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Abstract

Using close to 800,000 (2,000,000) transactions by 66,000 (303,000) households in the United States (in Finland), we show that individual investors with longer holding periods choose to hold less liquid stocks in their portfolios, consistent with Amihud and Mendelson's (1986) theory of liquidity clienteles. The relationship between holding periods and transaction costs is stronger amongst more financially sophisticated households. Households whose holding periods are positively related to transaction costs also earn higher gross returns on their investments before accounting for transaction costs, suggesting that attention to non-salient transaction costs is an indication of investing ability. We confirm our findings by analyzing changes to investors' holding periods around exogenous shocks to stock liquidity.

JEL Classifications: G11, G12, G14, G32, G33, M4, L14, D82

Keywords: individual investors' liquidity decisions; individual investors' rationality; liquidity decisions and trading ability; attention to non-salient transaction costs and rationality

1. Introduction

In a theoretical model, Amihud and Mendelson (1986) show that transaction costs cause a clientele effect in equity markets. Investors with longer holding periods choose to hold stocks with higher transaction costs in equilibrium. Amihud and Mendelson (1986) emphasize that this relationship between transaction costs and holding periods of investors represents a rational response by an efficient market. Counter to Amihud and Mendelson's (1986) conjecture that investors understand and incorporate the impact of transaction costs, recent findings in the behavioral finance literature suggest that individual investors have bounded rationality and tend to ignore non-salient costs when making investment decisions. In this paper, we use the trading records of households in the US and in Finland, to investigate whether individual investors are cognizant of transaction costs when making trading decisions and hold illiquid securities longer as stipulated by Amihud and Mendelson (1986), or whether they ignore transaction costs consistent with the findings in the behavioral finance literature.

There is evidence that investors ignore non-salient costs as they relate to mutual fund fees. Barber, Odean and Zheng (2005) show that investors pay attention only to the salient costs of mutual funds, but ignore hidden operating costs. Consistent with these findings Gil-Bazo and Verdu (2008, 2009) document that there is a negative relation between mutual funds' before-fee performance and the fees they charge to investors. Surveys also suggest that retail investors do not understand all costs associated with investing in mutual funds (NASD Investor Literacy Survey 2003; Alexander, Jones, and Nigro, 1998).[1]

[1] For example, only 21% of the retail investors that responded to NASD Investor Literacy Survey (2003) knew the meaning of a "no load" mutual fund.

There is also evidence that investors do not pay attention to non-salient costs in other domains. Hossain and Morgan (2006), using a field experiment, show that buyers in Ebay auctions ignore shipping costs that are not as salient as the price of the item being auctioned. Chetty, Looney and Kroft (2009), document that consumers underreact to taxes that are not salient. Similarly Finkelstein (2009) finds that drivers are less aware of tolls paid electronically and estimates that tolls are 20 to 40 percent higher than they would have been without electronic toll collection. These findings suggest that individual investors may not fully understand and incorporate non-salient transaction costs such as bid-ask spreads and price impact when trading.

Consistent with this notion of investors not paying attention to non-salient costs, a number of studies have found that individual investors tend to overtrade and lose substantial amounts to transaction costs without any gain in performance. Barber and Odean (2000), for instance, show that while there is little difference in the gross performance of individual investors who trade frequently and those who trade infrequently, the net returns of infrequent traders are higher by about 7% per year, after accounting for transaction costs. Barber and Odean (2000) attribute their findings to individual investors' overconfidence.[2]

However, losses incurred by individual investors after accounting for transaction costs do not necessarily imply that these investors are not paying attention to transaction costs. First, investors can trade for a variety of reasons other than information or behavioral biases. Investors may trade when they experience income shocks (Lynch and Tan 2011) or when they experience

[2] Similarly, Barber et al. (2009), using a complete transaction history of all investors in Taiwan, find that individual investor losses due to transaction costs equal 2.2 % of GDP, without any gain in performance. French (2008) finds that, each year, investors spend about 0.67% of the aggregate value of the market on transaction costs, again without any gain in performance. He estimates the capitalized cost of active investing to be at least 10% of the total market capitalization.

exogenous liquidity shocks (Huang 2003). Second, even if most of the overtrading by individual investors could be attributed to overconfidence, there is no reason for such investors to not be paying attention to transaction costs. In this paper, we directly test whether investors pay attention to transaction costs by examining the relationship between transaction costs and the holding periods of individual investors. Rather than focusing on trading performance alone, we analyze if individual investors understand the trade-offs between selling an illiquid asset more quickly than a liquid one. This amounts to testing the first proposition in Amihud and Mendelson (1986) that investors will hold stocks with higher transaction costs longer compared to stocks with lower transaction costs.

In order to test Amihud and Mendelson's (1986) first proposition, we model investors' sell versus hold decisions with survival analyses using 799,469 transactions made by 66,000 US households. In particular, we model investors' holding periods using Cox hazard regressions. Our findings are three-fold. First, we find that transaction costs are an important determinant of investors' holding periods after controlling for various household and stock characteristics, confirming Amihud and Mendelson's (1986) predictions. Specifically, we find that a stock in the highest transaction cost decile is 40% less likely to be sold compared to a more liquid stock with similar firm and investor characteristics conditional on the stock not having been sold up to that point in time.

We confirm our results by analyzing transactions data from Finland, which serves as an "out-of-sample" verification of the US findings. Almost identical to the US results, we find that a stock in the highest transaction cost decile in Finland is 40% less likely to be sold compared to a stock that has lower transaction costs with similar firm and investor characteristics. Since the dataset from Finland includes the complete transactions of all Finnish households between 1995 and 2003, the results suggest that our findings can be generalized to the full cross-section of households. Our results are robust to various controls, different measures of transaction costs and to controlling for firm and household specific effects.

Second, we find that households differ in how much attention they pay to the transaction costs of the securities they trade. Specifically, we find that investors who are more financially sophisticated pay more attention to transaction costs. We follow the extant literature and assume that financial sophistication is correlated with education, occupation and resources available to an investor such as income and wealth. We also use information contained in investors' trades to identify sophisticated investors. In particular, we classify households who trade options, foreign securities and hold short positions as financially more sophisticated. A number of papers have shown significant variation in trading ability and performance in the cross-section of individual traders (see for instance, Grinblatt and Keloharju 2001 and Coval, Hirshleifer, and Shumway 2005). Our findings suggest that investor sophistication plays a role in how much attention investors pay to transaction costs as well.

Third, we find that investors who pay closer attention to transaction costs make better investment decisions overall. In particular, we find that households whose holding periods are positively correlated with transaction costs have higher *gross* returns (before accounting for transaction costs) compared to households whose holding periods are negatively correlated with transaction costs. It would not be surprising to find that investors who do not pay attention to transaction costs to have lower *net* returns (after accounting for transaction costs). The fact that we find these investors to have lower *gross* returns suggests that paying closer attention to transaction costs is a sign of investor ability. As expected, we find that investors who pay attention to transaction costs realize lower spreads in trades.[3]

There is likely to be endogeneity in the relationship between holding periods and measures of transaction costs used in this paper. As trading interest in a stock increases the costs associated with transacting the stock decreases. We should note however the baseline or the average costs of transacting a given stock is likely to change slowly over time. There are also likely other exogenous factors that determine the liquidity level of a given stock, such as the size of the company in terms of revenues or assets. For instance, the liquidity level of a penny stock, would increase with increased trading interest, but it's not likely to achieve the same level of liquidity of a large cap stock purely based on investor interest or attention. Nonetheless, in order to address potential endogeneity concerns, we study investor behavior around periods of quasi-exogenous liquidity shocks.

Specifically, we examine how holding periods change around stock split events. A long line of literature documents a significant reduction in transaction costs and increase in liquidity subsequent to stock splits.[4] It has also been documented that post-split performance of splitting firms is statistically indistinguishable from non-splitting firms with similar characteristics when

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[3] Spreads are computed as in Barber and Odean (2000) as the percentage difference between the transaction price and the CRSP closing price.

[4] The prior literature suggests that liquidity increases after stock splits. For example Schultz (2000) shows that the number of trades, especially small trades, increases significantly subsequent to stock splits. Desai, Nimalendran, and Venkataraman (1998) find that both informed trades and noise trades increase after stock splits. Kryzanowski and Zhang (1996) show that absolute trading volumes of Canadian stocks increase subsequent to stock splits. Conroy, Harris, and Benet (1990) also show a significant reduction in the absolute bid-ask spread following stock splits.

appropriate firm controls are used (Byun and Rozeff 2003).[5] In other words, splits do not appear to provide a signal to the market about the future prospects of the splitting firm, as some theoretical papers suggest. Taken together, these two findings would imply that the transaction costs channel is the main channel through which a stock split could affect the average holding period of households.

Consistent with the prior literature, we first verify that transaction costs decrease (stock liquidity increases) subsequent to stock splits in our sample time-period. Then we show that investors' average holding period declines in response to the increase in liquidity following stock splits. Our analysis suggests that the holding period for a stock decreases by about 37 trading days, or nearly two trading months after a stock-split. This finding is economically significant as the mean holding period, defined as the number of trading days from the first purchase of a stock to the first sale, is 185 days.

The remainder of this paper is organized as follows. Section 2 presents the hypotheses tested in the paper. Section 3 describes the individual transaction data sets and the construction of the main liquidity variables used in this study. Section 4 reports our main findings using US trades that show the relationship between transaction costs and holding periods. Section 5 studies the implications of liquidity decisions of individual investors on their investment performance, and empirically documents that households who pay closer attention to transaction costs earn higher raw and characteristics-adjusted excess returns. Section 6 provides robustness tests to address concerns that holding periods are determined endogenously and also uses individual transactions from Finland as an out-of-sample test to verify US results. Section 7 concludes.

[5] In particular, Byun and Rozeff (2003) document that post-split equity return performance of splitting firms is statistically indistinguishable from non-splitting firms with similar characteristics.

2. Hypotheses

Amihud and Mendelson (1986) develop a model where risk neutral investors with different exogenous holding periods and limited capital trade securities subject to fixed transaction costs. They show that transaction costs result in a clientele effect, with investors who have longer holding periods selecting to hold illiquid stocks in equilibrium.

Amihud and Mendelson's (1986) model assumes that the holding periods of investors are exogenously determined. This static model has been extended to incorporate dynamic decisions of investors to endogenize the holding period (Constantinides 1986, Vayanos 1998, Vayanos and Vila 1999, Heaton and Lucas 1996, Huang 2003, Lynch and Tan 2011, Lo, Mamaysky and Wang 2004). These dynamic models differ in their assessment about the magnitude of transaction costs on assets' prices, but they are similar to Amihud and Mendelson (1986) in that they also expect investors' holding periods to positively correlate with transaction costs. Furthermore, while Amihud and Mendelson (1986) model each investor with a fixed holding period, models with endogenous trading horizons allow for investors to have different trading horizons for each asset. To accommodate the possibility that an investor's holding period could be different for each stock, we conduct our analyses at the transaction level. We empirically test whether households' holding periods are positively related to transactions. Our first hypothesis is:

H1: Holding periods of households are positively related to measures of transaction costs, after controlling for investor and stock characteristics.

Previous studies have shown that, on average, households' stock investments perform poorly. Odean (1999), for instance, reports that individual investors' purchases under-perform their sales by a significant margin. However, other studies have concluded that there exists a subset of retail investors who display greater financial sophistication and market understanding than the average retail investor. For instance, Coval, Hirshleifer, and Shumway (2005) document strong persistence in the performance of individual investors' trades, suggesting that some skillful individual investors might be able to earn positive abnormal profits. Feng and Seasholes (2005) find that investor sophistication reduces a well-known behavioral bias, the disposition effect. Ivkovic, Sialm and Weisbenner (2008) propose and empirically document that individual investors who hold more concentrated portfolios are financially more sophisticated as they possess informational advantages that allow them to outperform investors with diversified portfolios. Li, Geng, Subrahmanyam, and Yu (2016) show that wealthy investors profitably trade around companies' announcements of high stock dividends, particularly those registered in their localities.

Given that previous studies have documented heterogeneity in the performance and investment decisions of individual investors, we expect to find similar cross-sectional differences in the correlation between holding periods and transaction costs across households. In particular, we expect such differences to occur due to differences in financial sophistication. We follow the extant literature and assume that financial sophistication is correlated with education, occupation and resources available to an investor such as income and wealth. We also use information contained in investors' trades to identify sophisticated investors. The first part of our second hypothesis is:

H2.a: The correlation between holding periods and transactions costs is higher for financially more sophisticated investors.

The correlation between holding periods and transaction costs is likely to impact portfolio performance on both a *gross* (before accounting for transaction costs) and a *net* (after accounting for transaction costs) basis. Households who do not pay attention to transaction costs when they trade are likely to have lower *net* returns due to transaction costs. As mentioned earlier, previous studies have shown investor sophistication to be correlated with higher portfolio performance and lower levels of behavioral biases. We conjecture that paying closer attention to the impact of transaction costs could be a sign of financial sophistication and market knowledge leading to better overall portfolio performance. We predict that households whose holding periods are positively correlated with transaction costs should have higher trading ability and earn higher *gross* returns in addition to earning higher *net* returns compared to households whose holding periods are negatively correlated with transaction costs. Hence, the second part of our second hypothesis is:

> **H2.b**: Households who pay closer attention to transaction costs earn higher gross returns before accounting for transaction costs.

In testing the above hypothesis, we consider both raw portfolio returns as well as characteristics-adjusted returns computed as in Daniel et al (1997).

3. Data

3.1 Household Transactions and Demographics

This study uses two distinct datasets in order to explore the trading behaviors of households. The first dataset contains transactions for a subset of individual investors in the United States, while the second dataset contains transactions of all investors in Finland. The individual trade data for the United States comes from a major U.S. discount brokerage house. It records the daily trading of 78,000 households from January 1991 to December 1996 and is the same dataset used in Barber and Odean (2000). We focus only on the common stock transactions of households in this study, which account for nearly two-thirds of the total value of household investments. We exclude from the current analysis investments in mutual funds (both open-end and closed-end), American Depositary Receipts (ADRs), warrants, and options. About 66,000 out of the 78,000 households trade common stocks, making about eight hundred thousand transactions over the sample period. The transaction record includes the number of shares traded, the price traded, each household's month-end positions, and value of their position at market close. The dataset also includes demographic information for a smaller sub-sample of households, such as income, age, gender, occupation and marital status.[6] A comparison of this dataset with Survey of Consumer Finances, IRS and TAQ data has shown it to be representative of U.S. individual investors (Ivkovic, Sialm, and Weisbenner 2008, Ivkovic, Poterba, and Weisbenner 2005, and Barber, Odean, and Zhu 2006).

To address concerns that our findings are specific to the data we employ, we repeat the analyses using a similar dataset from Finland which reports the complete trading records of all market participants.[7] This dataset comes from the central register in the Finnish Central Securities Depository (FCSD). The register officially records all the trades of all Finnish

[6] For a more detailed description of this dataset please refer to Barber and Odean (2000, 2001)

[7] The analyses regarding Finland have been taken from Yıldızhan's unpublished project titled "Individual Trading Decisions in Financial Markets." The said project utilizes data from the Helsinki Stock Exchange (HEX). We thank Jussi Keppo for providing us with this unique dataset.

investors - both individual and institutional- on a daily basis from January 1995 to December 2003. For purposes of this current study, we only utilize the trades of individual investors in Finland. Similar to the U.S. dataset, the Finnish dataset reports for each transaction, the number of shares traded and the daily closing price. Furthermore, we observe the initial holdings for each account at the beginning of the dataset, allowing us to keep track of the holdings of households on a daily basis. The dataset also reports individuals' demographic information, such as age and gender. We do not have information about income, occupation, and marital status. A more detailed description of the Finnish dataset could be found in Grinblatt and Keloharju (2000, 2001).

3.2 Measures of Transaction Costs

Transactions costs are a multi-faceted concept, and are usually defined in terms of the costs and risks associated with transacting financial securities. These costs capture price impact, asymmetric information and inventory risk. In this study we use three different measures of transaction costs previously utilized in the literature. In particular, we use the adjusted Amihud ratio (*AdjIlliq*), Roll's measure (*Roll's C*), and zero return frequency (*Zerofreq*), which can be calculated using data that is available for both the United States and Finland.

The first measure is the Amihud illiquidity ratio from Amihud (2002), calculated as:

$$Illiq_{i,t} = \frac{1}{D_{i,t}} \sum_{d=1}^{D_{i,t}} \frac{|r_{i,d}|}{dvol_{i,d}} \tag{1}$$

$r_{i,d}$ is the daily stock return for firm i in day d. $dvol_{i,d}$ is the dollar volume in day d. $D_{i,t}$ is the number of trading days in month *t*. $Illiq_{i,t}$ is Amihud's illiquidity measure. *t*. The Amihud measure is similar to Kyle's lambda and captures the price impact of a trade. We adjust the Amihud measure as in Acharya and Pedersen (2005) to remove outliers and to make it stationary: $AdjIlliq_{i,t} = \min[0.25 + 30 \times Illiq_{i,t} \times M_{t-1}, 30]$. M_{t-1} is the ratio of value-weighted market portfolio at the end of the month *t-1* to that of the market portfolio in July of 1962. The higher the adjusted Amihud ratio, the more illiquid the stock is.

The second measure we use is the Bayesian version of Roll's (1984) transaction cost measure:

$$c_{i,t} = \begin{cases} \sqrt{-cov(r_{i,t}, r_{i,t-1})} & if cov(r_{i,t}, r_{i,t-1}) < 0; \\ 0 & otherwise. \end{cases} \quad (2)$$

It is based on the model $r_{i,t} = c_{i,t}\Delta q_{i,t} + \varepsilon_{i,t}$ where $q_{i,t}$ is a trade direction indicator, $c_{i,t}$ is the transaction cost measure, and $\varepsilon_{i,t}$ is an error term, all for stock *i* at time t. Roll's measure (Roll's C) is derived under the assumption that buyer- and seller-initiated trades are equally likely. The Bayesian estimation of this cost measure using the Gibbs sampler is described in detail in Hasbrouck (2009). The higher the Roll's C, the more illiquid the stock is.

The third liquidity measure captures the proportion of trading days with zero returns. The frequency of zero-return days as a liquidity proxy was introduced by Lesmond, Ogden, and Trzcinka (1999). We compute the proportion of days with zero returns for each stock within each year to estimate Zerofreq. The higher the Zerofreq, the more illiquid the stock is. To reduce potential endogeneity arising from contemporaneous measurement and to smooth out idiosyncratic changes, we use the twelve month moving average of each liquidity measure in our analyses.

Table 1 reports summary statistics for stock and investor characteristics for the US.[8] Only stocks that are traded by households in the dataset are considered. Summary statistics are calculated by pooling annual observations over the 1991-1996 time period. The results show that our major transaction costs measure – adjusted Amihud ratio (AdjIlliq) - is positively skewed with a mean of 3.30, but a much smaller median of 0.46. The distributions of other transaction costs measures are similarly positively skewed as Roll's C has a mean of 1.73 and a median of 1.06 and Zerofreq has a mean of 4.82% and a median of 2.70%. Size is also positively skewed, with the average market capitalization almost 8 times as large as the median firm size.

The mean (median) US individual investor's portfolio value is $80,342 ($22,952) for the transactions analyzed in this study. 10% of the primary US account holders for the transactions analyzed in this study are female. US individual investors utilize short-trades frequently as 38% of the accounts have held a short position at some time over the sample period analyzed. 14% of US individual investors have traded options at least once over the sample period and 22% of them have traded foreign securities. 66% of the US individual investors in our transactions dataset hold technical or managerial positions. The mean (median) US individual investor's annual income over the time period studied is $76,840 ($87,500). The mean (median) US individual investor's portfolio concentration is .52 (.48), which roughly corresponds to holding two stocks with equal dollar weights of 50%.

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[8] We report stock and investor characteristics for Finland in Table 7 and discuss the analyses for Finland in Section 6.

4. Transaction Costs and Holding Periods in the US

4.1 Holding periods and Transaction Costs

In this section, we provide empirical evidence in support of the first hypothesis (*H1*): *Holding periods are positively related to measures of transaction costs, after controlling for investor and stock characteristics.* We begin by computing a holding period for each transaction in the dataset.[9] The holding period is defined as the number of trading days from the first purchase of a stock to the first sale, following the approach of Seru, Shumway, and Stoffman (2010).[10] This generates 799,469 holding period observations, with a mean (median) of 185 (86) trading days for retail investors in the United States.

Figure 1 shows the median holding periods for transactions grouped by investors' age, account type, the amount of capital they have invested in the stock market, as well as transactions grouped by the underlying stocks' transaction costs.[11] The median holding period is longer for stocks held in retirement accounts. Investors who are older and who have less wealth invested in the market have longer holding periods. There is also a strong negative relationship between holding periods and liquidity of stocks traded by the investors in the dataset.

Next, we rank and assign the 799,469 holding period observations to ten groups based on the length of the respective holding periods. For the stocks in each group, we then calculate averages

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[9] We also estimate portfolio level holding periods and transaction costs for each investor in the dataset. Our analysis of investor portfolios yields results consistent with transaction-level analysis. As explained in the Introduction section, transaction-level analysis allows for the same investor to have different holding periods for different assets and as such is more in line with models that assume endogenous trading horizons.

[10] We obtain similar results by alternatively defining the holding period as the number of trading days from first purchase till the day when all positive positions are closed as in Feng and Seasholes (2005).

[11] In the figure, a stock is defined as Illiquid if it belongs to the highest transaction cost decile of stocks ranked according to the adjusted Amihud illiquidity ratio. Other category includes all other stocks not in the highest transaction cost decile.

for the three transaction costs measures of interest as well as price, and market capitalization. The transaction costs measures are calculated as of the purchase day, by averaging transaction costs measures over the previous 12 months. The results are reported in Table 2, where we find a strong positive univariate relationship between holding periods and the average transaction costs of the stocks in each holding period decile. The relationship is monotonic and does not appear to be a simple function of price or market capitalization. The adjusted Amihud illiquidity measure, for instance, increases monotonically from 0.92 for the shortest holding period decile to 1.83 for the longest holding period decile. The differences in the average liquidity of the stocks traded in the top and the bottom deciles of holding period are always significant regardless of the liquidity measure we utilize. Roll's C measure increases monotonically from 0.66 to 0.82, while the percentage of zero return days also increases monotonically from 2.52% to 3.83% from the shortest holding period decile to the longest holding period decile.

Figure 2 shows this relationship graphically. We plot Kaplan-Meier survival probabilities for stocks that are in the highest illiquidity decile using the adjusted Amihud illiquidity measure, and for all other stocks in the dataset. The x-axis shows the number of days that have passed since the purchase of a stock, and the two lines plot the probability of an investor holding a stock conditional upon no sale up to that point in time. The lighter gray line plots the survival probability for stocks in the most illiquid decile, while the black line is for the rest of the sample. The graph shows that stocks ranked in the highest illiquidity decile have significantly higher survival probabilities, which suggests that investors tend to hold the most illiquid stocks for longer periods of time before selling them. This analysis provides initial evidence that holding periods are strongly related to measures of transaction costs.

We next move on to perform more detailed analyses that controls for related stock and investor characteristics. In particular, we use a hazard model to analyze the relationship between holding periods and transaction costs.[12] This framework allows us to control for the confounding effects of stock and investor characteristics. With hazard models, an investor's trade decision regarding a specific asset can be explicitly modeled by considering the investor's sell versus hold decision each day. In this paper, we use a Cox proportional hazard model.[13] The hazard model takes the following form:

$$h(t) = h_0(t)exp(\beta'X + \theta'Z_t) \tag{3}$$

This proposed hazard model is a statistical framework that describes how long an investor in the dataset will hold a stock before selling it. The left hand side variable, $h(t)$, is the hazard rate, the probability of selling a stock on day t conditional upon holding that stock until that point in time. X is a vector of explanatory variables which are static and do not change over time, and Z_t are time-varying covariates which can take on different values at each point in time. $h_0(t)$ is called the baseline hazard rate and describes the average hazard rate when the independent covariates are equal to zero. Using the Cox (1972) estimator one can estimate coefficients on X and Z_t without specifying a baseline $h_0(t)$ hazard rate. Positions that are not closed by the end of the sample period are treated as censored observations within the hazard framework.

[12] The hazard model framework has been used in the past by Seru, Shumway and Stoffman (2010) as well as Feng and Seasholes (2005) to model holding periods of individual investors.

[13] Details about estimating the proportional hazard model can be found in Cox and Oakes (1984).

The covariates used in the main analyses include a set of variables related to the demographics of the investors, such as age, income, gender, marital status, employment status and occupation, as well as another set of variables related to the characteristics of the stocks they trade, such as liquidity, size, book-to-market ratio, and momentum. We control for size, book-to-market ratio, and momentum in the model to account for investors' preferences for certain stock characteristics that are known to be associated with expected returns. As there is likely to be seasonality in purchases and sales, year and calendar month dummies are also included in the hazard regressions.[14]

Following standard reporting conventions, we report hazard ratios instead of estimated coefficients from the hazard regression in Panel A of Table 3. The hazard ratio is similar to the odds ratio estimated from a binary choice model and is defined as the ratio of two hazard functions when one explanatory variable is changed by one unit holding everything else equal. In the current context, the hazard ratio reports the marginal effect of higher exposure to an explanatory variable on the probability of selling vs. holding the stock. A hazard ratio that is less than one would suggest that a higher exposure to the explanatory variable will reduce the probability of selling the stock versus holding it. In other words, a higher exposure to the explanatory variable would lead to a higher likelihood of holding on to the stock. Similarly, a hazard ratio larger than one would suggest that a higher exposure to the explanatory variable would increase the likelihood of selling the stock.

In column (1) of Table 3-Panel A, we report the hazard ratio for the adjusted Amihud illiquidity ratio (AdjIlliq) without taking into account stock or investor characteristics. The

[14] Open stock positions, for instance, may be closed out in December for tax reasons.

estimated hazard ratio for the adjusted Amihud illiquidity ratio is 0.981 and statistically significant, implying that the higher the transaction cost of a stock is, the less likely it will be sold. We obtain similar results using Roll's C and the Zero-frequency measures which are reported in columns (2) and (3) respectively. Overall, these results are consistent with the univariate sorts – investors' holding periods are higher for illiquid stocks.

Households may not have the same preferences and could potentially have different baseline holding periods. Specification in column (1) does not take into account this potential heterogeneity across investors. One way to account for heterogeneity across households within a hazard framework is to assume different baseline hazard rates for each household, but compute common coefficients on the explanatory variables. Such a model is estimated by partial likelihood using the method of stratification. By doing household level stratification, we allow for the possibility of each household to a have a different baseline holding period. This is similar to using household fixed effects in OLS regressions. Similarly, by using firm stratification, we allow for the possibility of each stock having a different average holding period. In column (4) in Table 3-Panel A, we report the results of a hazard analysis similar to the one in column (1) by additionally accounting for household and firm specific effects using both firm and household level stratification.[15]

Results reported in column (4) show that the impact of transaction costs on the probability of a sale increases once we control for household and firm specific effects. The estimated hazard ratio for the adjusted Amihud illiquidity measure is reduced from 0.981 (column 1) to 0.973

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[15] We obtain similar results using Roll's C and the Zero-frequency measures, but for brevity we report results the adjusted Amihud illiquidity measure.

(column 4). The result suggests that after we allow for the baseline hazard to be different for each household and each stock, the relationship between holding periods and transaction costs gets stronger

In terms of economic significance, the hazard ratio of 0.973, estimated in column 4, would suggest that an increase in the adjusted Amihud ratio by one standard deviation would decrease the probability of a stock sale by a given household by 30%, indicating that the impact of illiquidity on the sale decision is economically highly significant. Results in columns (1) through (4) of Table 3-Panel A would support the notion that the average investor understands the impact of liquidity on holding period and pays attention to transaction costs when making trading decisions.[16]

In column (5) of Table 3-Panel A we control for stock characteristics such as size, book-to-market and momentum, in addition to controlling for the adjusted Amihud illiquidity measure and household specific effects. The basic finding is unchanged as the loading on the adjusted Amihud illiquidity measure is less than one (0.981) and statistically significant. The estimated hazard ratio for momentum is statistically significant and larger than one (1.135), which indicates that investors are more likely to sell the recent winners, while retaining recent losers, consistent with the disposition effect. The estimated hazard ratios for size (0.649) and book-to-market ratio (0.681) are both less than one and highly statistically significant, suggesting that US individual investors tend to hold large and value stocks for longer periods.

[16] In unreported results, we conduct a similar analysis using dummy variables for the most illiquid and most liquid stocks where the dummy variable takes on a value of one if the stock belongs to the most illiquid (liquid) decile among all stocks in a given year. We find that a stock in the highest illiquidity (liquidity) group is 40% (20%) less (more) likely to be sold compared to a stock not belonging to that group.

Next, we turn our attention to understanding how the relationship between transaction costs and the decision to hold versus sell a stock is impacted by trader characteristics. For this purpose, we extend the analysis in column (5) of Table 3-Panel A with additional controls for trader characteristics in column (6).[17] Demographic related controls include investor age, Age; log of annual income in dollars, Log (Income); a dummy variable that is equal to one if the trader is married, Married Dummy; a gender dummy that is equal to one if the trader is male, Male Dummy; a dummy to capture if the trader holds a technical or managerial position, Professional Dummy; a dummy that takes on the value of one if the trading account is a retirement account, Retirement Acct Dummy; and a dummy that takes on the value of one if the trader is retired, Retired Dummy.

In addition to basic demographic controls we also identify certain trader characteristics from each household's trading history. In particular, we document the type of assets a household trades, as well as estimating the total dollar value and the concentration-level of each household's portfolio. More specifically, we assign the value of one to the dummy variable, Foreign securities Dummy, if the household has ever traded foreign securities, one to the dummy variable, Option user Dummy, if the household has ever traded options, and one to the dummy variable, Short user Dummy, if the household has ever held a short position. We control for the total value invested by each household computed as the log of total equity investments, Log (Total Equity). Finally, we control for the concentration of each household portfolio, Concentration, which is defined as in Ivkovic et al. (2008), and is equal to the sum of the squared values of the dollar weight of each stock in a household's portfolio.

[17] These trader characteristics convey demographics related information particular to each household, including the financial sophistication level of a trader.

Column (6) of Table 3-Panel A reports the coefficient on adjusted Amihud illiquidity ratio (AdjIlliq) after controlling for stock characteristics, demographics and trade level information. Unsurprisingly, the coefficient on (AdjIlliq) is less than one (0.983) and statistically highly significant. Our analysis in column (6) suggests that the basic relationship between transaction costs and holding periods is unchanged after controlling for additional household and trade characteristics. In the next section, we investigate the interaction between transaction costs and these characteristics on the decision to sell versus hold a security.

4.2 Impact of Investor Sophistication

In this section we investigate how household and trade characteristics introduce heterogeneity in the relationship between transaction costs and holding periods of investors. In particular, we provide empirical evidence in support of the first part of our second hypothesis (*H2.a*): *The correlation between holding periods and transactions costs is higher for sophisticated investors.*

Following Goetzmann and Kumar (2008), we assume that financial sophistication is correlated with education and resources available to each investor. In particular, we assume that investors who have more income (Log (Income)), who work in technical and managerial positions (Professional Dummy), who invest larger amounts of capital in the stock market (Log (Total Equity)), and investors with experience trading options (Option user Dummy), foreign securities (Foreign securities Dummy), as well as those who have held a short equity position (Short user Dummy) are likely to be financially more sophisticated. Ivkovic, Sialm and Weisbenner (2008) propose and empirically document that investors who hold more concentrated portfolios are financially more sophisticated as they possess informational advantages that allow them to outperform investors with diversified portfolios. We also assume that households with more concentrated portfolios (Concentration) are more likely to be financially sophisticated. We examine the impact of sophistication by first creating a composite Sophistication measure and then interacting Sophistication with the AdjIlliq variable. The computed sophistication measure ranges from a minimum value of 0 for the least sophisticated investor to a maximum value of 7 for the most sophisticated investor.[18]

In column (6) of Panel A the coefficients on Foreign securities Dummy, Option user Dummy, Short user Dummy, Log (Total Equity) and Concentration are greater than one and statistically significant suggesting that most of the characteristics we associate with investor sophistication, except for Log (Income), are correlated with shorter holding periods. Similar to results in Panel A we show in columns (1) and (2) of Panel B in Table 3 that investors with higher Sophistication scores on average have shorter holding periods as the hazard ratio coefficient on Sophistication is greater than one and highly statistically significant. While these results document that more sophisticated investors trade more frequently we turn our attention to the interaction of Sophistication with AdjIlliq to better understand if more sophisticated investors pay closer attention to transaction costs.

We show in columns (1) and (2) in Panel B of Table 3 that those who are sophisticated tend to pay closer attention to the transaction costs as the coefficient on the interaction of the

[18] In the US transactions dataset the most financially sophisticated investor would have an income greater than $75,000 per year, would be in the top quartile in terms of total equity holdings, would trade options and foreign securities, would have held at least one short position over the sample period, would have a portfolio concentration greater than 0.35 and would work either in a technical or managerial role. The least financially sophisticated investor would have a score of zero in all seven attributes.

composite Sophistication score with AdjIlliq is statistically significant and less than one.[19] More specifically the hazard ratio on AdjIlliq × Sophistication is 0.995 before controlling for household specific effects in column (1) and it becomes 0.994 in column (2) after using stratification to control for household specific factors. These results indicate that individuals who are more sophisticated have holding periods that are positively correlated with transaction costs, suggesting that sophisticated investors pay more attention to transaction costs than unsophisticated investors.[20]

Figure 3 plots the hazard ratios of the variable AdjIlliq computed by running separate regressions for different groups of investors based on their level of sophistication indicated in the x-axis. The regression model used is the same as model (1) in Panel B of Table 3. The dotted lines show the 95th percentile confidence intervals of the estimated hazard ratios. Group 0 corresponds to investors with a Sophistication score of zero, while group 7 includes investors with a perfect Sophistication score of seven. The figure illustrates that as investor sophistication increases the hazard ratio on the adjusted Amihud illiquidity measure (AdjIlliq) monotonically decreases verifying that financially more sophisticated investors pay closer attention to transaction costs.

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[19] The coefficients on the interactions of individual terms that constitute the Sophistication measure with AdjIlliq are not reported for brevity. The only interaction term that is marginally greater than one is AdjIlliq × Log (Income) which is statistically insignificant. All other interaction terms (AdjIlliq × Foreign securities Dummy, AdjIlliq × Option user Dummy, AdjIlliq × Short user Dummy, AdjIlliq × Professional Dummy, AdjIlliq × Log (Total Equity) and AdjIlliq × Concentration) are statistically significant and less than one.

[20] In unreported results we repeat a similar analysis using two dummy variables: First, a dummy variable (*Sophistication > 3 Dummy*) that takes on the value of one if the *Sophistication* value for a given household is greater than three. Second, a dummy variable (*AdjIlliq Dummy*) that takes on the value of one if a stock is in the highest quintile ranked by the adjusted Amihud illiquidity ratio over the previous 12 months prior to a transaction. Using these two dummy variables allows us to compare the trading behavior of the most financially sophisticated households with the rest of households. We find that an investor with a *Sophistication* score greater than three is 30% less likely to sell a highly illiquid equity at a given point in time, compared to an investor whose *Sophistication* score is three or less.

Results in section 4 empirically verify our first (*H1*) and second (*H2.a*) hypotheses and hence confirm Amihud and Mendelson's (1986) predictions. In particular, we show that households choose to hold stocks with higher transaction costs for longer durations and that financially more sophisticated investors pay closer attention to the impact of transaction costs when deciding to hold versus sell a stock.[21]

5. Attention to Transaction Costs and Trading Ability

In this section, we study the implications of liquidity decisions of individual investors on their investment performance. We showed in section 4 that there are cross-sectional differences in the correlation between holding periods and transaction costs across households. As hypothesized in section 2, this correlation may also impact the portfolio performance of households. In particular, a negative correlation between holding periods and transaction costs could indicate low levels of financial sophistication and market knowledge, resulting in lower returns.

To identify households who pay more attention to transaction costs, we use the same hazard model as before, but now instead of pooling across all households, we estimate the coefficient on the transaction costs variable (*AdjIlliq*) for each household individually. We then use the correlation between holding periods and transaction costs as a proxy for how much attention each investor pays to transaction costs. In order to obtain robust estimates, we require that

[21] These findings are also in line with the predictions of dynamic models that endogenize the holding period decision (Constantinides (1986), Vayanos (1998), Vayanos and Vila (1999), Heaton and Lucas (1996), Huang (2003), Lynch and Tan (2011), Lo, Mamaysky and Wang (2004)).

households make at least 50 round-trip trades over the sample period.[22] This leaves us with a sample of 2,192 households. For the majority of households in the dataset (over 60%), holding periods are positively correlated with transaction costs, as the corresponding hazard ratio for the transaction costs variable, AdjIlliq, is less than one for these observations. This finding suggests that most individual investors in our dataset pay attention to transaction costs, as they hold illiquid securities in their portfolio for longer periods than they hold liquid securities.

We categorize households into two groups based on the magnitude of the hazard ratio on the transaction costs variable (AdjIlliq). In particular, we classify investors as paying attention to transaction costs if the hazard ratio is less than one (Group 1 in Table 4) and not paying attention to transaction costs if the hazard ratio is greater than one (Group 2 in Table 4). We then compute 1, 6 and 12 month returns for each stock from the date of purchase.[23] We also compute, 1, 6 and 12 month characteristics-adjusted returns as in Daniel et al. (1997) in order to make sure that the differences in the returns between these two investor groups are not driven by differences in stock characteristics. These returns are reported in Table 4. We report two sets of results. In Panel A, we report returns only for households for whom we are able to compute the hazard ratio on the Amihud illiquidity measure -AdjIlliq -with a minimum significance level of 10%. In Panel B, we report results for all households regardless of the significance level of the hazard ratio.

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[22] We obtain similar results using 20 or 30 trades instead of 50 trades.

[23] This is following by Seru, Shumway and Stoffman (2010) and others. Using realized returns based on closed trades is problematic and can introduce biases. For instance, if the disposition effect is strong, only profitable trades would be closed.

We calculate 1, 6 and 12 month raw and characteristics-adjusted returns from the day of purchase for all transactions executed by these investors in order to assess their investment ability. There is a stark difference in the investment performance of these two groups. Households who pay attention to transaction costs earn 0.1%, 1.3%, and 2.9% more in raw returns and 0.1%, 1.0%, and 2.5% more in characteristics-adjusted excess returns over 1-month, 6-month and 12-month holding periods respectively. The returns reported for all households in Panel B are similar in magnitude.

Table 4 also reports the average holding period and the realized spread for the two groups of investors. *Spread* is the ex-post realized bid-ask spread paid by the investors for each transaction in the dataset. The calculation is the same as in Barber and Odean (2000), and is calculated as the transaction price divided by the CRSP closing price minus one. This value is multiplied by minus one for purchases. The round trip spread that is reported is computed as the sum of sale and purchase spreads. The difference in spreads between the two groups of households is 2.8%, which is economically and statistically significant. This result indicates that investors who do not pay attention to transaction costs pay significantly higher transaction costs as a result. This in turn suggests that the differences between the two groups' net returns after adjusting for transaction costs would be even higher.

Overall, the findings in this section provide evidence in favor of our hypothesis *H2.b.* Investors who pay attention to transaction costs have on average better performance even before accounting for transaction costs, consistent with these investors being more sophisticated.

6. Robustness Tests

In this section, we conduct two robustness tests around our main findings. The first robustness test aims to address a potential omitted-variables problem. It is possible that stock liquidity is related to a certain unobserved variable that in turn affects investors' decision to sell versus hold. In order to address this potential endogeneity problem, we study investor behavior around periods of quasi-exogenous liquidity shocks that are unlikely to affect holding periods directly. Specifically, in section 6.1 we examine how stock liquidity and holding periods change around stock split events.

The second robustness test is meant to address potential selection issues with the US sample. Transaction-level dataset used in the US captures only a fraction of the US households' trades during certain years and hence may be insufficient to test our main predictions. In order to address this criticism, we repeat our main analyses in section 6.2 utilizing another dataset which covers all Finnish individual investors' complete trading records. Using an additional dataset from another country also provides us with an "out-of-sample" test of our main findings.

6.1 Quasi-exogenous shocks to liquidity

As we have mentioned earlier, a long line of literature documents a significant reduction in transaction costs and improved liquidity subsequent to stock splits (Schultz 2000, Desai, Nimalendran, and Venkataraman 1998, Kryzanowski and Zhang 1996, Conroy, Harris, and Benet 1990). These studies also show that post-split performance of splitting firms is statistically indistinguishable from that of non-splitting firms with similar characteristics (see for instance, Byun and Rozeff 2003), implying that stock splits do not credibly signal improved performance. This suggests that one plausible motivation for why investors decide to trade splitting stocks more is the reduction in transaction costs subsequent to split events. Thus, we use stock split events as quasi-exogenous shocks to liquidity and investigate investors' trading decisions around stock splits to address the potential omitted-variables problem.

We first empirically establish that stock splits indeed lead to an increase in liquidity and a reduction in transaction costs. For this purpose, we utilize close to two thousand stock split events that took place in the US between 1991 and 1996, and document that transaction costs decrease by about ten percent for the median stock following stock splits. If investors hold illiquid securities for longer periods as predicted by Amihud and Mendelson (1986), then the reduction in transaction costs subsequent to stock splits should lead to shorter average holding periods, increasing the likelihood of selling the splitting stock. We empirically test this prediction, and show that the average splitting stock is 18% more likely to be sold subsequent to a stock-split.

We identify a total of 3,586 stock splits between 1991 and 1996 in our sample. We exclude 1,067 observations that have a cash-dividend distribution within a [-30, +30] days window around the stock split event to make sure that our results are not contaminated by the influence of other types of shareholder distributions. Following the prior literature on stock splits, we further remove reverse splits and forward splits, and splits that have a split factor of less than 0.25. Our final sample includes 1,850 pure forward split events with available data.

First, we verify that our measures of transaction costs decline subsequent to a split. We regress the adjusted Amihud illiquidity ratio (AdjIlliq) on a time period indicator, After Split dummy, which equals one for the time periods of six-month (+6 months), nine-month (+9 months) and twelve-month (+12 months) subsequent to the split event, and zero otherwise.[24] Table 5 presents the results. We find that transaction costs, proxied by the adjusted Amihud Illiquidity ratio, decrease subsequent to stock splits. The coefficient on the After Split dummy is negative and statistically significant. For example in column (2), we observe that the coefficient on the After Split dummy is -0.186, controlling for stock characteristics. Considering that the median US stock has an adjusted Amihud illiquidity ratio of 1.66, the estimated -0.186 coefficient on the After Split dummy suggests transaction costs decrease by about 10% for the median stock after a split. Thus, we conclude that for the firms in our dataset the impact of stock splits on transaction costs is economically significant over the sample period.

Having established that stock splits lead to lower transaction costs, we next investigate if households reduce their holding periods subsequent to stock splits. In particular, we investigate the marginal impact of a split event on the likelihood of a stock being sold. In doing so, we study individuals' trading behavior over 6, 9 and 12-month periods subsequent to the ex-split dates using a dynamic hazard regression framework. In the dynamic hazard regression framework, the dependent variable is the duration until a transaction is closed, i.e. until a share bought earlier is sold. Following Christakis and Allison (2006), we create a time-varying dummy variable set to one during the time period 6, 9, 12 months after a split and zero otherwise. As before, if a sale is not observed, i.e. in case the investors hold their positions until the end of the sample period without selling it, we treat these observations as censored.

[24] We also analyze two-month and three-month windows, and don't observe significant changes in stock liquidity. According to Lakonishok and Lev (1987), trading volume starts to increase from 7 months prior to the time a stock splits and then declines within 2 months subsequent to the split event. The pattern observed by Lakonishok and Lev (1987) might explain the insignificant results when we use two or three month windows.

To construct the appropriate dataset for the dynamic hazard framework, we split the duration period of the transaction into multiple parts. The first part covers the time period from the purchase of the share until the split event. In this first period we assign a value of zero to the After Split dummy. The second part is for the time period from the split until the end of the window of interest. This window varies from 6-months to 12-months for the different models we study. For the second period, After Split dummy takes on a value of one. The third part corresponds to the period subsequent to the after split window. For this time period the After Split dummy takes on a value of zero.[25] Since it's possible for transactions to be open even after 6, 9, 12 months after a split, this setup ensures that After Split dummy will only equal one when a sale event falls within the event window, and as time elapses to the post-event window period, the After Split dummy will switch back to 0. The After Split dummy switches back to zero subsequent to the window of interest as the impact of splits on transaction costs and holding period decisions is not expected to be permanent. In this analysis the After Split dummy captures the marginal impact of stock splits on sale decisions over a distinct event horizon. Given the reduction in transaction costs subsequent to stock splits, we would expect to find a hazard ratio greater than one on the After Split dummy as households would be more likely to reduce their holding periods subsequent to the split event.

Table 6 reports the estimated results of the dynamic hazard regression. In all models in Table 6 we control for calendar year and month specific effects, and in models (2), (4), and (6) we further control for stock characteristics - size, book-to-market and momentum. As before, we

[25] In the rare instances where there are multiple splits before a transaction is closed, we split the transaction duration into more parts setting the After Split dummy equal to one during the 6,9,12 month time period after the second split.

calculate all stock characteristics when the transaction is closed.[26] In all specifications, we find that the estimated hazard ratio for the After Split dummy is larger than one and statistically significant at the one percent level. For example, results in column (2) show that with stock and calendar time controls, the estimated hazard ratio is 1.183 for the After Split dummy, indicating that investors are 18% more likely to sell a stock in the initial six months subsequent to its split. The reduction in average holding period subsequent to a stock split is equivalent to 37 trading days, or nearly two months. We should note that the baseline hazard rate captures the increasing probability of a sale as time passes. After Split dummy, therefore, captures the marginal impact of being in post-split time period on the probability of a sale, and does not simply capture a mechanical relationship due to the fact that probability of a sale increases as time passes on. Our results document that individual investors reduce their average holding periods significantly subsequent to stock splits. Considering that the median holding period for our sample is 185 days, the reduction in average household holding period is economically significant.

Our results are also robust to controlling for different event horizons. In particular, we find that the After Split dummy coefficient takes on a statistically significant value of 1.192 for the nine-month window analysis, and 1.198 for the twelve-month window analysis after controlling for stock characteristics. Overall, our results confirm that subsequent to stock splits transaction costs decline and individual investors respond by selling their holdings in splitting stocks.

[26] The methodology used for the dynamic hazard regression naturally increases the number of observations. If there is a single split event for a stock this event will lead to the creation of two additional lines for each account affected by the split, tripling the data. As a result of this there are 943,137 observations in Table 6, which is significantly larger than the number of observations in Table 3.

6.2 Out of Sample Test: Transaction Level Analyses in Finland

In this section, we provide further robustness analysis in support of our main findings, using transaction-level data from Finland. The transaction-level dataset from Finland covers individual investors' complete trading records. There are approximately two million transactions attributable to 303,235 households over the 1995 to 2003 for which we have complete information for our regression analyses. Similar to the U.S. dataset, the Finnish dataset reports for each transaction, the number of shares traded and the daily closing price. Furthermore, we observe the initial holdings for each account at the beginning of the dataset, allowing us to keep track of the total holdings of all households on a daily basis. There is also additional information regarding individuals' demographic information, such as age and gender. Unlike in the US, we do not have information about income, occupation, and marital status. We obtain stock and firm characteristics from Datastream.

Table 7 reports summary statistics for stock and investor characteristics for Finland. Only stocks that are traded by households in the dataset are considered. Summary statistics are calculated by pooling observations over the 1995-2003 time period. All liquidity measures are annual averages as defined earlier in the text. The results show that our major illiquidity measure – adjusted Amihud ratio (AdjIlliq) - is positively skewed with a mean of 10.61, but a much smaller median of 6.21. The distributions of other illiquidity measures are similarly positively skewed. Roll's C has a mean (median) of 2.96 (2.30) and Zerofreq has a mean (median) of 21.90% (20.64%). Size is also positively skewed, with the average market capitalization approximately 11 times as large as the median firm size.

The mean (median) household portfolio value is 10,823 (2,079) Euros in Finland. 4% of households trade options, while 33% of the primary account holders are female. Less than one percent of the households in Finland have ever held a short position during the 1995-2003 time period.[27] Mean portfolio concentration is 0.20, roughly corresponding to holding five stocks with equal value weights of 20%.

We use a framework similar to the one we utilize in the US, in order to test the validity of hypotheses (1) and (2.a) for Finnish investors. We run a hazard model estimating the conditional probability that a stock is sold controlling for stock illiquidity, firm characteristics, investors' demographic information as well as investor sophistication. Consistent with our US analysis and following standard reporting convention, we report hazard ratios instead of estimated coefficients.

Panel A of Table 8 reports results for the hazard model run on the transaction-level Finnish dataset. Results are remarkably similar to the US. Hazard ratio coefficient on the adjusted Amihud illiquidity measure (AdjIlliq) in column (1) is less than one (0.984) and statistically significant. Using either Roll's C (in column 2) or Zerofreq (in column 3) instead of AdjIlliq yields similar results. Our basic analysis suggests that the average investor in Finland holds stocks with higher transaction costs for a longer period of time, consistent with our findings in the United States and as predicted by Amihud and Mendelson (1986). When we control for household and firm specific effects using stratification in column (4) we find that the hazard ratio coefficient on the adjusted Amihud illiquidity measure (AdjIlliq) is still less than one (0.976) and statistically significant.

Similarly, further controlling for stock characteristics in addition to household specific effects in column (5) also yields a hazard ratio coefficient on the adjusted Amihud illiquidity

[27] This is not entirely surprising since Bris, Goetzman, and Zhu (2007) suggest that short selling became legal in Finland in 1998 but that tax laws inhibit would be short sellers.

measure (AdjIlliq) that is less than one (0.982) and statistically significant. In column (6) we control for household and stock characteristics together and once again find a hazard ratio of 0.982 on the adjusted Amihud illiquidity measure. This hazard ratio would suggest that the average investor is 20% less likely to sell a stock she or he holds when the stock's illiquidity measure increases by one standard deviation, suggesting that households in Finland are cognizant of transaction costs and pay attention to liquidity when trading. The economic significance of the estimated hazard ratio of AdjIlliq for Finnish stocks is similar to that for the US stocks.

We further investigate how household characteristics introduce heterogeneity in the relationship between transaction costs and holding period. In particular, we examine if financially more sophisticated investors pay more attention to transaction costs. In doing so, we control for the effects of demographic characteristics available in the Finnish dataset such as age and gender. As in the US analysis, we assume that financial sophistication is correlated with education and resources available to each investor. Investors who invest larger amounts of capital in the stock market – higher Log (Equity Holding)-, households with experience trading options – one for Option user Dummy- or that have higher portfolio concentration (Concentration) are assumed to be financially more sophisticated. Since a very small percentage of Finnish households have ever held short positions, we do not include this criteria in the construction of our Sophistication measure. Since the Finland transaction data doesn't provide information regarding investors' income and professions, or information about whether the investor has ever traded any foreign securities, we exclude these criteria in the construction of the Finnish sophistication measure.

Our sophistication measure for Finland ranges from a minimum of zero (0) for the least sophisticated investors to a maximum of three (3) for the most sophisticated investors. Column (1) of Panel B in Table 8 reports that the hazard ratio of the Amihud illiquidity measure interacted with the overall sophistication measure, AdjIlliq×Sophistication, is statistically significant and less than one (0.996). This result suggests that Finnish investors who are more financially sophisticated on average pay greater attention to transaction costs, and as such hold illiquid stocks for a longer period of time than less sophisticated investors do. In Column (2), we control for household specific effects using stratification and find consistent results.

In order to better interpret the economic significance of the results shown in Table 8, we assign each stock into liquidity deciles based on the adjusted Amihud ratio. We construct a dummy variable and assign a value of one to the decile with the most illiquid securities. In unreported results we repeat the analyses in Panel A of Table 8 using decile values of the adjusted Amihud ratio and find that a stock in the highest illiquidity group in Finland is 40% less likely to be sold compared to a more liquid stock with similar firm and investor characteristics, which is comparable to the findings in the US.

These results serve as an out-of-sample test for our main findings in the US, verifying that our findings are not confined to one market and are not unique to one specific time period. More importantly, since the dataset from Finland includes the complete transactions of all Finnish households between 1995 and 2003, our findings are generalizable to the full cross-section of households in Finland.

7. Conclusions

This paper investigates how the trading decisions of 66,000 (303,000) households in the US (Finland) are influenced by transaction costs. It provides a direct link between investors' holding periods and transaction costs and empirically verifies Amihud and Mendelson's (1986) theory of liquidity clienteles. Three main conclusions follow from our analysis. First, we show that transaction costs are an important determinant of investment decisions of individual investors. Consistent with theoretical models of investor behavior, households rationally reduce the frequency with which they trade illiquid securities subject to high transaction costs. This finding is robust to controlling for household and stock characteristics.

Second, we show that there is cross-sectional variation in the relationship between holding periods and transaction costs across households. Particularly, we find that the relationship between transaction costs and holding periods is stronger among more sophisticated investors. Third, we show that paying attention to transaction costs has important implications for investment performance. Households whose holding periods are negatively related to transaction costs earn lower gross returns even before adjusting for transaction costs when compared to households whose holding periods are positively related to transaction costs, suggesting that those investors who pay closer attention to transaction costs have better trading ability.

Finally, to address endogeneity and selection concerns, we study how investors' holding periods change around quasi-exogenous changes in transaction costs, and we extend our analyses to a sample of investors from Finland. We show that our main findings are robust to potential endogeneity and selection concerns.

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Table 1: Summary Statistics of Stock and Investor Characteristics in the US

Table 1 reports descriptive statistics for stock and investor characteristics in the US, where only stocks that have observed individual investor transactions in the dataset are considered. Summary statistics are calculated by pooling annual observations over the 1991-1996 time period. We report the mean, standard deviations (Std.Dev), as well as median, the 25th (P25) and 75th (P75) percentile values for all variables used in the study. All liquidity measures are annual averages as defined in the text. Price is the annual average of daily closing prices. Mkt Cap is the average market capitalization in millions of US dollars. B/M is the book-to-market ratio. Past Returns (-12, -2) is a proxy for momentum and measures cumulative returns during the past 10 month starting at month -12 and ending two months prior. AdjIlliq is the adjusted Amihud illiquidity ratio. Roll's C is the Bayesian estimate of Roll's (1984) transactions cost measure. Zerofreq is zero-return frequency which reports the percentage of zero-return days. Age in 1996 is the biological age of the investor in 1996. Married is a dummy variable that equals one for married traders. Gender is a dummy variable that equals one if head of the household is a female. Professional occupation is a dummy variable and is equal to one for traders that hold either technical or managerial positions. Retired is a dummy variable that is equal to one for traders who already retired. Retired Account is a dummy variable that equals one if the transaction takes place in a retirement account such as a 401(k). Portfolio concentration is defined as in Ivkovic, Sialm and Weisbenner (2008) and is calculated as the sum of squared value weights of each stock in a household's portfolio. Equity Portfolio Value reports the total dollar value of a household's equity portfolio. Income is annual self-reported income in thousands of dollars. Trades Option is a dummy variable that equals one if a trader has traded options at least once over the entire sample period. Trades Foreign Securities is a dummy variable that equals one if a trader has traded non-US securities at least once over the entire sample period. Short Position is a dummy variable that equals one if an investor has shorted any security at least once over the entire sample period.

	Mean	P25	Median	P75	Std. Dev
	Stock Characteristics				
Price ($)	22.56	7.25	15.75	28.25	139.95
Mkt Cap ($mil)	1,804.96	70.83	241.32	1058.16	6000
B/M	0.69	0.20	0.41	0.77	1.40
Past Returns (-12, -2)	0.34	-0.12	0.16	0.52	0.92
AdjIlliq	3.30	0.28	0.46	2.04	6.570
Roll's C	1.73	0.45	1.06	2.26	2.05
Zerofreq	4.82%	0.00%	2.70%	8.33%	7.85%
	Investor Characteristics				
Age in 1996	49.58	40	48	58	12.40
Married (1=married)	0.76	1	1	1	0.43
Gender (1=female)	0.10	0	0	0	0.30
Professional occupation	0.66	0	1	1	0.47
Retired	0.15	0	0	0	0.36
Retired Account	0.39	0	0	1	0.49
Portfolio Concentration	0.52	0.28	0.48	0.73	0.28
Equity Portfolio Value, USD	80,342	8,900	22,952	62,087	313,568
Income, USD	76,840	45,000	87,500	112,500	33,190
Trades Option	0.14	0	0	0	0.34
Trades Foreign Securities	0.22	0	0	0	0.42
Short Position	0.38	0	0	1	0.49

Table 2: Impact of Transaction Costs on Households' Holding Periods in the US, univariate analysis

Table 2 presents univariate analysis of the relationship between stock illiquidity and the holding period for each transaction in the US between 1991 and 1996. Holding Period is the number of trading days elapsed between the purchase and the first sale of that asset by a specific investor. Holding period for censored transactions, i.e. when sales of the assets are not observed, are estimated assuming the asset is sold on the last available date in the dataset. All transactions are ranked into ten portfolios based on their holding periods accordingly. Averages for the various liquidity measures for the underlying securities are then calculated for each group. All illiquidity measures are annual averages and are defined in the text. Price is the annual average of daily closing prices. Mkt Cap is the average market capitalization in millions of dollars. AdjIlliq is the adjusted Amihud illiquidity ratio. Roll's C is the Bayesian estimate of the Roll's (1984) transaction cost measure. Zerofreq is zero return frequency which measures the proportion of zero-return days per year. By definition, as the values of AdjIlliq, Roll's C and Zerofreq increase, liquidity decreases. High minus Low reports the differences for each variable between transactions groups with the longest and shortest holding-periods. Statistical significance at the 10%, 5% and 1% levels are denoted by *, **, and ***, respectively.

	Holding Period	Price $	Mkt Cap (Millions)	AdjIlliq	Roll's C	Zerofreq (%)
Low	6	33.46	7,283	0.9172	0.6608	2.52
2	20	31.36	6,880	0.9865	0.6834	2.72
3	44	30.25	7,153	1.0592	0.7054	2.84
4	79	30.16	8,410	1.0828	0.7072	2.85
5	127	33.46	8,601	1.2310	0.7337	3.06
6	194	30.29	9,547	1.2279	0.7312	3.03
7	294	30.51	9,814	1.3938	0.7382	3.09
8	470	28.50	9,712	1.5231	0.7312	3.14
9	771	30.49	11,508	1.6347	0.7425	3.40
High	1225	34.37	9,686	1.8397	0.8182	3.83
High-Low	1219***	0.91	2,403***	0.9224***	0.1575***	1.32***

Table 3: Impact of Transaction Costs on Households' Holding Periods in the US, hazard analysis

Table 3 examines the impact of transaction costs on individual investors' holding periods in the US using a hazard model framework. Panel A reports the estimated hazard ratios from the hazard regressions for US households between 1991 and 1996, where the conditional probability of sale is the dependent variable. Independent variables include the adjusted Amihud illiquidity ratio; firm characteristics; a set of demographic controls; trade variables; as well as the interactions of transactions costs measures with investor characteristics. Proxies for transactions costs (AdjIlliq, as well as Roll's C and Zerofreq) are calculated averages over the previous 12 months before each sale transaction. Size is the market value of equity. B/M or book-to-market ratio is computed as the ratio of previous year-end book value to the most recent market capitalization. Momentum is the cumulative returns over the ten-month period between month -12 to month -2. Stock characteristics are calculated at the beginning of the month when a sale takes place. Age refers to the age of the head of the household. Income is the total self-reported annual income. Married Dummy is a dummy variable that equals one if the investor is married. Male Dummy is equal to one if the head of the household is a male. Professional Dummy is one for investors who hold technical or managerial positions, and Retired Dummy is equal to one for investors who already retired. Retirement Acct Dummy equals one if the underlying account is a retirement (IRA or Keogh) account. Trade variables for each individual investor are derived from all the transactions he/she executes during the sample period. Short User Dummy equals one if an investor executed at least one short sale during the sample period. Option User Dummy is one if an investor ever traded options. Foreign Securities Dummy is set to one if an investor traded at least once any foreign assets, including ADRs, foreign stocks or foreign mutual funds during the sample period. Portfolio concentration is defined as in Ivkovic, Sialm and Weisbenner (2008) and is equal to the sum of squared value weights of each stock in a household's portfolio. Panel B investigates if investor sophistication affects investors' attention to transaction costs. Investor sophistication is presumed to cumulatively increase with each of the following criteria met: if the investor has an income higher than $75K; if the investor is ranked among the top 25% of all investors based on equity holdings at any point in time during the sample period; if the investor holds either technical or managerial positions and as such is considered a professional; if the investor traded options at least once during the entire sample period; if the investor has ever held any short positions during the sample period; if the investor has ever traded foreign securities, including ADRs, foreign stocks or mutual funds; and if the investor's portfolio is more concentrated than the median investor's, i.e. if the investor's portfolio concentration is greater than 0.48. The most sophisticated investors in the US have a Sophistication score of seven (7), while the least sophisticated have a Sophistication score of zero (0). Calendar month dummies (not reported) are twelve dummy variables that equals one if the sale transaction happens during the specific month. Year dummies (not reported) equal one for the year during which a transaction happens. Clustered robust standard errors are calculated at the household level. Ties are handled using the Efron procedure. Wald test is used for each additional set of regressors. P-values are reported below each coefficient. Statistical significance at the 10%, 5% and 1% levels are denoted by *, **, and ***, respectively.

Panel A: Hazard Regressions, Impact of Transaction Costs on Individual Traders' Holding Period Decisions in US

	(1) AdjIlliq	(2) Roll's C	(3) Zerofreq	(4) AdjIlliq	(5) AdjIlliq	(6) AdjIlliq
Illiquidity measure	0.981***	0.982***	0.322***	0.973***	0.981***	0.983***
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Stock characteristics						
Size					0.649***	0.724***
					<.0001	<.0001
B/M					0.681***	0.889***
					<.0001	<.0001
Momentum					1.135***	1.113***
					<.0001	<.0001
Demographic variables						
Age						0.997***
						<.0001
Log (Income)						0.927***
						<.0001
Married Dummy						0.959***
						<.0001
Male Dummy						1.103***
						<.0001
Professional Dummy						1.001
						0.891
Retirement Acct Dummy						0.912***
						<.0001
Retired Dummy						1.076***
						<.0001
Trade variables						
Foreign securities Dummy						1.245***
						<.0001
Option User Dummy						1.395***
						<.0001
Short User Dummy						1.877***
						<.0001
Log (Total Equity)						1.079***
						<.0001
Concentration						3.228***
						<.0001
Firm stratification	No	No	No	Yes	No	No
Household stratification	No	No	No	Yes	Yes	No
Calendar month dummies	Yes	Yes	Yes	Yes	Yes	Yes
Calendar year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	799,469	799,469	766,168	799,469	589,794	156,350
Wald test	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

Panel B: Hazard Regressions, Impact of Sophistication on Attention to Transaction Costs in US		
	(1)	(2)
AdjIlliq	0.988**	0.984**
	0.020	0.011
Age	0.993***	0.994***
	<.0001	<.0001
Married Dummy	0.879***	0.873***
	<.0001	<.0001
Male Dummy	1.046***	1.045***
	0.001	0.005
Retirement Acct Dummy	0.840***	0.862***
	<.0001	<.0001
Retired Dummy	1.379***	1.401***
	<.0001	<.0001
AdjIlliq × Age	1.000***	1.000***
	<.0001	<.0001
AdjIlliq × Married Dummy	1.003*	1.006***
	0.053	0.010
AdjIlliq × Male Dummy	0.993**	0.992**
	0.021	0.043
AdjIlliq × Retirement Acct Dummy	0.999	0.997
	0.441	0.251
AdjIlliq × Retired Dummy	0.990***	0.988***
	<.0001	<.0001
Sophistication	1.265***	1.272***
	<.0001	<.0001
AdjIlliq × Sophistication	0.995***	0.994***
	<.0001	<.0001
Stock Controls	Yes	Yes
Household stratification	No	Yes
Calendar month dummies	Yes	Yes
Calendar year dummies	Yes	Yes
Number of Observations	156,350	156,350
Wald test	<.0001	<.0001

Table 4: Attention to Transaction Costs and Trading Ability

Table 4 reports returns for two groups of households. The two groups are formed based on the magnitude of their hazard ratios for the transaction cost variables, which are estimated from US household level hazard regressions described in Section 5. Hazard ratio on adjusted Amihud's illiquidity ratio, AdjIlliq, is used as a proxy for how much attention the individual pays to transaction costs. To get robust estimates, households are required to have made at least 50 trades during the sample period to be included in the analysis. 1-, 6-, and 12-month returns are calculated starting from the date of purchase. Characteristics adjusted returns are calculated as returns net of characteristics matched portfolios, as in Daniel et al. (1997). Spread is estimated as in Barber and Odean (2000) and is equal to trading price divided by the CRSP closing price minus one for sales. The ratio is multiplied by minus one for purchases. Round trip spread is the sum of sale and purchase spreads and is reported below.. Transactions with a purchase or sale price less than $2, and holding periods less than 2 days, are excluded from the sample. Panel A reports returns for the two groups where the hazard ratio of the transaction cost variable, AdjIlliq, is estimated with a minimum significance level of 10%. Panel B reports returns for the full sample. Statistical significance at the 10%, 5% and 1% levels is denoted by *, **, and ***, respectively.

Panel A: Observations with AdjIlliq Hazard Ratio at >10% Significance

	Group 1 Pays Attention to Transaction Costs	Group 2 Doesn't Pay Attention to Transaction Costs	Group 1 - Group 2
1 Month return	0.018	0.018	0.001
1 Month return Char. adj.	-0.001	-0.001	0.001
6 Month return	0.079	0.066	0.013***
6 Month return Char. adj.	-0.001	-0.002	0.010***
12 Month return	0.161	0.132	0.029***
12 Month return Char. adj.	-0.010	-0.035	0.025***
Spread (%)	0.675	3.457	-2.782***
Holding Period (days)	100.0	156.9	-56.9***

Panel B: All Observations

	Group 1 Pays Attention to Transaction Costs	Group 2 Doesn't Pay Attention to Transaction Costs	Group 1 - Group 2
1 Month return	0.018	0.017	0.001**
1 Month return Char. adj.	-0.001	-0.002	0.002**
6 Month return	0.079	0.070	0.009***
6 Month return Char. adj.	-0.010	-0.019	0.009***
12 Month return	0.162	0.146	0.016***
12 Month return Char. adj.	-0.009	-0.027	0.018***
Spread (%)	1.093	3.321	-2.228***
Holding Period (days)	115.6	147.4	-31.8***

Table 5: Change in Illiquidity around Stock Splits

Table 5 reports the changes in illiquidity for stocks that split in the US around their ex-split dates. There are 1,850 forward stock splits during our sample period with a split factor larger than or equal to 0.25. An OLS regression of stock illiquidity on a time period indicator – After Split-dummy is estimated, controlling for size, book-to-market and momentum. The dependent variable is the monthly adjusted Amihud illiquidity ratio. The comparison of illiquidity involves different event windows, namely 6 months, 9 months and 12 months after stock splits. The time period indicator – After Split-dummy equals to one for observations of splitting stocks within the specified event window subsequent to their splits, otherwise it is zero. Each coefficient reported below for the –After Split-dummy comes from a single OLS regression. Size, book-to-market and momentum are also calculated monthly. For brevity, the coefficients for size, book-to-market and momentum are not reported. For each event window, we first report OLS results without firm controls and followed by results with firm controls in the adjacent columns. Standard errors are below each estimated coefficients. Statistical significance at the 10%, 5% and 1% levels are denoted by *, **, and ***, respectively.

Window	6-months		9-months		12-months	
	(1)	(2)	(3)	(4)	(5)	(6)
After Split dummy	-0.193***	-0.186***	-0.250***	-0.248***	-0.293***	-0.289***
	(0.016)	(0.017)	(0.013)	(0.014)	(0.011)	(0.012)
Stock Controls	No	Yes	No	Yes	No	Yes
Observations	31,652	27,703	47,271	40,488	62,744	52,484
Adj. R^2	0.005	0.044	0.008	0.046	0.011	0.048

Table 6: Impact of US Stock Splits on Holding Period Decisions

Table 6 examines the impact of stock splits on individual investors' holding period decisions. It reports the estimated hazard ratios from dynamic hazard regressions in the US where the conditional probability of sale is the dependent variable. Holding period is calculated as previously defined. For each stock-holding position, there is one observation for each day *t* the position is open, up to and including the day the stock is sold, or in cases where sales of stocks are not observed, until the last day of the dataset. The dependent variable, which is sale conditional on holding until day *t* is 1 if the stock is sold on this particular day, otherwise it is zero. We define three different event windows, which range from 6 months to 12 months. The After Split dummy is equal to1 if the stock experienced a split within 6 months (or other time horizon, i.e. 9 months, or 12 months) prior to day t, otherwise it is equal to0. The table reports the estimated hazard ratios on the – After Split- dummy. In all specifications, we control for time specific effects with calendar year and month dummies. We also control for size, book-to-market and momentum in models (2), (4) and (6). Firm characteristics are measured at the beginning of the month during which the sales are observed while year and month dummies equal to one when a sale takes place. For brevity, estimated hazard ratios for firm characteristics and calendar year and month dummies are not reported. P-values are included below each coefficient. Statistical significance at the 10%, 5% and 1% levels are denoted by *, **, and ***, respectively.

Impact of Stock Splits on Holding Period Decisions

Window	6-months		9-months		12-months	
	(1)	(2)	(3)	(4)	(5)	(6)
After Split dummy	1.344***	1.183**	1.328***	1.192***	1.310***	1.198***
	<.0001	<.0001	<.0001	<.0001	<.0001	0.0001
Stock controls	No	Yes	No	Yes	No	Yes
Calendar month dummies	Yes	Yes	Yes	Yes	Yes	Yes
Calendar year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	943,137	702,494	943,727	704,085	947,485	706,846
Wald test	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

Table 7: Summary Statistics of Stock and Investor Characteristics in Finland

Table 7 reports descriptive statistics for stock and investor characteristics in Finland. Summary statistics are calculated by pooling annual observations over the 1996-2003 time period. We report the mean, standard deviation, as well as median, the 25th and 75th percentile values for all variables used in the study. All liquidity measures are annual averages and are defined in the text. Price is the annual average of the daily closing prices. Mkt Cap is the average market capitalization in millions of Euros. AdjIlliq is the adjusted Amihud illiquidity ratio. Roll's C is the Bayesian estimate of Roll's (1984) transactions cost measure. Zerofreq is zero-return frequency which reports the percentage of zero-return days. Age in 1995 is the biological age of the investor in 1995. Gender (1=female) is a dummy variable that equals one for female traders. Portfolio concentration is defined as in Ivkovic, Sialm and Weisbenner (2008) and is calculated as the sum of squared value weights of each stock in a household's portfolio. Average portfolio value is the average mark-to-market value of an investor's portfolio in Euros using daily closing prices, calculated on an annual basis. Trades Option is a dummy variable that takes on a value of one for traders that have traded options at least once over the entire sample period.

Summary Statistics for Finland					
	Mean	P25	Median	P75	Std. Dev
	Stock Characteristics				
Price (€)	12.61	2.69	7.67	16.4	11.20
Mkt Cap (€mil)	1132	33	125	498	8414.34
AdjIlliq	10.61	1.07	6.21	20.12	10.25
Roll's C	2.96	0.66	2.30	3.88	3.51
Zerofreq	21.90%	13.50%	20.64%	27.75%	13.42%
	Investor Characteristics				
Age in 1995	39.5	27	40	52	18.48
Gender (1=female)	0.33	0	0	1	0.47
Portfolio Concentration	0.20	0.09	0.17	0.27	0.18
Average Portfolio Value, EUR	10,823	1,341	2,079	5,292	80,125
Trades Option	0.04	0	0	0	0.18

Table 8: Impact of Liquidity on Households' Holding Periods in Finland, hazard analysis

Table 8 examines the impact of stock liquidity on individual investors' holding periods in Finland using a hazard model framework. Panel A reports estimated hazard ratios from the hazard regressions where the conditional probability of sale is the dependent variable. Independent variables include measures of liquidity: the adjusted Amihud illiquidity ratio (alternative proxies for transactions costs including Roll's C and Zerofreq); firm characteristics; a set of demographic controls; trade variables; as well as the interaction of our proxy for transactions costs with investor characteristics. Proxies for transactions costs (AdjIlliq, Roll's C and Zerofreq) are calculated over the previous 12 months prior to a sale transaction. Size is the market value of equity. B/M , the book-to-market ratio, is computed as the ratio of previous year-end book value to the most recent market capitalization. Momentum is the cumulative return over the period between month -12 to month -2. All stock characteristics are calculated at the beginning of the month that a sale takes place. Demographic variables include age and gender. Age is the biological age of the head of the household. Male Dummy is one if the head of the household is male. Trade variables for each investor are derived from all the transactions carried out by the each specific investor in the dataset. Option User Dummy equals one if an investor has ever traded options over the course of the sample period. Log (Equity Holding) captures the logarithmic value of the household's total equity holdings. Concentration is defined as in Ivkovic, Sialm and Weisbenner (2008) and is equal to the sum of squared value weights of each stock in a household's portfolio. Year Dummies are dummy variables that equal one if the sale transaction takes place during that particular year. Calendar month dummy is equal one if a sale takes place during that particular month. For brevity, estimated hazard ratios on the year and month dummy variables are not reported. Panel B investigates if sophistication affects an investor's attention to transaction costs. A Finnish investor's sophistication is presumed to cumulatively increase with each of the following criteria met: if the household is ranked among the top 25% of all investors based on equity holdings at any point in time during the sample period; if the investor's portfolio is more concentrated than the median investor's; if the investor has ever traded options at least once during the entire sample period. The most sophisticated investors in Finland have a Sophistication score of three (3), while the least sophisticated have a Sophistication score of zero (0). We also control for size, B/M, momentum, as well as calendar year and month specific effects. Robust standard errors are calculated as in Lin and Wei (1989). Ties are handled using the Efron procedure. Statistical significance at the 10%, 5% and 1% levels is denoted by *, **, and ***, respectively.

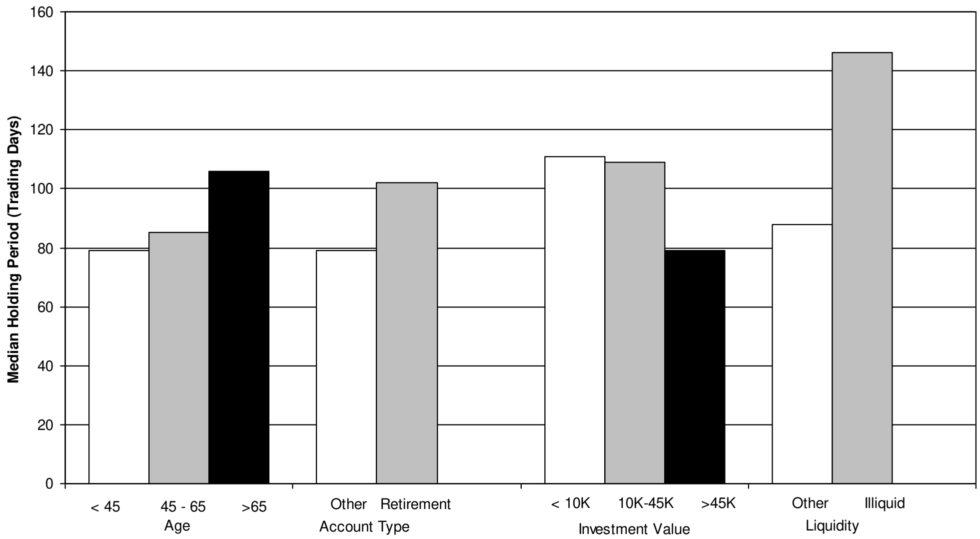
Panel A: Hazard Regressions, Impact of Transaction Costs on Individual Traders' Holding Period Decisions in Finland

	(1) AdjIlliq	(2) Roll's C	(3) Zerofreq	(4) AdjIlliq	(5) AdjIlliq	(6) AdjIlliq
Illiquidity measure	0.984***	0.975***	0.105***	0.976***	0.982***	0.982***
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
			Stock characteristics			
Size					1.003***	1.001 ***
					<.0001	<.0001
BM					0.993***	0.996***
					<.0001	<.0001
Momentum					1.014***	1.008***
					<.0001	<.0001
			Demographic Controls			
Age						0.994***
						<.0001
Male Dummy						1.290***
						<.0001
			Trade Variables			
Option User Dummy						1.713***
						<.0001
Log (Equity Holding)						1.157***
						<.0001
Concentration						5.456***
						<.0001
Firm stratification	No	No	No	Yes	No	No
Household stratification	No	No	No	Yes	Yes	No
Calendar month dummies	Yes	Yes	Yes	Yes	Yes	Yes
Calendar year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,304,232	2,304,232	2,304,232	2,304,232	2,131,366	1,522,716
Wald test	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

Panel B: Hazard Regressions, Impact of Sophistication on Attention to Transaction Costs in Finland

	(1)	(2)
Illiquidity measure	1.005***	1.013***
	<.0001	<.0001
Age	0.995***	0.995***
	<.0001	<.0001
Male Dummy	1.371***	1.339***
	<.0001	<.0001
Sophistication	1.588***	1.552***
	<.0001	<.0001
AdjIlliq × Age	1.000***	1.000
	<.0001	0.236
AdjIlliq × Male Dummy	0.990***	0.992***
	<.0001	<.0001
AdjIlliq × Sophistication	0.996***	0.997***
	<.0001	<.0001
Stock Controls	Yes	Yes
Household stratification	No	Yes
Calendar month dummies	Yes	Yes
Calendar year dummies	Yes	Yes
Observations	1,522,716	1,522,716
Wald test	<.0001	<.0001

Figure 1: Holding Periods of Households



This figure shows the median holding period for various investor and stock groups. Age is the age of the investor. Account type denotes whether the account is a retirement account. Investment value is the average amount invested by the household in the stock market. A stock is defined as illiquid if it belongs to the lowest liquidity decile of stocks ranked according to the adjusted Amihud illiquidity ratio. The holding period is calculated only for positions that are closed-out by the end of the sample period.

Figure 2: Survival Probabilities for Stocks in the United States

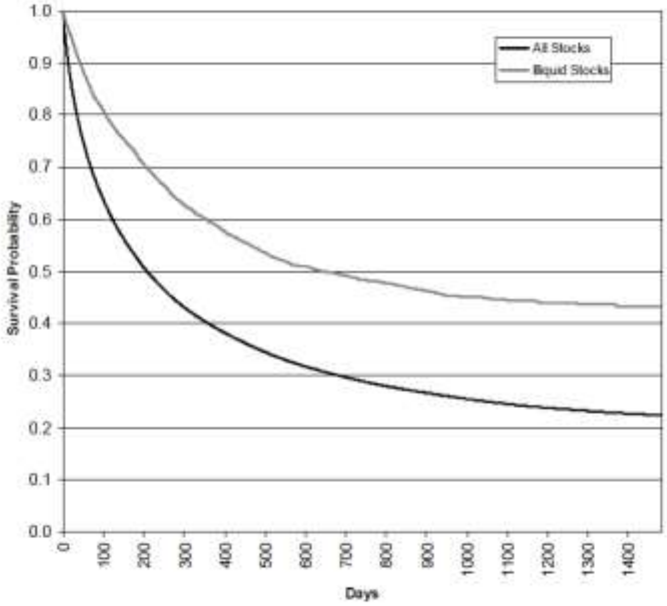


Figure 2 plots Kaplan-Meier survival probabilities for two groups of stocks held by households in the United States over the 1991-1996 time period. Illiquid stocks in the figure are stocks that are in the highest illiquidity decile of stocks ranked according to the adjusted Amihud illiquidity measure. The gray line stands for the probability of holding onto illiquid stocks, and the black line stands for the probability of holding all the rest stocks.

Figure 3: Investor Sophistication and Hazard Ratios

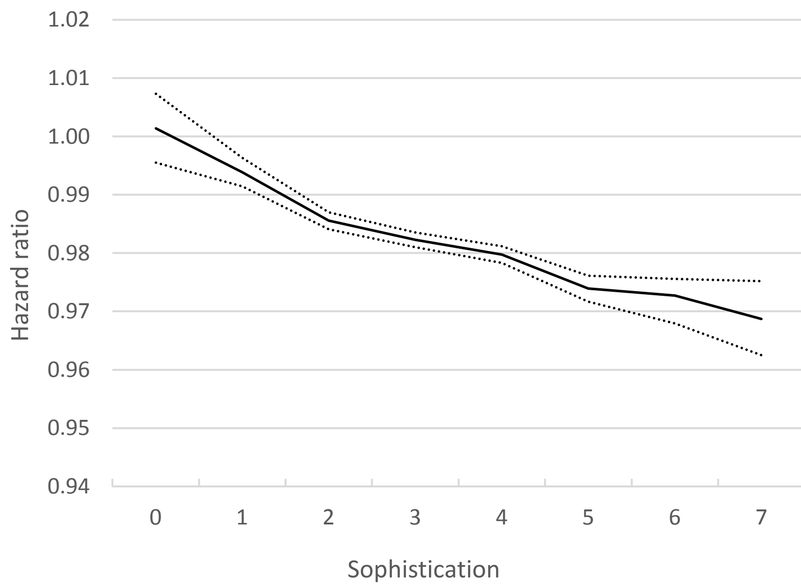


Figure 3 plots the hazard ratios of the variable AdjIlliq computed by running separate regressions for different groups of investors based on their level of sophistication indicated in the x-axis. Sophistication ranges from a low of zero (0) to a high of seven (7). The regression model used is the same as in column (1) of Panel B in Table 3. The dotted lines show the 95th percentile confidence intervals of the estimated hazard ratios.