Solomon, and Westerfield (2016) and test for the disposition effect in stocks and options by using the following regression specifications:

$$Sale_{ijt} = \beta_0 + \beta_1 Gain_{ijt} + \varepsilon_{ijt}, \quad (1)$$

$$Sale_{ijt} = \beta_0 + \beta_1 Gain_{ijt} + \beta_2 Option_j + \beta_3 Gain_{ijt} \times Option_j + \varepsilon_{ijt}. \quad (2)$$

The dependent variable *Sale* is a dummy variable that equals one if investor i sold asset j on day t. *Gain* is a dummy variable that equals one if the return since purchase on the asset is positive. *Option* is a dummy variable that equals one if the asset is an option. In both specifications, standard errors are clustered by investor and day.

The specification in Equation 1 is estimated separately for stocks and options. The constant term β_0 is the probability of selling an asset trading at a loss. The measure of the disposition effect is the *Gain* coefficient β_1, which captures the increase in the selling probability when the position is trading at a gain. A positive β_1 indicates that investors have a higher tendency to sell gains than losses, and thus exhibit the disposition effect.

The specification in Equation 2 is estimated simultaneously for stocks and options. The *Option* coefficient β_2 captures the increase in the selling probability for options compared to stocks, while the interaction coefficient β_3 captures the difference in the strength of the disposition effect for stocks and options. A positive β_3 indicates that investors exhibit a stronger disposition effect in options. To allow for heterogeneity in the overall probability of selling across investors and days, the specification in Equation 2 is also estimated with investor and day fixed effects.

Each observation in our data set is a position of an investor in a given asset on a given day. For consistency with Odean (1998), Chang, Solomon, and Westerfield (2016), and the common practice in the empirical disposition effect literature, in the main text we limit our sample to those investor-asset-days on which an investor made at least one sale of stock or options in their portfolio. As a result, every selling probability we report should be interpreted as the daily probability of selling an asset conditional on the investor having made at least one sale on the same day. For the sake of completeness, we report our main results using the full sample of all investor-asset-days in the Internet Appendix. Our results are not sensitive to whether we use sell days or all days.

The results of the regressions are presented in Table 3. The positive *Gain* coefficient in Column (1) confirms the well-known result that investors exhibit a disposition effect when trading stocks. Compared to a baseline selling probability of 12.46%, a stock position trading at a gain increases the probability of selling to 16.64%. In other words, investors are around 1.34 times more likely to sell gains than losses when trading stocks. This is comparable to Chang, Solomon, and Westerfield (2016), who find that investors at a large discount brokerage in the U.S. are around 1.18 times more likely to sell gains than losses when trading stocks.

The positive *Gain* coefficient in Column (2) shows that investors also exhibit a disposition effect when trading options. Compared to a baseline selling probability of 24.15%, an option position trading at a gain increases the probability of selling to 57.81%.

In other words, investors are around 2.39 times more likely to sell gains than losses when trading options. The same investors thus exhibit an even stronger disposition effect when trading options.

The same result is illustrated in Column (4). The positive and highly significant coefficient on the $Gain \times Option$ interaction shows that investors exhibit a stronger disposition effect when trading options. The inclusion of investor fixed effects in Column (5) and investor and day fixed effects in Column (6) has minimal impact on the results. The results with the full sample of all investor-asset-days are reported in Table A2.

2.1.1 Robustness Tests

We perform several additional tests to evaluate the robustness of the results presented in Table 3 and to rule out potential explanations. Motivated by the prior literature and the descriptive statistics presented in Table 1, we start by focusing on the holding period, trading experience, and trading activity as three key dimensions along which stocks and options differ, and which have been linked to the strength of the disposition effect. We then consider other controls related to investor demographics, the rank effect of Hartzmark (2015), calendar effects, position size, portfolio characteristics, and differences in return distributions between stocks and options, and report the results for various subsamples. Finally, we consider the effect of investor self-selection into stocks and options. Across all of these additional tests, we consistently find a disposition effect that is statistically significant and stronger in options than in stocks.

Holding Period. Ben-David and Hirshleifer (2012) show that the strength of the disposition effect decreases as the holding period of a trade increases. Since the option trades in our data set tend to have shorter holding periods than the stock trades, the stronger disposition effect we find in options could potentially be explained by this holding period effect.

To rule out this possibility, in Table A3 we control for the effect of the holding period in multiple ways. First, in Column (1) we control for the holding period directly, and in Column (2) we interact the holding period with the *Gain*, *Option*, and *Gain* $\times$ *Option* variables. Next, in Column (3) we allow for heterogeneity in the overall probability of selling for different holding periods by including holding period fixed effects. Finally, in Column (4) we include investor-holding period fixed effects, to allow each investor to have different selling probabilities for each holding period. In each specification, the coefficient on the *Gain* $\times$ *Option* interaction remains positive and statistically significant, indicating that the stronger disposition effect in options is not explained by differences in holding periods between stocks and options.

Trading Experience and Trading Activity. Seru, Shumway, and Stoffman (2010) show that the strength of the disposition effect decreases as the number of years of trading experience an investor has increases, and as the total number of trades an investor makes increases. The investors in our data set make more trades in stocks and have more years of stock trading experience, so the difference in the strength of the disposition effect between stocks and options could potentially be explained by these differences in trading experience and trading activity.

To rule out this possibility, in Table A4 we again control for trading experience directly, perform a three-way interaction with the *Gain*, *Option*, and *Gain* $\times$ *Option* variables, and include experience and investor-experience fixed effects. In Table A5 we do the same with trading activity. In all specifications, the coefficient on the *Gain* $\times$ *Option* interaction remains positive and statistically significant.

Additional Controls. In Tables A6 and A7 we augment the regression specification in Equation 2 with controls related to investor demographics, the rank effect, calendar effects, position size, portfolio characteristics, and returns. Specifically, the demographic variables are the investor's age, a dummy variable that equals one if the investor is female, and the investor's geographical location measured at the postal code level. The rank effect variables are *Best*, which is a dummy variable that equals one if the asset has the highest return since purchase in the investor's portfolio, and *Worst*, which is the same but for the asset with the lowest return. To ensure that *Best* and *Worst* are uniquely determined, in Columns (2) and (4) of Table A6 we exclude all investor-asset-days during which an investor held only one asset. The position size is the natural logarithm of the euro value of a position, and the portfolio characteristics are the number of assets in an investor's portfolio and the natural logarithm of the euro value of the portfolio. Following Ben-David and Hirshleifer (2012), we also include separate linear controls for positive and negative returns to ensure that the results are not driven by stocks and options having different return distributions. Finally, we include a dummy variable for the month of December, since prior research has shown that tax considerations can affect investors' selling behavior in December (e.g., Grinblatt and Keloharju, 2004; Barber and Odean, 2004). In each specification, the coefficient on the $Gain \times Option$ interaction remains positive and statistically significant.

Subsample Analysis. In Tables A8, A9, and A10 we present the results from the regression specifications in Equations 1 and 2 estimated for subsamples formed on holding period, gender, age, trading experience, trading activity, option type, whether an option was purchased in the money, and time to expiration. Across all of the subsamples, we find a disposition effect that is statistically significant and stronger in options than in stocks.

Investor Self-Selection into Stocks and Options. Comparing the strength of the disposition effect across stocks and options is complicated by the possibility that investors who choose to trade options may differ from investors who choose to trade stocks along some potentially unobservable dimension that is related to the strength of the disposition effect. Differences in the strength of the disposition effect across stocks and options could thus be driven by different kinds of investors choosing to trade stocks or options, rather than by investors actually trading stocks and options differently. The fact that we limit our sample to investors who trade both stocks and options means that the stronger disposition effect we find in options cannot be explained by this kind of simple selection effect. However, investors can still differ in how actively they trade in the two markets, with some investors being more active in stocks and others being more active in options. It thus remains possible that a weaker version of the selection effect could partly explain our results.

We rule out this possibility in two ways. First, we include investor fixed effects in Column (5) of Table 3 to show that investor-level differences in the overall probability of selling do not explain our results. Second, in Table A11 we split investors into quartiles based on the proportion of their trades that are in stocks or options. The investors with the highest proportion of their trades in options are in Quartile 1 and the investors with the highest proportion of their trades in stocks are in Quartile 4. Across each quartile, the $Gain \times Option$ interaction remains positive and statistically significant.

2.1.2 Heterogeneity Across Investors

The results in Table 3 show that retail investors as a whole exhibit a disposition effect in options, and that the effect is stronger in options than in stocks. To see whether these aggregate results are consistent across individuals, we estimate Equation 1 separately for the stock and option trades of each individual investor. To ensure that we have enough data to estimate the *Gain* coefficients accurately, we include only those investors who made at least ten stock sales and ten option sales during the sample period, and we estimate the regressions using the full sample of all investor-asset-days.

The left panel of Figure A1 presents a histogram of *Gain* coefficients estimated from the stock trades of individual investors, while the right panel presents the corresponding histogram for the option trades. The left panel shows that 81% of the investors in our data set exhibit a disposition effect when trading stocks. This is consistent with Dhar and Zhu (2006), who find that 80% of investors at a large discount brokerage in the U.S. exhibit a disposition effect when trading stocks. By contrast, the right panel shows that almost 96% of investors exhibit a disposition effect when trading options. In addition to being stronger in options than in stocks, the disposition effect is thus also more prevalent in options than in stocks.

2.1.3 Expiration, Moneyness, and the Disposition Effect

A fundamental difference between stocks and options is that options expire. This means that an investor wishing to mitigate the negative burst of realization utility (Barberis and Xiong, 2012) or the cognitive dissonance (Chang, Solomon, and Westerfield, 2016) associated with selling an option at a loss can choose to let the option expire rather than to sell it.[11] Compared to stocks, for which a similar possibility does not exist, this would decrease the probability of selling losing options and increase the disposition effect.

In Figure 1 we present evidence consistent with this mechanism, by plotting the probability that an option expires as a function of the option's moneyness, separately for options trading at a gain and options trading at a loss. Across all levels of moneyness, the probability that a loss expires is higher than the corresponding probability for a gain.[12] The difference is particularly pronounced for out-of-the-money options, implying that the impact of option expiration on the disposition effect should be larger for out-of-the-money options. Figure 2 confirms this intuition. It shows that for in-the-money options the strength of the disposition effect is rather stable, being only marginally stronger than the disposition effect in stocks. By contrast, for out-of-the-money options the disposition effect is much stronger, and the strength increases considerably as an option falls deeper out of the money.[13]

Figure 2 thus confirms that the moneyness of an option modulates the strength of the disposition effect. In the next section, we analyze in more detail the relations between moneyness, the strike price, and the disposition effect, and document a novel behavioral bias that we refer to as the strike price disposition effect.

[11]This could either be a deliberate choice, or the result of selective inattention to negative information, in line with the ostrich effect of Karlsson, Loewenstein, and Seppi (2009).

[12]The probability of expiring for both gains and losses increases as moneyness decreases. One possible explanation for this trend is that fixed transaction costs are relatively larger for low-priced out-of-the-money options, making it prohibitively expensive for investors to sell some of their out-of-the-money options. However, transaction costs are unrelated to a given investor's gain or loss status, so they cannot explain why the probability of expiring is higher and increases more dramatically for losses.

[13]As mentioned in Section 1, the options in our data set are cash-settled, which means that liquidity-constrained investors do not need to sell their winners before expiry. We would expect the disposition effect to be even stronger for options with physical delivery, since physical delivery encourages investors to sell their in-the-money positions, and these positions are more likely to be gains.

2.2 The Strike Price Disposition Effect

The disposition effect of Shefrin and Statman (1985) deals with the question of whether investors have a higher propensity to sell gains than losses. Central to this question is the determination of the reference point that investors use to evaluate whether their positions are gains or losses. Indeed, as already emphasized by Odean (1998, p. 1782), *"[a]ny test of the disposition effect is a joint test of the hypothesis that people sell gains more readily than losses and of the specification of the reference point from which gains and losses are determined."*

The standard practice in the disposition effect literature has been to use the purchase price as the reference point. This choice is natural since the purchase price is the benchmark from which capital gains and losses are measured. However, the purchase price need not be the reference point that investors use to subjectively evaluate their investments.[14] For example, Barberis and Xiong (2009, 2012) assume the reference point is the purchase price scaled up by the risk-free rate, arguing that an investor may not think of an investment as a positive one if the return on the position is lower than the return they could have obtained by investing in the risk-free asset. More recently, Shi, Cui, Yao, and Li (2015), Meng and Weng (2018), and Andrikogiannopoulou and Papakonstantinou (2020) have proposed models of the disposition effect where investors dynamically update their reference points over time.

Two recent empirical papers have also considered the possibility that investors use multiple reference points when making their selling decisions. In the first paper, Quispe-Torreblanca, Gathergood, Loewenstein, and Stewart (2022) present evidence consistent with the idea that investors form a new reference point when they log in to their brokerage account and view their portfolio. In the second paper, Quispe-Torreblanca, Hume, Gathergood, Loewenstein, and Stewart (2023) present evidence showing that investors also form a new reference point when the assets they own achieve a new peak price. In both cases, the authors show that investors exhibit a

[14] As highlighted by Baillon, Bleichrodt, and Spinu (2020), not much is known about how investors subjectively form reference points given the large number of potential reference points they could use.

disposition effect around the new reference point, in the sense that they are more likely to sell an asset if it is trading at a gain relative to the new reference point. This holds even when controlling for the standard disposition effect relative to the purchase price. The price at the most recent login and the peak price during the holding period thus represent additional salient prices that affect investors' selling decisions.

Motivated by the results on moneyness and the disposition effect in Figure 2, and by the previously cited literature on how salient attributes can influence behavior, in this section we examine whether investors also use the strike price of an option as a reference point. We argue that the strike price is a particularly salient price for option traders because it is a prominently displayed option feature, and because the payoff of an option depends directly on whether the price of the underlying finishes above or below the strike price. Whether an option is in the money or out of the money could thus have an impact on the selling decisions of investors.

To see whether the moneyness of an option affects its probability of being sold, we follow Ben-David and Hirshleifer (2012) and estimate a propensity to sell function using all of the option positions in our data set for which we can determine the moneyness. Specifically, we run a probit regression of the dummy variable *Sale* on a set of dummy variables corresponding to the moneyness of an option grouped into 1% bins from -50% to 50%, and use the model to estimate the probability of selling an option as a function of its moneyness.

Figure 3 shows that the moneyness of an option clearly affects its probability of being sold. Starting from low selling probabilities for options that are deep out of the money, the probability of selling increases sharply as the price of the underlying approaches the strike price. The probability of selling then peaks for options that are slightly in the money, before leveling off for higher values of moneyness. Consistent with investors exhibiting a disposition effect around the strike price of an option, the probability of selling in-the-money options is considerably higher than the probability of selling out-of-the-money options.

Option positions that are in the money are more likely to be trading at a gain relative to the purchase price than option positions that are out of the money. To ensure that the strike price disposition effect suggested by Figure 3 is truly distinct from the standard disposition effect, and to see how the strike price and the purchase price interact to influence investors' selling behavior, we use the following regression specification:

$$Sale_{ijt} = \beta_0 + \beta_1 Gain_{ijt} + \beta_2 ITM_{jt} + \beta_3 Gain_{ijt} \times ITM_{ijt} + \varepsilon_{ijt}. \tag{3}$$

The new variable ITM is a dummy variable that equals one if option j is in the money on day t.

The specification in Equation 3 adds the ITM dummy and an interaction between $Gain$ and ITM to the standard disposition effect regression specification in Equation 1. The ITM coefficient β_2 captures the increase in the selling probability when an option position is in the money, and is thus a measure of the strike price disposition effect. The interaction coefficient β_3 measures the difference in the strength of the standard disposition effect for in-the-money and out-of-the-money options. A positive β_3 indicates that investors exhibit a stronger disposition effect when an option is in the money, while a negative β_3 indicates that investors exhibit a weaker disposition effect when an option is in the money. To allow for heterogeneity in the overall probability of selling across investors and days, the specification in Equation 3 is also estimated with investor and day fixed effects.

The results of the regressions are presented in Table 4. Consistent with the results of Figure 3, the positive ITM coefficient in Column (2) confirms that investors have a higher probability of selling in-the-money positions than out-of-the-money positions. Compared to a baseline selling probability of 18.74%, an option position being in the money increases the probability of selling to 45.01%. In other words, investors are around 2.40 times more likely to sell in-the-money positions than out-of-the-money positions. Column (3) shows that the ITM coefficient remains positive and highly significant even after controlling for $Gain$, which confirms that the strike price disposition effect is novel and distinct from the standard disposition effect.

Consistent with the results of Figure 2, the $Gain \times ITM$ interaction coefficient in

Column (4) of Table 4 is negative and statistically significant, indicating that investors exhibit a weaker disposition effect when an option is in the money. The inclusion of investor fixed effects in Column (5) and investor and day fixed effects in Column (6) has minimal impact on the results. The results with the full sample of all investor-asset-days are reported in Table A12.

To visualize the relations between returns, moneyness, and the probability of selling, Figure 4 plots the probability of selling an option as a function of its return since purchase, separately for in-the-money and out-of-the-money options. Unsurprisingly, the probability of selling is highest for in-the-money gains and lowest for out-of-the-money losses. More interestingly, the selling probabilities of in-the-money losses and out-of-the-money gains are relatively similar. Consistent with investors using both the purchase price and the strike price as reference points, investors seem to be more reluctant to sell out-of-the-money gains compared to in-the-money gains, while simultaneously being more willing to sell in-the-money losses compared to out-of-the-money losses.

2.2.1 Robustness Tests

Tables A13 and A14 augment the regression specification in Equation 3 with controls related to investor demographics, the rank effect, trading experience, trading activity, option type, whether an option was purchased in the money, time to expiration, holding period, position size, and portfolio characteristics. In each specification, the coefficients on $Gain$, ITM and the $Gain \times ITM$ interaction remain highly statistically significant.

Table A15 presents the results from the regression specification in Equation 3 estimated for subsamples formed on option type, whether an option was purchased in the money, and time to expiration. Across all of the subsamples, the coefficients on $Gain$, ITM and the $Gain \times ITM$ interaction remain highly statistically significant.

2.2.2 Heterogeneity Across Investors

The results in Table 4 show that retail investors as a whole use both the purchase price and the strike price as reference points when making their selling decisions. However, this doesn't necessarily mean that each investor uses both reference points. Instead, it could be that some investors use the purchase price as their sole reference point, while other investors use the strike price as their sole reference point, thus making both reference points significant determinants of selling decisions in the aggregate.

To examine this possibility, we estimate Equation 3 separately for each individual investor. To ensure that we have enough data to estimate the coefficients accurately, we include only those investors who made at least ten sales of in-the-money options and ten sales of out-of-the-money options during the sample period, and we estimate the regressions using the full sample of all investor-asset-days.

The results are presented in Figure A2. The left panel shows that almost 97% of investors have a positive *Gain* coefficient, and thus exhibit the disposition effect.[15] The right panel shows that 89% of investors have a positive ITM coefficient, and thus exhibit the strike price disposition effect. In total, almost 87% of investors exhibit both the disposition effect and the strike price disposition effect, which confirms that both reference points are important for a significant majority of investors.

2.3 The Peak Price Disposition Effect

In this section, we begin by showing that investors in Finland exhibit the peak price disposition effect when trading stocks. We thus provide out-of-sample validation of the original findings in Quispe-Torreblanca, Hume, Gathergood, Loewenstein, and Stewart (2023). We then extend the analysis to show that investors also exhibit the peak price disposition effect when trading options. Consistent with the results for the standard disposition effect, we find that the peak price disposition effect is also stronger in options than in stocks.

[15] The left panel of Figure A2 is slightly different from the right panel of Figure A1 because the sample selection criteria are more stringent for Figure A2.

Following Quispe-Torreblanca, Hume, Gathergood, Loewenstein, and Stewart (2023), we call the price of asset j on day t a peak price for investor i if it satisfies two conditions. First, it is the highest price achieved by the asset from day 0 to day t of the investor's holding period. Second, it remains the highest price for at least the next week. We then test for the peak price disposition effect in stocks and options by using the following regression specifications:

$$Sale_{ijt} = \beta_0 + \beta_1 Gain_{ijt} + \beta_2 Peak_{ijt} + \varepsilon_{ijt}, \tag{4}$$

$$\begin{aligned} Sale_{ijt} = \beta_0 + \beta_1 Gain_{ijt} + \beta_2 Peak_{ijt} + \beta_3 Option_j \\ + \beta_4 Gain_{ijt} \times Option_j + \beta_5 Peak_{ijt} \times Option_j + \varepsilon_{ijt}. \end{aligned} \tag{5}$$

The new variable *Peak* is a dummy variable that equals one if the return since peak on the asset is positive. In both specifications, standard errors are clustered by investor and day.

The specification in Equation 4 is estimated separately for stocks and options. The measure of the peak price disposition effect is the *Peak* coefficient β_2, which captures the increase in the probability of selling when a position is trading at a gain relative to a peak price, after controlling for whether the position is trading at a gain relative to the purchase price.

The specification in Equation 5 is estimated simultaneously for stocks and options. The primary coefficient of interest is the $Peak \times Option$ interaction coefficient β_5, which captures the difference in the strength of the peak price disposition effect for stocks and options. A positive β_5 indicates that investors exhibit a stronger peak price disposition effect in options. The specification in Equation 5 is also estimated with investor and day fixed effects, to allow for heterogeneity in the overall probability of selling across investors and days.

The results of the regressions are presented in Table 5. The positive *Peak* coefficient in Column (1) shows that the investors in our data set exhibit a peak price disposition effect when trading stocks. The positive *Peak* coefficient in Column (2) shows that the investors also exhibit a peak price disposition effect when trading options. The positive $Peak \times Option$ interaction coefficient in Column (3) shows that the peak price disposition effect is stronger in options than in stocks, even after controlling for the standard disposition effect in stocks and options. The inclusion of investor fixed effects in Column (4) and investor and day fixed effects in Column (5) has minimal impact on the results. The results with the full sample of all investor-asset-days are reported in Table A16.

2.3.1 Robustness Tests

Tables A17 and A18 augment the regression specification in Equation 5 with controls related to investor demographics, the rank effect, trading experience, trading activity, holding period, position size, and portfolio characteristics. In each specification, the peak price disposition effect is statistically significant and stronger in options than in stocks.

Table A19 presents the results from the regression specification in Equation 4 estimated for subsamples formed on option type, whether an option was purchased in the money, and time to expiration. The peak price disposition effect in options remains stable and statistically significant across all of the subsamples.

2.3.2 Heterogeneity Across Investors

To see whether the aggregate results presented in Table 5 are consistent across individuals, we estimate Equation 4 separately for the stock and option trades of each individual investor. To ensure that we have enough data to estimate the *Peak* coefficients accurately, we include only those investors who made at least ten stock sales and ten option sales during the sample period, and we estimate the regressions using the full sample of all investor-asset-days.

The left panel of Figure A3 presents a histogram of *Peak* coefficients estimated from the stock trades of individual investors, while the right panel presents the corresponding histogram for the option trades. The left panel shows that 84% of the investors in our data set exhibit a peak price disposition effect when trading stocks, while the right panel shows that 84% of investors also exhibit a peak price disposition effect when trading options. The peak price disposition effect is thus a prevalent feature of both stock and option trading by retail investors.

2.3.3 Moneyness and the Peak Price Disposition Effect

To study the relation between the strike price disposition effect and the peak price disposition effect in options, we use the following regression specification:

$$\begin{aligned} Sale_{ijt} = \beta_0 + \beta_1 Gain_{ijt} + \beta_2 Peak_{ijt} + \beta_3 ITM_{jt} \\ + \beta_4 Gain_{ijt} \times ITM_{jt} + \beta_5 Peak_{ijt} \times ITM_{jt} + \varepsilon_{ijt}. \end{aligned} \tag{6}$$

The primary coefficient of interest is the $Peak \times ITM$ interaction coefficient β_5, which captures the difference in the strength of the peak price disposition effect for in-the-money and out-of-the-money options. A positive β_5 indicates that investors exhibit a stronger peak price disposition effect when an option is in the money, while a negative β_5 indicates that investors exhibit a weaker peak price disposition effect when an option is in the money. To allow for heterogeneity in the overall probability of selling across investors and days, the specification in Equation 6 is also estimated with investor and day fixed effects.

The results of the regressions are presented in Table 6. The positive and statistically significant *Gain*, *Peak*, and ITM coefficients in Column (1) show that purchase, peak, and strike prices are all significant determinants of retail investors' option selling decisions. They also reconfirm that the disposition effect, peak price disposition effect, and strike price disposition effect are distinct effects.

The statistically insignificant $Peak \times ITM$ interaction coefficient in Column (2) shows that the peak price disposition effect is neither stronger nor weaker for in-the-money options. The inclusion of investor fixed effects in Column (3) and investor and day fixed effects in Column (4) has minimal impact on the results. Overall, the results in

Table 6 suggest that investors use both peak prices and strike prices as reference points when making their selling decisions, but that the two prices do not interact in the same way that purchase prices and strike prices do.

2.4 Behavioral Biases and Option Trading Performance

The behavioral biases that retail investors exhibit when trading options are important sources of heterogeneity in option trading performance. Table 7 presents the average lifetime profits and average daily returns of investors split into quintiles based on the strength of their disposition effect, strike price disposition effect, and peak price disposition effect.[16] The disposition effect and peak price disposition effect are estimated from the regression specifications in Equations 1 and 4 for each investor who made at least ten option sales during the sample period. The strike price disposition effect is estimated from the regression specification in Equation 3 for each investor who made at least ten sales of in-the-money options and ten sales of out-of-the-money options during the sample period. In each case, the regressions are estimated using all investor-asset-days.

For each bias, investors' lifetime losses increase as the strength of the bias increases. For example, the differences in lifetime losses between investors in the high and low quintiles of the strike price disposition effect and the peak price disposition effect are over €21 000 for both effects. A similar pattern emerges when looking at average daily returns. For example, investors in the high quintile of the disposition effect have average daily returns of -0.54%, compared to returns of -0.15% for the low quintile. Overall, Table 7 shows that retail option traders' behavioral biases contribute to the losses they experience with their option trades.

[16] The profits and returns are calculated assuming there are no trading fees or commissions. The performance results should thus be considered an upper bound on the true, after-cost performance.

3 Conclusion

Using comprehensive account-level trading data from Finland spanning over fifteen years, we provide novel insights on the option trading behavior of retail investors. Our results reveal that the decision-making processes of retail traders are more biased in derivatives than in stocks, as evidenced by both the disposition effect and the peak price disposition effect being much stronger in options than in stocks. We also provide novel evidence of investors using the strike price of an option as an objective and instrument-specific reference point that shapes their selling decisions. We consider a number of explanation for these results and conclude that option features and the incremental complexity of options relative to stocks are the main drivers of our findings. We also show that the biases retail option traders exhibit contribute negatively to their option trading performance. Taken together, we hope our findings can help policymakers better understand the long-term welfare implications of the recent boom in retail investor participation in option markets.

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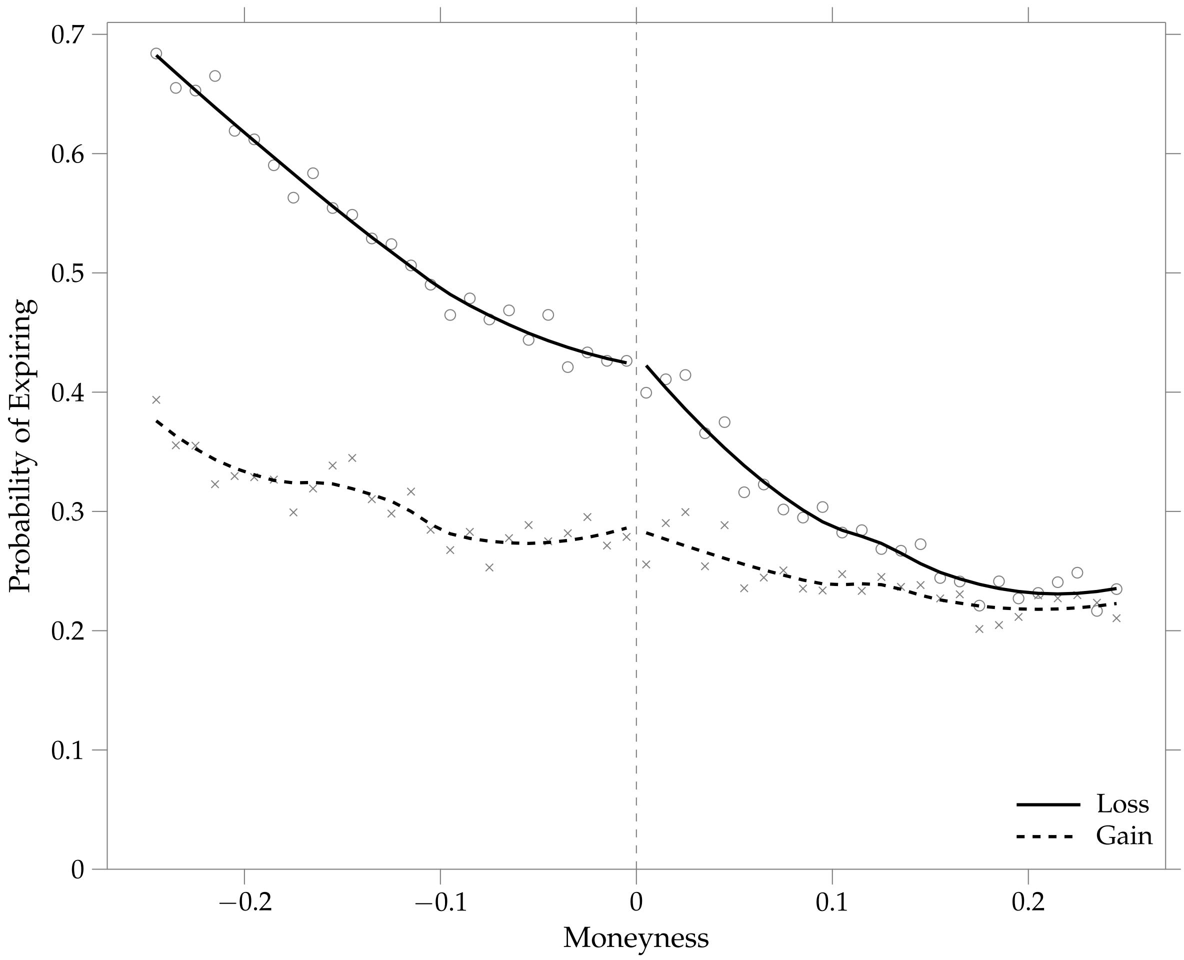


Figure 1: Option Expiration by Moneyness.
Plotted are the probabilities that an option expires estimated from probit regressions of a dummy variable *Expire* on a set of dummy variables corresponding to the moneyness of an option grouped into 1% bins from -25% to 25%, separately for options trading at a gain and options trading at a loss. The moneyness of a call option is defined as the price of the underlying minus the strike price, divided by the strike price. The moneyness of a put option is defined as the strike price minus the price of the underlying, divided by the strike price. The solid and dashed lines are loess curves estimated separately for the positive and negative domains. The data set contains the option trades of all retail investors in Finland, in those options for which we can determine the moneyness. The sample period is Aug-2007 to Dec-2017.

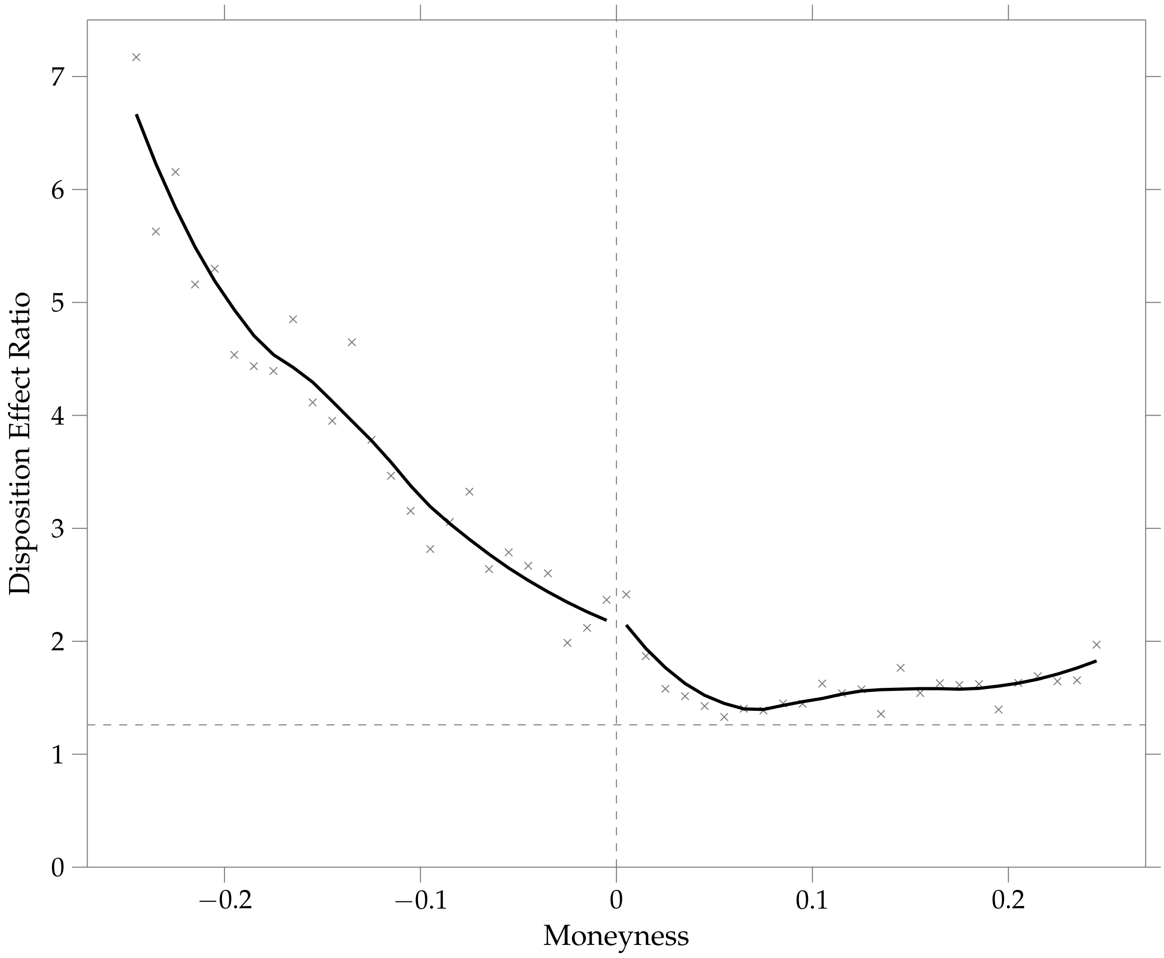


Figure 2: Disposition Effect in Options by Moneyness.
Plotted are disposition effect ratios, defined as the probability of selling winners divided by the probability of selling losers, from the regression specification in Equation 1 estimated separately for options grouped into 1% bins from -25% to 25% based on their moneyness. The moneyness of a call option is defined as the price of the underlying minus the strike price, divided by the strike price. The moneyness of a put option is defined as the strike price minus the price of the underlying, divided by the strike price. The solid lines are loess curves estimated separately for the positive and negative domains. The dashed horizontal line is the disposition effect ratio for stock trades. The data set contains the option trades of all retail investors in Finland, in those options for which we can determine the moneyness. The sample period is Aug-2007 to Dec-2017.

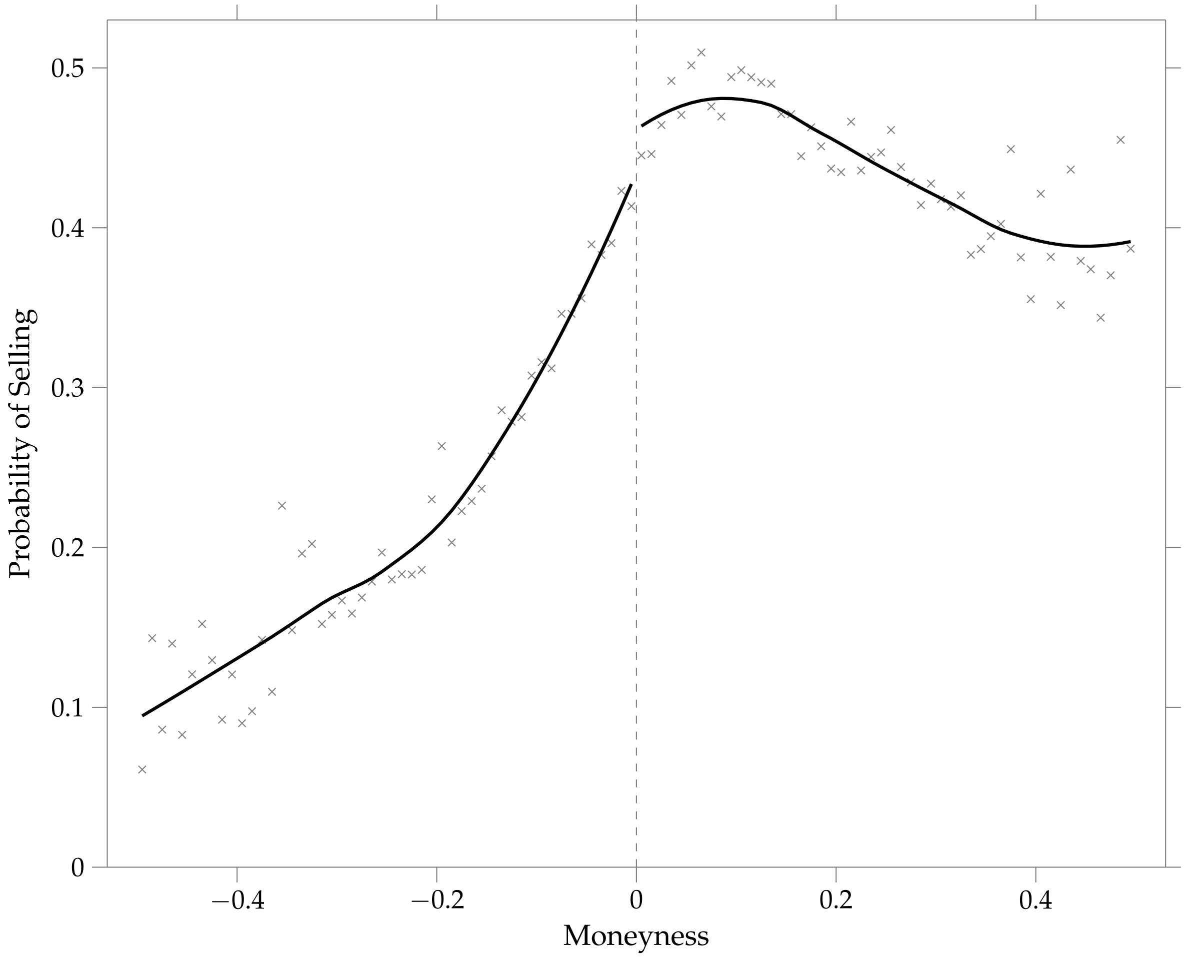


Figure 3: Propensity to Sell Options by Moneyness.
Plotted is the propensity to sell function estimated from a probit regression of the dummy variable *Sale* on a set of dummy variables corresponding to the moneyness of an option grouped into 1% bins from -50% to 50%. The moneyness of a call option is defined as the price of the underlying minus the strike price, divided by the strike price. The moneyness of a put option is defined as the strike price minus the price of the underlying, divided by the strike price. The solid lines are loess curves estimated separately for the positive and negative domains. The data set contains the option trades of all retail investors in Finland, in those options for which we can determine the moneyness. The sample period is Aug-2007 to Dec-2017.

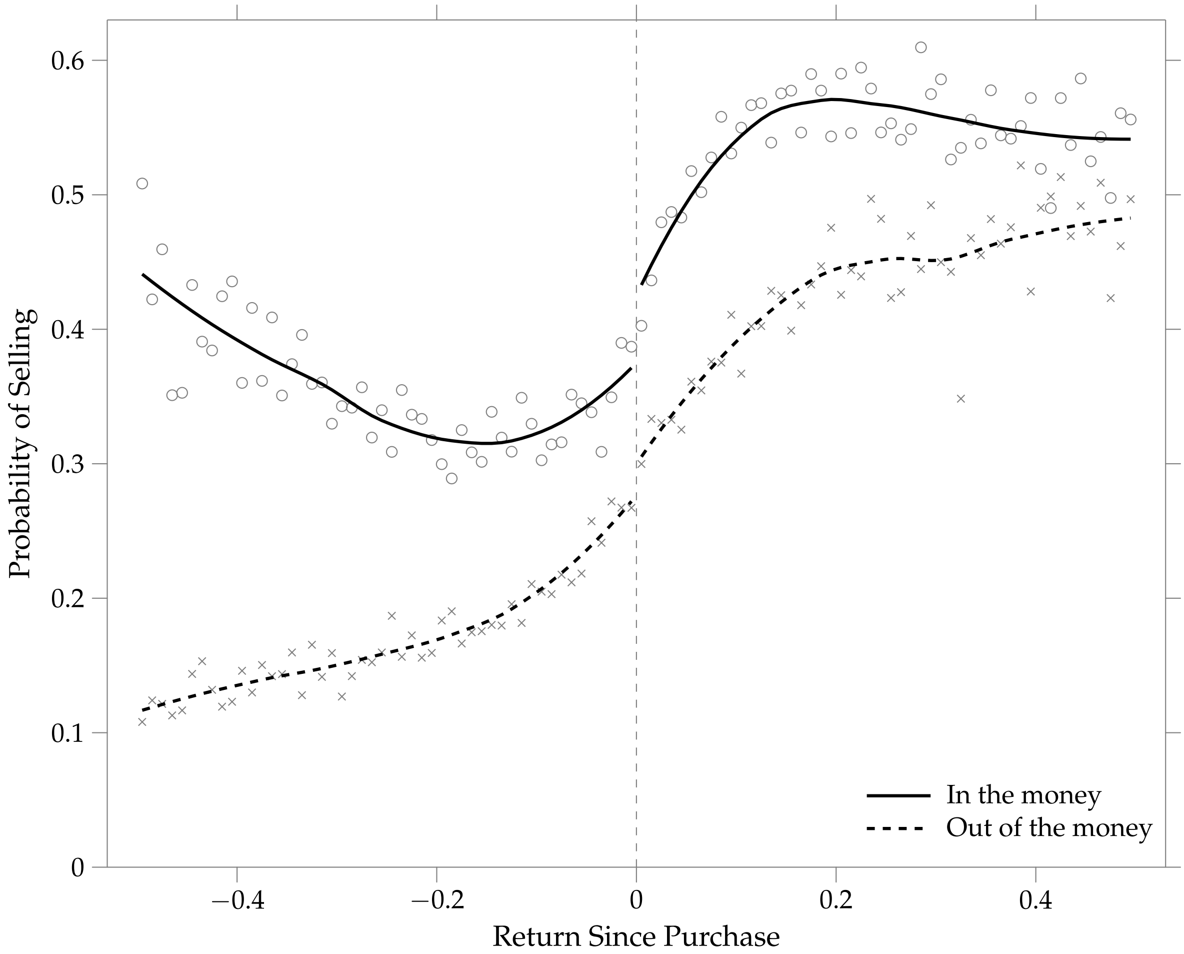


Figure 4: Propensity to Sell Options by Return and Moneyness.
Plotted are propensity to sell functions estimated from probit regressions of the dummy variable *Sale* on a set of dummy variables corresponding to the return since purchase of an option grouped into 1% bins from -50% to 50%, separately for in-the-money and out-of-the-money options. The solid and dashed lines are loess curves estimated separately for the positive and negative domains. The data set contains the option trades of all retail investors in Finland, in those options for which we can determine the moneyness. The sample period is Aug-2007 to Dec-2017.

Table 1: Summary Statistics.
Reported are summary statistics about investor, trade, and sample characteristics. We first calculate the average value of a characteristic separately for each investor, and then report the distribution of the investor-level averages. Investor age and years of trading experience are measured at the beginning of each new trade. Trade size is averaged over all purchases, including additional purchases of an asset than an investor already holds. An observation is a position of an investor in a given asset on a given day. The data set contains the stock and option trades of all retail investors in Finland who traded at least one option during the sample period. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options.

Panel A: Investor Characteristics					
	Mean	SD	25th Pct.	Med.	75th Pct.
Female (%)	10.61				
Age (years)	37.01	12.79	28.00	34.57	44.66
Experience, Stocks (years)	6.31	4.75	2.12	5.68	9.84
Experience, Options (years)	1.07	1.73	0.00	0.21	1.45
Total Trades, Stocks	259.90	647.89	37.00	97.00	238.00
Total Trades, Options	60.72	207.49	3.00	9.00	36.00
Panel B: Trade Characteristics					
	Mean	SD	25th Pct.	Med.	75th Pct.
Trade Size, Stocks (euros)	75 689	266 917	8 576	22 339	60 542
Trade Size, Options (euros)	1 376	4 322	225	556	1 320
Holding Period, Stocks (days)	363.66	386.29	91.27	232.54	501.34
Holding Period, Options (days)	64.54	102.82	10.87	27.80	68.00
Panel C: Sample Characteristics					
	N				
Investors	19 635				
Observations, Stocks	275 195 901				
Observations, Options	9 923 522				

Table 2: Characteristics of Purchased Options.
Reported are the percentage of option purchases with specific option characteristics for different investor groups. The low experience group contains investors with 10 or fewer previous option purchases. Moneyness for calls is defined as the price of the underlying minus the strike price divided by the strike price, and for puts as the strike price minus the price of the underlying divided by the strike price. An option is defined to be at the money if its moneyness is between -1 and 1%. The data set contains the option purchases of all retail investors in Finland from Dec-2000 to Dec-2017.

			Gender		Age		Experience	
Characteristic	Category	All	Male	Female	≤ 40	> 40	Low	High
Option Type	Call	0.66	0.66	0.66	0.64	0.67	0.77	0.65
	Put	0.34	0.34	0.34	0.36	0.33	0.23	0.35
Trade Size	Below 250	0.21	0.21	0.20	0.24	0.20	0.30	0.20
(euros)	250–1 000	0.37	0.37	0.36	0.38	0.37	0.40	0.37
	1 000–10 000	0.38	0.37	0.40	0.35	0.40	0.29	0.39
	Above 10 000	0.04	0.04	0.04	0.03	0.04	0.02	0.04
Time to Expiry	0–5 days	0.04	0.04	0.03	0.03	0.04	0.03	0.04
	1–4 weeks	0.20	0.20	0.20	0.19	0.20	0.15	0.20
	1–3 months	0.46	0.46	0.47	0.46	0.46	0.40	0.47
	3–12 months	0.25	0.25	0.26	0.26	0.24	0.29	0.24
	Over a year	0.06	0.06	0.05	0.06	0.06	0.12	0.05
Moneyness	Above 10%	0.19	0.19	0.18	0.19	0.18	0.14	0.20
(calls)	1% to 10%	0.16	0.16	0.15	0.15	0.16	0.14	0.16
	At the money	0.04	0.04	0.05	0.04	0.04	0.04	0.04
	-1% to -10%	0.25	0.25	0.27	0.25	0.25	0.26	0.25
	Below -10%	0.36	0.36	0.35	0.37	0.36	0.42	0.35
Moneyness	Above 10%	0.27	0.27	0.24	0.30	0.26	0.26	0.28
(puts)	1% to 10%	0.22	0.22	0.22	0.21	0.23	0.22	0.22
	At the money	0.05	0.05	0.06	0.05	0.05	0.05	0.05
	-1% to -10%	0.23	0.23	0.23	0.22	0.23	0.23	0.23
	Below -10%	0.23	0.23	0.25	0.22	0.24	0.25	0.23

Table 3: The Disposition Effect.
Reported are the results from the regression specifications in Equations 1 and 2. The dependent variable *Sale* is a dummy variable that equals one if investor *i* sold asset *j* on day *t*. *Gain* is a dummy variable that equals one if the return since purchase on the asset is positive. *Option* is a dummy variable that equals one if the asset is an option. Standard errors clustered by investor and day are in parentheses. The data set contains the stock and option trades of all retail investors in Finland who traded at least one option during the sample period. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale					
	(1)	(2)	(3)	(4)	(5)	(6)
Gain	0.0418***	0.3366***	0.0617***	0.0418***	0.0497***	0.0508***
	(0.0018)	(0.0054)	(0.0021)	(0.0018)	(0.0014)	(0.0015)
Option			0.2196***	0.1169***	0.0708***	0.0732***
			(0.0057)	(0.0053)	(0.0040)	(0.0040)
Gain × Option				0.2948***	0.2740***	0.2725***
				(0.0054)	(0.0048)	(0.0048)
Constant	0.1246***	0.2415***	0.1150***	0.1246***		
	(0.0028)	(0.0052)	(0.0027)	(0.0028)		
	Fixed Effects					
Investor	No	No	No	No	Yes	Yes
Day	No	No	No	No	No	Yes
Observations	15 064 369	1 211 057	16 275 426	16 275 426	16 275 426	16 275 426
Adjusted R^2	0.0035	0.1108	0.0297	0.0398	0.1378	0.1429
Sample:	Stocks	Options	All	All	All	All

Table 4: The Strike Price Disposition Effect.
Reported are the results from the regression specification in Equation 3. The dependent variable *Sale* is a dummy variable that equals one if investor *i* sold option *j* on day *t*. *Gain* is a dummy variable that equals one if the return since purchase on the option is positive. *ITM* is a dummy variable that equals one if the option is in the money. Standard errors clustered by investor and day are in parentheses. The data set contains the option trades of all retail investors in Finland, in those options for which we can determine the moneyness. The sample period is Aug-2007 to Dec-2017. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale					
	(1)	(2)	(3)	(4)	(5)	(6)
Gain	0.3277***		0.2705***	0.3280***	0.2982***	0.2896***
	(0.0083)		(0.0088)	(0.0103)	(0.0100)	(0.0097)
ITM		0.2627***	0.1590***	0.2296***	0.1787***	0.1792***
		(0.0080)	(0.0084)	(0.0086)	(0.0069)	(0.0067)
Gain $\times$ ITM				-0.1566***	-0.0996***	-0.0935***
				(0.0107)	(0.0101)	(0.0098)
Constant	0.1580***	0.1874***	0.1311***	0.1192***		
	(0.0050)	(0.0058)	(0.0048)	(0.0044)		
	Fixed Effects					
Investor	No	No	No	No	Yes	Yes
Day	No	No	No	No	No	Yes
Observations	445 797	445 797	445 797	445 797	445 797	445 797
Adjusted R^2	0.1202	0.0725	0.1431	0.1486	0.3081	0.3238

Table 5: The Peak Price Disposition Effect.
Reported are the results from the regression specifications in Equations 4 and 5. The dependent variable *Sale* is a dummy variable that equals one if investor i sold asset j on day t. *Gain* is a dummy variable that equals one if the return since purchase on the asset is positive. *Peak* is a dummy variable that equals one if the return since peak on the asset is positive. *Option* is a dummy variable that equals one if the asset is an option. Standard errors clustered by investor and day are in parentheses. The data set contains the stock and option trades of all retail investors in Finland who traded at least one option during the sample period. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale				
	(1)	(2)	(3)	(4)	(5)
Gain	0.0180***	0.1455***	0.0180***	0.0231***	0.0225***
	(0.0014)	(0.0052)	(0.0014)	(0.0010)	(0.0010)
Peak	0.1086***	0.2147***	0.1086***	0.0868***	0.0936***
	(0.0024)	(0.0069)	(0.0024)	(0.0022)	(0.0023)
Option			0.0402***	0.0034	0.0056*
			(0.0036)	(0.0030)	(0.0030)
Gain × Option			0.1275***	0.1278***	0.1297***
			(0.0051)	(0.0045)	(0.0045)
Peak × Option			0.1061***	0.1083***	0.1026***
			(0.0070)	(0.0067)	(0.0066)
Constant	0.0961***	0.1363***	0.0961***		
	(0.0021)	(0.0033)	(0.0021)		
	Fixed Effects				
Investor	No	No	No	Yes	Yes
Day	No	No	No	No	Yes
Observations	10 575 216	360 899	10 936 115	10 936 115	10 936 115
Adjusted R^2	0.0125	0.0845	0.0189	0.0885	0.0960
Sample:	Stocks	Options	All	All	All

Table 6: Moneyness and the Peak Price Disposition Effect in Options.
Reported are the results from the regression specification in Equation 6. The dependent variable *Sale* is a dummy variable that equals one if investor i sold option j on day t. *Gain* is a dummy variable that equals one if the return since purchase on the option is positive. *Peak* is a dummy variable that equals one if the return since peak on the option is positive. *ITM* is a dummy variable that equals one if the option is in the money. Standard errors clustered by investor and day are in parentheses. The data set contains the option trades of all retail investors in Finland, in those options for which we can determine the moneyness. The sample period is Aug-2007 to Dec-2017. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale			
	(1)	(2)	(3)	(4)
Gain	0.0997***	0.1259***	0.1161***	0.1090***
	(0.0069)	(0.0075)	(0.0063)	(0.0060)
Peak	0.1743***	0.1793***	0.1322***	0.1144***
	(0.0102)	(0.0132)	(0.0112)	(0.0105)
ITM	0.1168***	0.1606***	0.1241***	0.1233***
	(0.0073)	(0.0077)	(0.0066)	(0.0064)
Gain × ITM		-0.0853***	-0.0362***	-0.0355***
		(0.0101)	(0.0086)	(0.0082)
Peak × ITM		0.0026	0.0121	0.0226*
		(0.0137)	(0.0125)	(0.0118)
Constant	0.0808***	0.0751***		
	(0.0034)	(0.0031)		
	Fixed Effects			
Investor	No	No	Yes	Yes
Day	No	No	No	Yes
Observations	160 714	160 714	160 714	160 714
Adjusted R^2	0.1012	0.1033	0.2421	0.2654

Table 7: Behavioral Biases and Option Trading Performance.
Reported are the average lifetime profits and average daily returns of investors split into quintiles based on the strength of their disposition effect, strike price disposition effect, and peak price disposition effect. The disposition effect and peak price disposition effect are estimated from the regression specifications in Equations 1 and 4 for each investor who made at least ten option sales during the sample period. The strike price disposition effect is estimated from the regression specification in Equation 3 for each investor who made at least ten sales of in-the-money options and ten sales of out-of-the-money options during the sample period. In each case, the regressions are estimated using all investor-asset-days. The lifetime profits and daily returns are calculated assuming there are no fees or commissions. The data set contains the option trades of all retail investors in Finland. The sample period is Dec-2000 to Dec-2017.

	Disposition Effect					
	Purchase Price		Strike Price		Peak Price	
Quintile	Profit (€)	Return (%)	Profit (€)	Return (%)	Profit (€)	Return (%)
Low	-8 021	-0.15	-16 740	-0.14	-10 535	-0.12
2	-7 776	-0.26	-17 851	-0.20	-16 133	-0.11
3	-9 285	-0.33	-37 338	-0.33	-15 132	-0.15
4	-11 280	-0.44	-35 469	-0.35	-14 025	-0.19
High	-13 749	-0.54	-37 927	-0.42	-33 276	-0.32
High - Low	-5 728	-0.39	-21 187	-0.28	-22 741	-0.20

Internet Appendix for:

“Striking Out: Biases and Losses of Retail Option Traders”

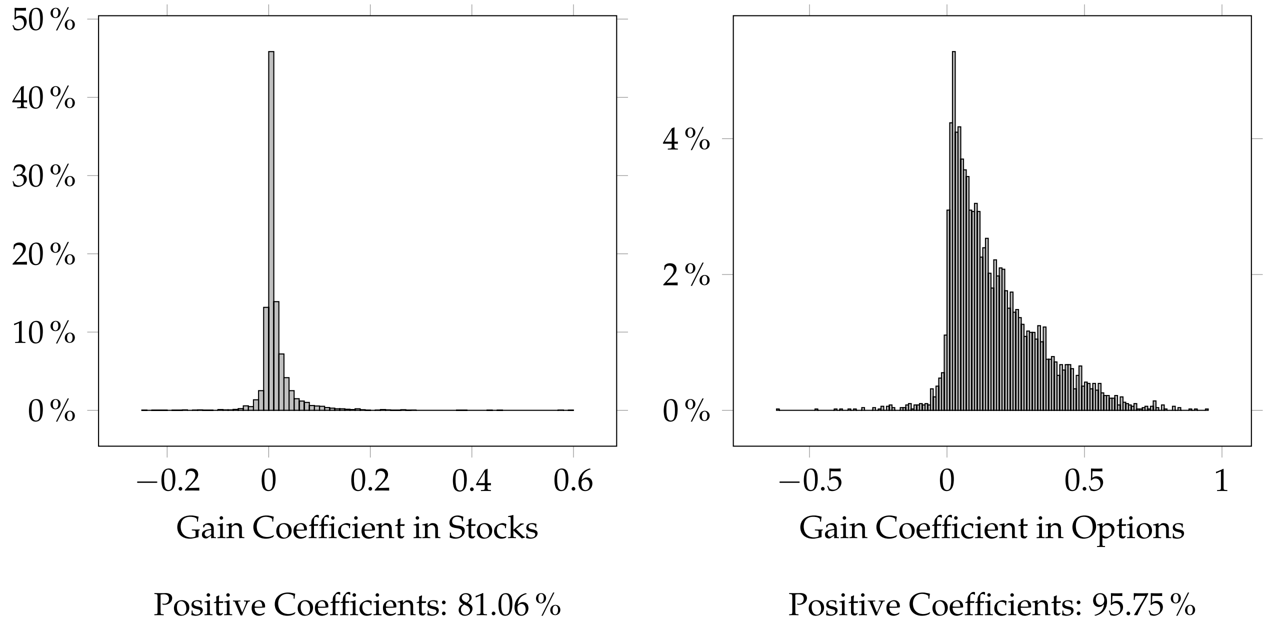
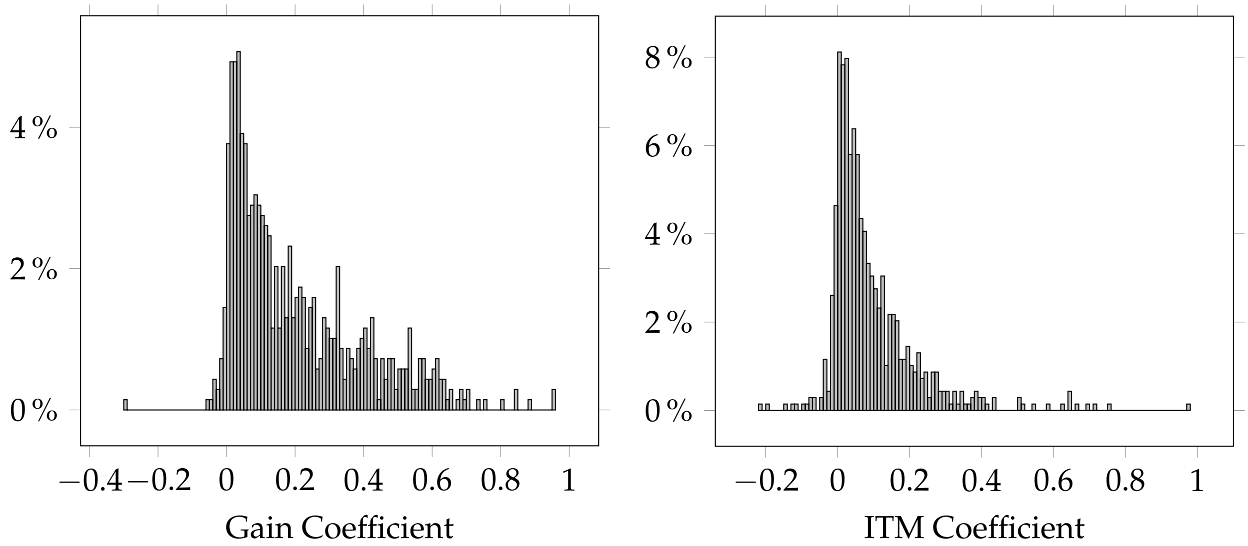


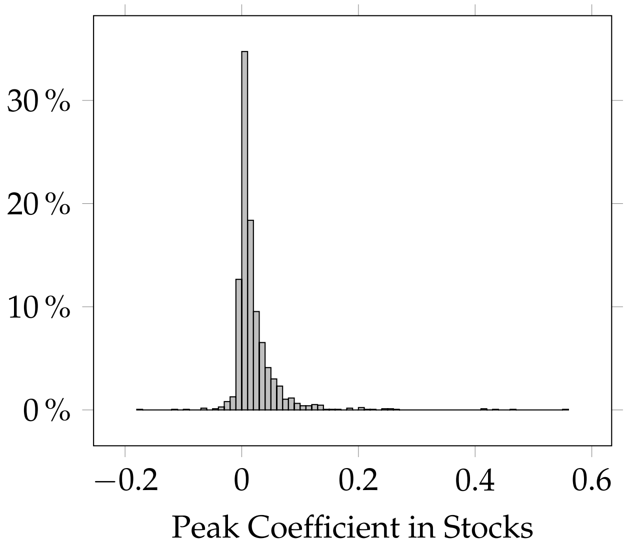
Figure A1: Investor Heterogeneity in the Disposition Effect.
Plotted are histograms of *Gain* coefficients estimated at the individual investor level. The left (right) panel plots *Gain* coefficients from the regression specification in Equation 1 estimated from the stock (option) trades of all retail investors in Finland who made at least ten stock sales and ten option sales during the sample period. The height of a bar represents the proportion of coefficients falling within a given interval. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options.



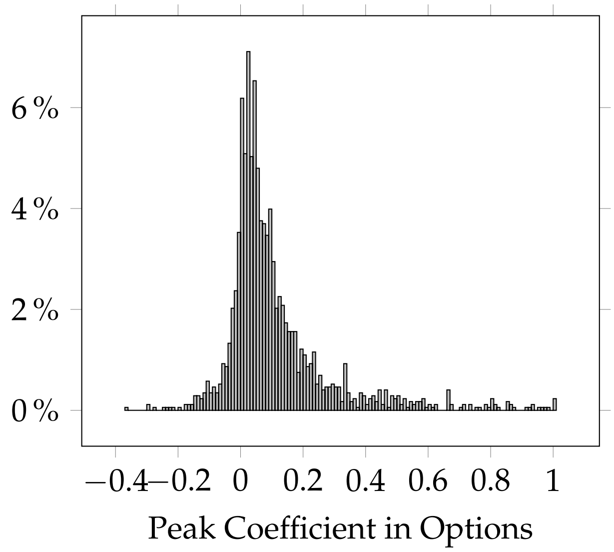
Positive Coefficients: 96.67 %

Positive Coefficients: 89.13 %

Figure A2: Investor Heterogeneity in the Strike Price Disposition Effect.
Plotted are histograms of *Gain* and *ITM* coefficients estimated at the individual investor level. The left (right) panel plots *Gain* (*ITM*) coefficients from the regression specification in Equation 3 estimated from the option trades of all retail investors in Finland who made at least ten sales of in-the-money options and ten sales of out-of-the-money options during the sample period, in those options for which we can determine the moneyness. The height of a bar represents the proportion of coefficients falling within a given interval. The sample period is Aug-2007 to Dec-2017.



Positive Coefficients: 84.45 %



Positive Coefficients: 83.99 %

Figure A3: Investor Heterogeneity in the Peak Price Disposition Effect.
Plotted are histograms of *Peak* coefficients estimated at the individual investor level. The left (right) panel plots *Peak* coefficients from the regression specification in Equation 4 estimated from the stock (option) trades of all retail investors in Finland who made at least ten stock sales and ten option sales during the sample period. The height of a bar represents the proportion of coefficients falling within a given interval. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options.

Table A1: Stock Option Purchases and Ownership of the Underlying Stock. Reported are the total number of purchases of calls and puts, and the total euro value of call and put purchases, based on whether an investor owns the underlying stock at the time of purchase or not. The data set contains the stock option purchases of all retail investors in Finland, in those options for which we can determine the underlying stock. The sample period is Aug-2007 to Dec-2017.

	Purchases		Value (€)	
	Call	Put	Call	Put
Owns Underlying	54 343	6 049	110 347 669	8 413 998
Does Not Own Underlying	100 101	32 151	188 607 742	56 502 497

Table A2: The Disposition Effect with All Days.
Reported are the results from the regression specifications in Equations 1 and 2 estimated with all investor-asset-days. The dependent variable *Sale* is a dummy variable that equals one if investor i sold asset j on day t. *Gain* is a dummy variable that equals one if the return since purchase on the asset is positive. *Option* is a dummy variable that equals one if the asset is an option. Standard errors clustered by investor and day are in parentheses. The data set contains the stock and option trades of all retail investors in Finland who traded at least one option during the sample period. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale					
	(1)	(2)	(3)	(4)	(5)	(6)
Gain	0.0034***	0.0914***	0.0054***	0.0034***	0.0046***	0.0042***
	(0.0001)	(0.0024)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Option			0.0439***	0.0231***	0.0146***	0.0139***
			(0.0012)	(0.0008)	(0.0006)	(0.0006)
Gain × Option				0.0881***	0.0880***	0.0875***
				(0.0024)	(0.0024)	(0.0023)
Constant	0.0068***	0.0299***	0.0059***	0.0068***		
	(0.0001)	(0.0008)	(0.0001)	(0.0001)		
	Fixed Effects					
Investor	No	No	No	No	Yes	Yes
Day	No	No	No	No	No	Yes
Observations	260 990 245	8 426 980	269 417 225	269 417 225	269 417 225	269 417 225
Adjusted R^2	0.0003	0.0307	0.0065	0.0109	0.0448	0.0478
Sample:	Stocks	Options	All	All	All	All

Table A3: The Holding Period and the Disposition Effect.
Reported are the results from the regression specification in Equation 2 augmented with various controls for the holding period. The dependent variable *Sale* is a dummy variable that equals one if investor i sold asset j on day t. *Gain* is a dummy variable that equals one if the return since purchase on the asset is positive. *Option* is a dummy variable that equals one if the asset is an option. *Hold* is the holding period of a position measured in trading days. Standard errors clustered by investor and day are in parentheses. The data set contains the stock and option trades of all retail investors in Finland who traded at least one option during the sample period. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale			
	(1)	(2)	(3)	(4)
Gain	0.0404***	0.0450***	0.0326***	0.0342***
	(0.0016)	(0.0018)	(0.0013)	(0.0013)
Option	0.0875***	0.1294***	-0.0055	-0.0079**
	(0.0052)	(0.0058)	(0.0043)	(0.0032)
Gain × Option	0.2953***	0.2913***	0.2500***	0.2389***
	(0.0054)	(0.0054)	(0.0045)	(0.0042)
Hold	-0.0000***	-0.0000***		
	(0.0000)	(0.0000)		
Gain × Hold		-0.0000***		
		(0.0000)		
Option × Hold		-0.0010***		
		(0.0000)		
Gain × Option × Hold		-0.0005***		
		(0.0000)		
Constant	0.1565***	0.1538***		
	(0.0027)	(0.0028)		
	Fixed Effects			
Hold	No	No	Yes	No
Investor × Hold	No	No	No	Yes
Observations	16 275 426	16 275 426	16 275 426	16 275 426
Adjusted R^2	0.0541	0.0579	0.1138	0.1863

Table A4: Trading Experience and the Disposition Effect.
Reported are the results from the regression specification in Equation 2 augmented with various controls for trading experience. The dependent variable *Sale* is a dummy variable that equals one if investor i sold asset j on day t. *Gain* is a dummy variable that equals one if the return since purchase on the asset is positive. *Option* is a dummy variable that equals one if the asset is an option. *Experience* is the years of trading experience, including both stocks and options. Standard errors clustered by investor and day are in parentheses. The data set contains the stock and option trades of all retail investors in Finland who traded at least one option during the sample period. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale			
	(1)	(2)	(3)	(4)
Gain	0.0435***	0.0739***	0.0428***	0.0518***
	(0.0017)	(0.0031)	(0.0017)	(0.0015)
Option	0.1118***	0.1287***	0.1109***	0.0856***
	(0.0051)	(0.0092)	(0.0051)	(0.0042)
Gain × Option	0.2937***	0.2923***	0.2943***	0.2655***
	(0.0053)	(0.0090)	(0.0053)	(0.0047)
Experience	-0.0034***	-0.0020***		
	(0.0003)	(0.0003)		
Gain × Experience		-0.0026***		
		(0.0002)		
Option × Experience		-0.0015*		
		(0.0008)		
Gain × Option × Experience		-0.0003		
		(0.0009)		
Constant	0.1633***	0.1475***		
	(0.0037)	(0.0035)		
	Fixed Effects			
Experience	No	No	Yes	No
Investor × Experience	No	No	No	Yes
Observations	16 275 426	16 275 426	16 275 426	16 275 426
Adjusted R^2	0.0427	0.0432	0.0454	0.1809

Table A5: Trading Activity and the Disposition Effect.
Reported are the results from the regression specification in Equation 2 augmented with various controls for trading activity. The dependent variable *Sale* is a dummy variable that equals one if investor *i* sold asset *j* on day *t*. *Gain* is a dummy variable that equals one if the return since purchase on the asset is positive. *Option* is a dummy variable that equals one if the asset is an option. *Trades* is the number of previous stock and option trades made by an investor. Standard errors clustered by investor and day are in parentheses. The data set contains the stock and option trades of all retail investors in Finland who traded at least one option during the sample period. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale			
	(1)	(2)	(3)	(4)
Gain	0.0415***	0.0447***	0.0406***	0.0570***
	(0.0018)	(0.0018)	(0.0017)	(0.0017)
Option	0.1159***	0.1204***	0.1200***	0.0894***
	(0.0051)	(0.0052)	(0.0049)	(0.0044)
Gain × Option	0.2948***	0.2893***	0.2941***	0.3054***
	(0.0053)	(0.0070)	(0.0053)	(0.0056)
Trades	-0.0000*	-0.0000		
	(0.0000)	(0.0000)		
Gain × Trades		-0.0000**		
		(0.0000)		
Option × Trades		-0.0000		
		(0.0000)		
Gain × Option × Trades		0.0000		
		(0.0000)		
Constant	0.1287***	0.1270***		
	(0.0023)	(0.0023)		
	Fixed Effects			
Trades	No	No	Yes	No
Investor × Trades	No	No	No	Yes
Observations	16 275 426	16 275 426	16 275 426	16 275 426
Adjusted R^2	0.0402	0.0403	0.0512	0.1766

Table A6: Robustness of the Disposition Effect.
Reported are the results from the regression specification in Equation 2 augmented with various controls. The dependent variable *Sale* is a dummy variable that equals one if investor *i* sold asset *j* on day *t*. *Gain* is a dummy variable that equals one if the return since purchase on the asset is positive. *Option* is a dummy variable that equals one if the asset is an option. *Age* is the investor's age. *Female* is a dummy variable that equals one if the investor is female. *Best* (*Worst*) is a dummy variable that equals one if the asset has the highest (lowest) return since purchase in the investor's portfolio. *December* is a dummy variable that equals one in December. *Location* is the investor's postal code. Standard errors clustered by investor and day are in parentheses. The data set contains the stock and option trades of all retail investors in Finland who traded at least one option during the sample period. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options. To ensure that *Best* and *Worst* are uniquely determined, Columns (2) and (4) exclude all days during which an investor held only one asset. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale			
	(1)	(2)	(3)	(4)
Gain	0.0443***	0.0255***	0.0418***	0.0277***
	(0.0015)	(0.0015)	(0.0018)	(0.0012)
Option	0.1004***	0.0735***	0.1169***	0.0676***
	(0.0043)	(0.0039)	(0.0053)	(0.0036)
Gain × Option	0.2892***	0.2635***	0.2948***	0.2633***
	(0.0051)	(0.0050)	(0.0054)	(0.0049)
Age	-0.0018***			-0.0012***
	(0.0001)			(0.0001)
Female	0.0061			0.0028
	(0.0067)			(0.0049)
Best		0.1805***		0.1594***
		(0.0028)		(0.0024)
Worst		0.0868***		0.0676***
		(0.0023)		(0.0019)
December			0.0009	-0.0002
			(0.0026)	(0.0019)
Constant		0.0953***	0.1245***	
		(0.0023)	(0.0028)	
	Fixed Effects			
Location	Yes	No	No	Yes
Observations	16 269 969	16 052 844	16 275 426	16 047 679
Adjusted R^2	0.0684	0.0619	0.0398	0.0765

Table A7: Robustness of the Disposition Effect.

Reported are the results from the regression specification in Equation 2 augmented with various controls. The dependent variable *Sale* is a dummy variable that equals one if investor i sold asset j on day t. *Gain* is a dummy variable that equals one if the return since purchase on the asset is positive. *Option* is a dummy variable that equals one if the asset is an option. *Size* is the natural logarithm of the euro value of the position. N is the number of assets in the portfolio. *Value* is the natural logarithm of the euro value of the portfolio. Ret^{-} (Ret^{+}) is the return since purchase on the asset if the return is negative (positive), and zero otherwise. Standard errors clustered by investor and day are in parentheses. The data set contains the stock and option trades of all retail investors in Finland who traded at least one option during the sample period. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale			
	(1)	(2)	(3)	(4)
Gain	0.0373***	0.0488***	0.0027	0.0182***
	(0.0019)	(0.0015)	(0.0016)	(0.0014)
Option	0.1580***	0.0467***	0.1252***	0.0947***
	(0.0055)	(0.0044)	(0.0052)	(0.0045)
Gain × Option	0.2875***	0.2827***	0.2880***	0.2657***
	(0.0054)	(0.0052)	(0.0053)	(0.0052)
Size	0.0157***			0.0260***
	(0.0008)			(0.0006)
N		-0.0027***		-0.0017***
		(0.0006)		(0.0005)
Value		-0.0220***		-0.0367***
		(0.0013)		(0.0012)
Ret^{-}			0.1185***	0.0722***
			(0.0030)	(0.0028)
Ret^{+}			-0.0000	-0.0000
			(0.0000)	(0.0000)
Constant	-0.0168**	0.4653***	0.1623***	0.4271***
	(0.0070)	(0.0114)	(0.0032)	(0.0106)
Observations	16 274 903	16 275 426	16 209 749	16 209 593
Adjusted R^2	0.0492	0.0872	0.0439	0.1090

Table A8: The Disposition Effect in Subsamples.
Reported are the results from the regression specification in Equation 2 estimated for subsamples formed on holding period, gender, and age. The dependent variable *Sale* is a dummy variable that equals one if investor *i* sold asset *j* on day *t*. *Gain* is a dummy variable that equals one if the return since purchase on the asset is positive. *Option* is a dummy variable that equals one if the asset is an option. Standard errors clustered by investor and day are in parentheses. The data set contains the stock and option trades of all retail investors in Finland who traded at least one option during the sample period. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Holding Period

	Dependent Variable: Sale			
	0–4 weeks	1–3 months	3–12 months	Over a year
Gain	0.0229***	0.0451***	0.0414***	0.0286***
	(0.0026)	(0.0018)	(0.0017)	(0.0019)
Option	0.0338***	-0.0227***	-0.0156***	-0.0119**
	(0.0069)	(0.0034)	(0.0035)	(0.0051)
Gain × Option	0.3060***	0.1985***	0.1372***	0.1587***
	(0.0057)	(0.0065)	(0.0088)	(0.0154)
Constant	0.2968***	0.1471***	0.1049***	0.0681***
	(0.0047)	(0.0020)	(0.0017)	(0.0021)
Observations	3 508 254	2 273 136	3 777 366	6 716 670
Adjusted R^2	0.0438	0.0116	0.0057	0.0032

Panel B: Gender and Age

	Dependent Variable: Sale			
	Gender		Age	
	Female	Male	≤ 40	> 40
Gain	0.0552***	0.0407***	0.0524***	0.0374***
	(0.0063)	(0.0019)	(0.0025)	(0.0021)
Option	0.1388***	0.1153***	0.1277***	0.1053***
	(0.0157)	(0.0056)	(0.0066)	(0.0066)
Gain × Option	0.2985***	0.2948***	0.2868***	0.2959***
	(0.0177)	(0.0055)	(0.0062)	(0.0070)
Constant	0.1169***	0.1252***	0.1553***	0.1109***
	(0.0065)	(0.0030)	(0.0034)	(0.0032)
Observations	1 233 374	15 036 595	5 056 523	11 213 446
Adjusted R^2	0.0416	0.0397	0.0439	0.0363

Table A9: The Disposition Effect in Subsamples.
Reported are the results from the regression specification in Equation 2 estimated for subsamples formed on trading experience and trading activity. The dependent variable *Sale* is a dummy variable that equals one if investor i sold asset j on day t. *Gain* is a dummy variable that equals one if the return since purchase on the asset is positive. *Option* is a dummy variable that equals one if the asset is an option. Standard errors clustered by investor and day are in parentheses. The data set contains the stock and option trades of all retail investors in Finland who traded at least one option during the sample period. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Trading Experience

	Dependent Variable: Sale		
	0–1 years	2–5 years	> 5 years
Gain	0.0951***	0.0714***	0.0349***
	(0.0047)	(0.0031)	(0.0019)
Option	0.0612***	0.1086***	0.1188***
	(0.0097)	(0.0101)	(0.0059)
Gain × Option	0.2394***	0.2742***	0.3001***
	(0.0119)	(0.0091)	(0.0061)
Constant	0.2022***	0.1490***	0.1167***
	(0.0039)	(0.0029)	(0.0031)
Observations	679 377	2 258 227	13 337 822
Adjusted R^2	0.0364	0.0416	0.0395

Panel B: Trading Activity

	Dependent Variable: Sale		
	0–10 trades	11–100 trades	> 100 trades
Gain	0.1262***	0.0628***	0.0300***
	(0.0045)	(0.0017)	(0.0020)
Option	0.1660***	0.1120***	0.1199***
	(0.0099)	(0.0040)	(0.0064)
Gain × Option	0.2244***	0.2794***	0.3026***
	(0.0106)	(0.0053)	(0.0065)
Constant	0.2347***	0.1451***	0.1150***
	(0.0060)	(0.0014)	(0.0034)
Observations	400 433	3 790 871	12 084 122
Adjusted R^2	0.0342	0.0360	0.0433

Table A10: The Disposition Effect in Option Subsamples.
Reported are the results from the regression specification in Equation 1 estimated for subsamples formed on option type, whether an option was purchased in the money, and time to expiration. The dependent variable *Sale* is a dummy variable that equals one if investor i sold option j on day t. *Gain* is a dummy variable that equals one if the return since purchase on the option is positive. Standard errors clustered by investor and day are in parentheses. The data set contains the option trades of all retail investors in Finland, in those options for which we can determine the moneyness. The sample period is Aug-2007 to Dec-2017. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Option Type and Moneyness at Purchase

	Dependent Variable: Sale			
	Option Type		Moneyness at Purchase	
	Call	Put	ITM	OTM
Gain	0.3315***	0.3517***	0.2851***	0.3067***
	(0.0085)	(0.0114)	(0.0098)	(0.0097)
Constant	0.1695***	0.3697***	0.2887***	0.1172***
	(0.0055)	(0.0131)	(0.0079)	(0.0044)
Observations	442 956	148 444	130 765	315 032
Adjusted R^2	0.1210	0.1163	0.0827	0.1149

Panel B: Time to Expiration

	Dependent Variable: Sale			
	0–5 days	1–4 weeks	1–3 months	Over 3 months
Gain	0.4737***	0.4256***	0.3749***	0.2589***
	(0.0145)	(0.0108)	(0.0081)	(0.0090)
Constant	0.2696***	0.2617***	0.2567***	0.1366***
	(0.0113)	(0.0092)	(0.0076)	(0.0057)
Observations	34 383	115 853	229 045	206 880
Adjusted R^2	0.1748	0.1630	0.1373	0.0864

Table A11: Investor Self-Selection and the Disposition Effect.
Reported are the results from the regression specification in Equation 2 estimated for subsamples formed on whether an investor primarily trades stocks or options. Investors with the highest proportion of their trades in options are in Quartile 1 and investors with the highest proportion of their trades in stocks are in Quartile 4. The dependent variable *Sale* is a dummy variable that equals one if investor i sold asset j on day t. *Gain* is a dummy variable that equals one if the return since purchase on the asset is positive. *Option* is a dummy variable that equals one if the asset is an option. Standard errors clustered by investor and day are in parentheses. The data set contains the stock and option trades of all retail investors in Finland who traded at least one option during the sample period. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale			
	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Gain	0.0518***	0.0490***	0.0450***	0.0364***
	(0.0041)	(0.0046)	(0.0040)	(0.0023)
Option	0.1602***	0.0849***	0.0251***	0.0069
	(0.0068)	(0.0076)	(0.0092)	(0.0068)
Gain × Option	0.3019***	0.2507***	0.2436***	0.2544***
	(0.0074)	(0.0079)	(0.0119)	(0.0137)
Constant	0.1087***	0.1355***	0.1397***	0.1192***
	(0.0054)	(0.0060)	(0.0050)	(0.0044)
Observations	2 493 745	2 756 249	3 019 340	8 006 092
Adjusted R^2	0.1427	0.0344	0.0106	0.0039

Table A12: The Strike Price Disposition Effect with All Days.
Reported are the results from the regression specification in Equation 3 estimated with all investor-asset-days. The dependent variable *Sale* is a dummy variable that equals one if investor *i* sold option *j* on day *t*. *Gain* is a dummy variable that equals one if the return since purchase on the option is positive. *ITM* is a dummy variable that equals one if the option is in the money. Standard errors clustered by investor and day are in parentheses. The data set contains the option trades of all retail investors in Finland, in those options for which we can determine the moneyness. The sample period is Aug-2007 to Dec-2017. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale					
	(1)	(2)	(3)	(4)	(5)	(6)
Gain	0.0623***		0.0476***	0.0583***	0.0626***	0.0625***
	(0.0026)		(0.0026)	(0.0030)	(0.0032)	(0.0031)
ITM		0.0579***	0.0357***	0.0508***	0.0284***	0.0314***
		(0.0024)	(0.0024)	(0.0021)	(0.0018)	(0.0018)
Gain $\times$ ITM				-0.0331***	-0.0100***	-0.0079***
				(0.0031)	(0.0031)	(0.0030)
Constant	0.0166***	0.0197***	0.0131***	0.0115***		
	(0.0007)	(0.0009)	(0.0007)	(0.0006)		
	Fixed Effects					
Investor	No	No	No	No	Yes	Yes
Day	No	No	No	No	No	Yes
Observations	3 768 163	3 768 163	3 768 163	3 768 163	3 768 163	3 768 163
Adjusted R^2	0.0229	0.0175	0.0283	0.0294	0.1220	0.1360

Table A13: Robustness of the Strike Price Disposition Effect.
Reported are the results from the regression specification in Equation 3 augmented with controls for investor demographics, the rank effect, trading experience, and trading activity. The dependent variable *Sale* is a dummy variable that equals one if investor i sold option j on day t. *Gain* is a dummy variable that equals one if the return since purchase on the option is positive. ITM is a dummy variable that equals one if the option is in the money. Standard errors clustered by investor and day are in parentheses. The data set contains the option trades of all retail investors in Finland, in those options for which we can determine the moneyness. The sample period is Aug-2007 to Dec-2017. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale			
	(1)	(2)	(3)	(4)
Gain	0.3187***	0.2461***	0.3305***	0.2520***
	(0.0100)	(0.0105)	(0.0103)	(0.0107)
ITM	0.2106***	0.1675***	0.2323***	0.1617***
	(0.0071)	(0.0076)	(0.0088)	(0.0068)
Gain × ITM	-0.1370***	-0.1154***	-0.1546***	-0.1026***
	(0.0103)	(0.0113)	(0.0110)	(0.0115)
Age	-0.0024***			-0.0011***
	(0.0003)			(0.0003)
Female	0.0398**			0.0210
	(0.0160)			(0.0128)
Best		0.1188***		0.1025***
		(0.0060)		(0.0047)
Worst		0.0360***		0.0245***
		(0.0050)		(0.0031)
Experience			-0.0053***	-0.0028***
			(0.0008)	(0.0006)
Trades			0.0000***	0.0000***
			(0.0000)	(0.0000)
Constant		0.0532***	0.1647***	
		(0.0052)	(0.0108)	
	Fixed Effects			
Location	Yes	No	No	Yes
Observations	445 775	342 561	445 797	342 553
Adjusted R^2	0.2104	0.1392	0.1554	0.1802

Table A14: Robustness of the Strike Price Disposition Effect.
Reported are the results from the regression specification in Equation 3 augmented with controls for option type, moneyness at purchase, time to expiration, holding period, position size, and portfolio characteristics. The dependent variable *Sale* is a dummy variable that equals one if investor *i* sold option *j* on day *t*. *Gain* is a dummy variable that equals one if the return since purchase on the option is positive. *ITM* is a dummy variable that equals one if the option is in the money. Standard errors clustered by investor and day are in parentheses. The data set contains the option trades of all retail investors in Finland, in those options for which we can determine the moneyness. The sample period is Aug-2007 to Dec-2017. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale			
	(1)	(2)	(3)	(4)
Gain	0.3326***	0.3297***	0.2962***	0.2961***
	(0.0101)	(0.0098)	(0.0093)	(0.0092)
ITM	0.1293***	0.1840***	0.1876***	0.0863***
	(0.0084)	(0.0084)	(0.0083)	(0.0076)
Gain × ITM	-0.1347***	-0.1336***	-0.1260***	-0.0921***
	(0.0109)	(0.0103)	(0.0099)	(0.0096)
Call	-0.1358***			-0.0976***
	(0.0123)			(0.0099)
Start ITM	0.0967***			0.0429***
	(0.0070)			(0.0055)
Expiry		-0.0004***		-0.0004***
		(0.0000)		(0.0000)
Hold		-0.0005***		-0.0004***
		(0.0000)		(0.0000)
Size			0.0502***	0.0573***
			(0.0025)	(0.0026)
N			-0.0116***	-0.0124***
			(0.0015)	(0.0014)
Value			-0.0444***	-0.0398***
			(0.0028)	(0.0030)
Constant	0.2298***	0.1929***	0.2035***	0.2846***
	(0.0123)	(0.0062)	(0.0177)	(0.0199)
Observations	445 797	441 930	445 759	441 892
Adjusted R^2	0.1661	0.1801	0.1921	0.2357

Table A15: The Strike Price Disposition Effect in Subsamples.
Reported are the results from the regression specification in Equation 3 estimated for subsamples formed on option type, whether an option was purchased in the money, and time to expiration. The dependent variable *Sale* is a dummy variable that equals one if investor *i* sold option *j* on day *t*. *Gain* is a dummy variable that equals one if the return since purchase on the option is positive. *ITM* is a dummy variable that equals one if the option is in the money. Standard errors clustered by investor and day are in parentheses. The data set contains the option trades of all retail investors in Finland, in those options for which we can determine the moneyness. The sample period is Aug-2007 to Dec-2017. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Option Type and Moneyness at Purchase

	Dependent Variable: Sale			
	Option Type		Moneyness at Purchase	
	Call	Put	ITM	OTM
Gain	0.3075***	0.4838***	0.4826***	0.3225***
	(0.0109)	(0.0146)	(0.0153)	(0.0103)
ITM	0.2223***	0.1928***	0.1880***	0.1854***
	(0.0091)	(0.0163)	(0.0096)	(0.0140)
Gain × ITM	-0.1593***	-0.2012***	-0.2657***	-0.2397***
	(0.0115)	(0.0178)	(0.0163)	(0.0169)
Constant	0.1073***	0.2096***	0.1645***	0.1143***
	(0.0042)	(0.0114)	(0.0071)	(0.0044)
Observations	379 858	65 939	130 765	315 032
Adjusted R^2	0.1375	0.1843	0.1013	0.1182

Panel B: Time to Expiration

	Dependent Variable: Sale			
	0–4 weeks	1–3 months	3–12 months	Over a year
Gain	0.6321***	0.5411***	0.4259***	0.2305***
	(0.0261)	(0.0134)	(0.0112)	(0.0098)
ITM	0.4115***	0.2198***	0.2115***	0.1684***
	(0.0165)	(0.0117)	(0.0104)	(0.0103)
Gain × ITM	-0.4618***	-0.3188***	-0.2097***	-0.1131***
	(0.0308)	(0.0171)	(0.0133)	(0.0131)
Constant	0.1350***	0.1596***	0.1354***	0.0872***
	(0.0088)	(0.0076)	(0.0052)	(0.0043)
Observations	24 911	79 870	157 679	179 470
Adjusted R^2	0.2978	0.2002	0.1738	0.0955

Table A16: The Peak Price Disposition Effect with All Days.
Reported are the results from the regression specifications in Equations 4 and 5 estimated with all investor-asset-days. The dependent variable *Sale* is a dummy variable that equals one if investor i sold asset j on day t. *Gain* is a dummy variable that equals one if the return since purchase on the asset is positive. *Peak* is a dummy variable that equals one if the return since peak on the asset is positive. *Option* is a dummy variable that equals one if the asset is an option. Standard errors clustered by investor and day are in parentheses. The data set contains the stock and option trades of all retail investors in Finland who traded at least one option during the sample period. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale				
	(1)	(2)	(3)	(4)	(5)
Gain	0.0012***	0.0169***	0.0012***	0.0018***	0.0015***
	(0.0000)	(0.0006)	(0.0000)	(0.0000)	(0.0000)
Peak	0.0094***	0.0491***	0.0094***	0.0080***	0.0081***
	(0.0002)	(0.0020)	(0.0002)	(0.0002)	(0.0002)
Option			0.0059***	0.0030***	0.0025***
			(0.0003)	(0.0003)	(0.0003)
Gain × Option			0.0157***	0.0163***	0.0163***
			(0.0006)	(0.0006)	(0.0006)
Peak × Option			0.0397***	0.0400***	0.0395***
			(0.0020)	(0.0020)	(0.0019)
Constant	0.0045***	0.0104***	0.0045***		
	(0.0000)	(0.0003)	(0.0000)		
	Fixed Effects				
Investor	No	No	No	Yes	Yes
Day	No	No	No	No	Yes
Observations	211 832 635	4 224 964	216 057 599	216 057 599	216 057 599
Adjusted R^2	0.0012	0.0155	0.0025	0.0135	0.0168
Sample:	Stocks	Options	All	All	All

Table A17: Robustness of the Peak Price Disposition Effect.
Reported are the results from the regression specification in Equation 5 augmented with controls for investor demographics, the rank effect, trading experience, and trading activity. Standard errors clustered by investor and day are in parentheses. The data set contains the stock and option trades of all retail investors in Finland who traded at least one option during the sample period. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale			
	(1)	(2)	(3)	(5)
Gain	0.0200***	0.0113***	0.0187***	0.0121***
	(0.0011)	(0.0011)	(0.0013)	(0.0009)
Peak	0.1005***	0.0962***	0.1052***	0.0911***
	(0.0024)	(0.0022)	(0.0024)	(0.0022)
Option	0.0265***	0.0179***	0.0355***	0.0114***
	(0.0031)	(0.0029)	(0.0033)	(0.0028)
Gain × Option	0.1280***	0.1149***	0.1279***	0.1156***
	(0.0048)	(0.0047)	(0.0051)	(0.0045)
Peak × Option	0.1086***	0.0932***	0.1076***	0.0971***
	(0.0069)	(0.0068)	(0.0070)	(0.0068)
Age	-0.0014***			-0.0009***
	(0.0001)			(0.0000)
Female	0.0063			0.0028
	(0.0057)			(0.0043)
Best		0.1348***		0.1193***
		(0.0024)		(0.0020)
Worst		0.0726***		0.0579***
		(0.0019)		(0.0015)
Experience			-0.0019***	0.0000
			(0.0002)	(0.0001)
Trades			-0.0000***	-0.0000**
			(0.0000)	(0.0000)
Constant		0.0755***	0.1237***	
		(0.0018)	(0.0028)	
	Fixed Effects			
Location	Yes	No	No	Yes
Observations	10 932 361	10 862 431	10 936 115	10 858 759
Adjusted R^2	0.0375	0.0364	0.0222	0.0467

Table A18: Robustness of the Peak Price Disposition Effect.
Reported are the results from the regression specification in Equation 5 augmented with controls for holding period, position size, and portfolio characteristics. Standard errors clustered by investor and day are in parentheses. The data set contains the stock and option trades of all retail investors in Finland who traded at least one option during the sample period. The sample period is Jan-1995 to Dec-2017 for stocks and Dec-2000 to Dec-2017 for options. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Sale			
	(1)	(2)	(3)	(5)
Gain	0.0179***	0.0139***	0.0247***	0.0186***
	(0.0013)	(0.0014)	(0.0012)	(0.0011)
Peak	0.0976***	0.1081***	0.0950***	0.0879***
	(0.0023)	(0.0024)	(0.0023)	(0.0022)
Option	0.0235***	0.0709***	-0.0021	0.0295***
	(0.0034)	(0.0039)	(0.0031)	(0.0032)
Gain × Option	0.1278***	0.1188***	0.1286***	0.1163***
	(0.0051)	(0.0051)	(0.0049)	(0.0048)
Peak × Option	0.1160***	0.1074***	0.1087***	0.1129***
	(0.0070)	(0.0071)	(0.0067)	(0.0066)
Hold	-0.0000***			-0.0000***
	(0.0000)			(0.0000)
Size		0.0110***		0.0195***
		(0.0007)		(0.0005)
N			-0.0020***	-0.0011***
			(0.0004)	(0.0004)
Value			-0.0159***	-0.0273***
			(0.0009)	(0.0009)
Constant	0.1153***	-0.0020	0.3456***	0.3157***
	(0.0019)	(0.0061)	(0.0083)	(0.0077)
Observations	10 936 115	10 936 085	10 936 115	10 936 085
Adjusted R^2	0.0239	0.0252	0.0516	0.0669

Table A19: The Peak Price Disposition Effect in Option Subsamples.
Reported are the results from the regression specification in Equation 4 estimated for subsamples formed on option type, whether an option was purchased in the money, and time to expiration. The dependent variable *Sale* is a dummy variable that equals one if investor i sold option j on day t. *Gain* is a dummy variable that equals one if the return since purchase on the option is positive. *Peak* is a dummy variable that equals one if the return since peak on the option is positive. Standard errors clustered by investor and day are in parentheses. The data set contains the option trades of all retail investors in Finland, in those options for which we can determine the moneyness. The sample period is Aug-2007 to Dec-2017. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Option Type and Moneyness at Purchase

	Dependent Variable: Sale			
	Option Type		Moneyness at Purchase	
	Call	Put	ITM	OTM
Gain	0.1455***	0.1832***	0.0994***	0.1433***
	(0.0070)	(0.0192)	(0.0108)	(0.0074)
Peak	0.1840***	0.2218***	0.2030***	0.1818***
	(0.0100)	(0.0143)	(0.0134)	(0.0110)
Constant	0.0944***	0.2163***	0.1877***	0.0774***
	(0.0035)	(0.0100)	(0.0073)	(0.0032)
Observations	157 387	25 050	33 234	127 480
Adjusted R^2	0.0852	0.0924	0.0599	0.0856

Panel B: Time to Expiration

	Dependent Variable: Sale			
	0–4 weeks	1–3 months	3–12 months	Over a year
Gain	0.3405***	0.2501***	0.1827***	0.1078***
	(0.0209)	(0.0146)	(0.0093)	(0.0072)
Peak	0.1645***	0.2106***	0.1918***	0.1604***
	(0.0260)	(0.0173)	(0.0113)	(0.0130)
Constant	0.2144***	0.1553***	0.1306***	0.0734***
	(0.0108)	(0.0067)	(0.0046)	(0.0036)
Observations	9 323	27 079	52 324	91 579
Adjusted R^2	0.1576	0.1300	0.1041	0.0638