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Liquidity Risk and Mutual Fund Manager's Stock Choice

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1. Introduction

From 1900 to 1945, about 5% of all equity investments were managed by institutional investors. Over time, this percentage has increased immensely. By the end of 2010, about 67% of all equities were being managed by institutional investors (Blume and Keim (2012)). With such an increase in the presence of institutional investors in the market, one might ask the following question: what characteristics does a fund manager look for when picking stocks? An institutional investment fund has a fund manager who invests money for an organization on behalf of its members. Examples of institutional investors are pension funds, insurance companies, mutual funds and endowment funds. Institutional investment is different than personal or commercial investment, and fund size can vary. Typically, mutual funds are attractive to investors who do not want to directly invest in the market due to the market's unpredictability and volatility, but they are interested in investing because they recognize the potential growth and returns that the market offers (Vyas (2013)).

Individual investors invest on a much smaller scale than large, institutional funds. These large funds must trade in size, unlike the individual investors. With increased trading size comes increased trading costs. Small funds order in small amounts which do not dramatically move prices; however, the increasing evidence of higher trading costs for large funds suggests that their large orders significantly impact the prices of the stocks that they buy into or sell out of (Keim (1998)). These large funds serve as "liquidity suppliers" when they buy large positions in these illiquid stocks; however, these large orders create worse prices for all funds attempting to purchase shares of the stock (Keim (1998)).

While almost all securities have prices that are sensitive to large orders, illiquid securities are the most price-sensitive. Based off of previous literature, it seems reasonable to conclude that mutual funds are less likely to hold these illiquid securities because the transaction costs associated with buying and selling them are high due to the size of the transaction. In general, mutual funds need to quickly process redemption requests from those who invest in the fund, so they always need cash on hand or positions in securities that can be easily converted to cash. These conversions are often in large size, and the goal of the manager is to quickly trade these large quantities at a low price without significantly moving the price (Pástor and Stambaugh (2003)).

This paper seeks to test the hypothesis that large funds avoid holding securities that are illiquid due to their price sensitivity. In order to test this hypothesis, I use two measures for liquidity that are commonly used in previous literature: the Amihud measure and the turnover rate. The Amihud measure measures the average percentage stock price change per unit of volume, and turnover measures how much volume is traded in a particular period. These measures are necessary to include because they control for the fact that large funds are more likely to trade all securities due to the fact that they are large and have more money to trade than small funds.

In this paper, I use 2017 mutual fund holdings data from the Thomson Reuters 13F filings. From this data, I was able to compile a list of all securities held by each fund and calculate each fund's total asset value to determine their size. To determine whether fund size plays a role in determining whether illiquid stocks are held, I collected a sample of 10 of the largest funds and 10 of the smallest funds in the data. Since there is a high likelihood that the very smallest and largest funds are potential outliers in my dataset, I took the 10 large funds from the 90th percentile of the fund sizes, and I took the 10 small funds from the 10th percentile. For two of my specifications, I added in 10 medium sized funds from the 50th percentile.

Next, I used The Center for Research in Security Prices (CRSP) daily security database to pull data for each stock present in the holdings data file. This data was needed to calculate the turnover rate and the Amihud measure as my liquidity variables for each stock. From here I used a Probit model with my dependent variable as *Invest* (1) or *Not Invest* (0). I used the liquidity factors, fund size and interactions between size and liquidity risk. The methodology is further explained in my *Empirical Strategy* section.

My results do not suggest that large funds tend to invest in more liquid assets which is not in agreement with my hypothesis. I find that as illiquidity increases, so does the likelihood that all funds invest, regardless of their size. My specifications find that large funds are more likely to invest than small funds in general, but this also holds true as illiquidity risk increases. While this does not fit conclusions that could potentially be drawn from Chen, Hong, Huang and Kubik's (2004) or Dong, Feng and Sadka's (2011) studies regarding size, it does fit the general conclusions found in the literature suggesting that all funds should invest in more illiquid stocks due to the illiquidity premium associated with these particular investments (See Idzorek, Xiong and Ibbotson (2012), Amihud (2002) and Datar, Naik and Radcliffe (1998)). It is intriguing that a seemingly obvious hypothesis was incorrect. This surprising, counterintuitive result leaves room for future research on the topic which I suggest in my conclusion.

The next section of my paper is a more in depth Literature Review. Section 3 discusses my hypothesis and gives a deeper discussion of my data. Section 4 describes my empirical strategy. Section 5 describes my results, and my conclusion is found in Section 6.

2. Literature Review

Current literature does not focus much on fund manager's specific stock choice based off of these liquidity measures; however, there is a large focus on these variables and their impact on a fund's return. Significant impact on returns should also suggest whether or not a fund should invest in certain securities based off of these characteristics.

Current literature suggests that more illiquid stocks tend to outperform more liquid stocks in the market. Investing in more liquid stocks allows investors to access their cash at a quicker rate; however, fund managers are incentivized to invest in less liquid stocks due to the premium realized for investing in these stocks (Idzorek, Xiong and Ibbotson (2012)). Both Amihud (2002) and Datar, Naik and Radcliffe (1998) also find that these illiquid stocks are outperforming the liquid stocks in the market.

Amihud (2002) measured illiquidity as an average of the ratio of a stock's daily return to its daily dollar volume. I use his measure within my study, so I go into further detail about the formula and measure later in my data section. He used data for stocks traded in the New York Stock Exchange (NYSE) from 1963 to 1997, and his cross sectional models found that illiquidity has a positive effect on returns. His models also suggest that there is variation in the liquidity premium for small stocks over time which implies that illiquidity affects small-cap stocks more than large-cap stocks. The liquidity risk that I observe in my paper deals with the costs associated with moving in and out of a position. This risk is best measured with methods using transaction costs and turnover, which Amihud does directly with stock price sensitivity per unit volume.

Datar, Naik and Radcliffe (1998) follow the same general thought experiment as Amihud; however, they choose to use a different measure of illiquidity—the turnover ratio. Like the Amihud measure, I use this measure in my study, as well, so I will go into further detail about the calculation in my data section. In general, the turnover ratio is the ratio of the number of shares traded to the number of shares outstanding. They believe the turnover rate is an intuitive measure for liquidity because it takes into account the differences in the number of shares outstanding and the shareholder base of each stock. Trading volume is not sufficient alone because it does not take into account the number of outstanding shares or the shareholder base, therefore, it is not an optimal proxy to measure liquidity (Datar, Naik and Radcliffe (1998)). In this study, they examine the relationship between returns and the turnover ratio over time, along with control variables for firm size, book to market ratio and the firm's beta. They conclude that returns and turnover rates are negatively related which leads them to conclude that illiquid stocks outperform liquid stocks. This conclusion is in line with Amihud's study. Both of these studies look at how liquidity impacts a specific stock's return, and their conclusions that illiquid stocks outperform more liquid stocks may suggest that funds are more likely to invest in more illiquid stocks. To determine this, I will use the measures used in these two papers to determine how they impact whether a fund manager chooses to invest in a stock or not.

While these two studies analyze liquidity risk on a general level, Idzorek, Xion and Ibbotson (2012) look more specifically at the risk for institutional investors and mutual funds. After they obtained the holdings data for a large sample of mutual funds, they focused on liquidity risk by looking at the turnover rate and the Amihud measure as I do in my study. They concluded that the liquidity of stocks held by funds dramatically impacts a fund's performance and that fund managers who choose to hold more illiquid stocks realized larger returns than managers who choose to hold more liquid stocks in their portfolio. Their study found that the Amihud measure produced positive but less significant results than the turnover rate which suggests that the Amihud measure measures liquidity differently than turnover. Their analysis suggests that the turnover rate tends to have a large value bias for low-liquidity funds while the Amihud measure has small value bias, and therefore, more volatility. While they find differences between these measures, I still use both in my study.

Leyong and Bok (2018) suggest that institutional investors should lock up some of their funds in illiquid assets due to the long term investment horizon that they have. They compared asset class returns from 2006 to 2016 and found that public pension funds with private equity portfolios significantly outperformed other portfolios. Private equity is considered one of the most illiquid assets to invest in. By locking up funds in these illiquid investments, this suggests that the fund trades these investments less often. While Leyong and Bok (2018) seem to believe that this is a reasonable option for large funds, a potential downside is that this can cause tracking error if the fund is evaluated relative to a benchmark. This tracking error creates discrepancies between returns and the comparable index which is not optimal (Keim (1998)). For illiquid investments, such as Private Equity, returns may be large, but the potential issue is different. In this case, it may be that these assets are so illiquid that they cannot be sold in a down market. This is a huge risk for large funds who need to ensure quick access to cash when investors request it.

Another variable that I consider is fund size. While previous studies advocate for investing in illiquid assets, some studies show that this may not be the optimal option for large funds. Chen, Hong, Huang and Kubik (2004) find that small funds significantly outperform large funds. They argue that this is likely due to the inability of large funds to avoid the high transaction costs due to the illiquidity of their underlying positions. These results suggest that large funds should tend towards buying positions in more liquid assets that are not associated with such high transaction costs.

While large funds incur higher transaction costs for holding illiquid securities, they also struggle to respond to changes in market illiquidity as efficiently as small funds (Dong, Feng and Sadka (2011)). Dong, Feng and Sadka find that the responses of large funds in times of economic crisis are not as effective as the responses of small funds which limits their ability to generate a significant performance. This inefficiency by large funds could be due to the higher transaction costs associated with illiquid securities in down markets. This suggests that large funds should steer away from holding less liquid positions and that small funds may be better suited to hold these illiquid securities in their portfolios.

Previous literature suggests that illiquid stocks outperform liquid stocks which may suggest that all funds would increase investment in these securities; however, the differences in performance between small and large funds suggest that large funds may steer more towards liquid assets. Current literature does not look at the specific liquidity measures associated with a stock and assess whether a fund manager chooses to invest in a stock or not based off of these measures. Since most of the prior research is based off of returns associated with illiquidity and fund size, my paper will look further into the individual stocks in a manager's portfolio and determine whether the liquidity risk associated with each individual security and the size of the fund itself has any significant impact on whether or not the manager chooses to invest in the stock. My paper will also use the most recent data from 2017 which will give the most up to date perspective on this topic.

3. Hypothesis and Data

3.1 Hypothesis

In my paper, I seek to determine how liquidity risk and fund size affects a manager's decision to invest in a security or not. My specific hypothesis is that large mutual funds avoid holding securities that are illiquid, or price sensitive. On a broad scale, liquidity describes a manager's ability to quickly trade large quantities at a low price without significantly impacting the price (Pástor and Stambaugh (2003)). To test my hypothesis, I use two measures of liquidity: the turnover rate and the Amihud measure. The turnover rate is a ratio of how much volume is traded to the number of outstanding shares while the Amihud measure is the average percentage price change per unit volume for each stock.

3.2 Holdings Data

For my analysis, I started with the Thomson and Reuters 13F filings database. This database contains the holdings information for all mutual funds and large institutional investors which gave me all funds and their holdings for 2017. This data is fitting for my research because I was able to obtain each fund's name, the fund number and each security in their portfolio. The data is aggregated from the SEC N-30D filings which include semi-annual reports to shareholders that are required to be filed with the SEC twice a year by mutual fund companies. Thomson also reaches out to mutual fund management companies to increase the frequency of theses updates.

This database allowed me to pull clean holdings data for 4,222 institutions. Included in the data is a manager type code. With this code, I chose to remove the banks from the study which left me with all Insurance Companies, Investment companies and their managers, Investment Advisors, and "All Others" which includes Pension Funds, University Endowments and other foundations. When looking at the largest funds in the sample prior to the removal of the banks, the top funds included Bank of New York Mellon, State Street Bank and Trust and JP Morgan Chase. These banks in the data set are custodian banks. While they do hold assets for their customers, they are not in charge of the actual investment decisions themselves, therefore, I decided to remove them from my sample. Since there is no way to differentiate banks that serve as actual investment funds from these custodian banks in the database, I removed all banks from the sample. This left me with 4,128 funds.

For each stock in the manager's holdings, I pulled the cusip and ticker to obtain further information which I will discuss in further detail in the next section, the price of the security, and the number of shares of each security that the fund held. With the price and number of shares, I was able to calculate the total assets that each fund held. I used the total asset value to break the funds into size groups which I will discuss later in this section, also.

With the holdings data, I compiled every stock in the sample with each fund along with the stock's turnover rate and Amihud measure (discussed in sections 3.4 and 3.5). I then created an indicator variable (*invest*) for whether or not the fund invested in the specific stock. The *Invest* indicator equals one if the fund holds that stock and zero if the fund does not hold that stock.

3.3 Daily Stock Data

After pulling the 13F Holdings data, I used the CRSP daily stock database to pull information about each individual stock. A second database was necessary because the filings only contained basic information about the holdings of each fund; however, my study aims to assess the specific daily data for each stock that each fund holds. With this database, I used all tickers and cusips that I pulled from the holdings data to find the individual information. At this point, some securities were eliminated because the cusips in the 13F data did not match to any records in the CRSP database. Even with this elimination, I was left with 5,337 stocks in my sample. While the elimination of some stocks may create some bias in the model, the random sample left after this elimination is still an appropriate amount of data to look at for these funds.

With the CRSP database, I was able to pull the daily trade volume, return and total shares outstanding. With this data, I was able to create my liquidity risk measures.

3.4 Turnover Rate as a Measure of Liquidity

The first measure I look at is the turnover rate. The turnover rate is the average daily volume for the year divided by the average number of shares outstanding. I was able to calculate this measure for each stock within the sample. Let D_{iy} be the number of days that the stock *i* was trading in year *y*, VOL_{iyd} be the daily volume for stock *i* in day *d* in year *y*, and S_y be the number of shares outstanding in year *y*. See equation below:

$$Turnover\ Rate_y = \frac{1}{S_y}\frac{1}{D_{iy}}\sum_{n} VOL_{iyd}$$

A larger turnover rate represents a stock that is more liquid, and a lower rate represents a more illiquid stock. I hypothesize that large funds will be less likely to hold stocks with lower turnover rates.

3.5 Amihud Measure as a Measure of Liquidity

Next, I calculated the Amihud measure of illiquidity. Amihud looks at illiquidity as an average of the ratio of a stock's daily return to its daily dollar volume (Amihud (2002)). Let D_{iy} be the number of days with available data for the stock *i* in year *y*, R_{iyd} be the stock return for stock *i* in day *d* in year *y*, and $VOLD_{iyd}$ be the daily volume for stock *i* in day *d* in year *y* in dollars. See formula below:

$$Amihud_y = 10^6 \frac{1}{D_{iy}} \sum_d \frac{|R_{iyd}|}{VOLD_{iyd}}$$

The relationship between the Amihud measure and liquidity is opposite from the relationship between the turnover rate and liquidity. A stock with a larger Amihud measure is more illiquid while a lower measure represents a stock that is more liquid. I hypothesize that large funds will be less likely to hold stocks with higher Amihud measures.

Summary statistics for the Amihud Measure and the Turnover Rate among the 5,337 stocks can be seen below in Table 1.

Table 1. Summary Statistics for Liquidity Measures

In this table, I report the summary statistics for the turnover rate and the Amihud measure that I discussed in Section 3.4 and 3.5. I generated these values for the entire sample of 5,337 stocks.

	Mean	*Median*	*Minimum*	*Maximum*
Turnover Rate	0.12819	0.06301	0.00006	50.1413
Amihud Measure	-0.55975	0.00000	-295.43	32.910
# Stocks	5,337	5,337	5,337	5,337

3.6 Measuring Fund Size

Outside of these two measures, I also have an indicator variable for size of the fund. To determine the fund size I calculated the total asset value for each fund. Let P_{ix} be the price of stock *i* in manager *x*'s portfolio and N_{ix} be the number of shares of stock *i* held in manager *x*'s portfolio. See formula below:

$$Total\ Asset\ Value_x = \sum_x P_{ix} * N_{ix}$$

Since I need all 5,337 stocks in my sample for each manager, I decided to take a sample of ten small funds and ten large funds for *Specification 1* and *Specification 3*. Since it is likely that the ten smallest and largest funds in the data are outliers, my small funds are ten from the 10^{th} percentile of asset values and my large funds are ten in the 90^{th} percentile of asset values. I created an indicator variable (*large*) based off of these groups. The indicator equals one if the fund is large and zero if it is small. For *Specification 2* and *Specification 4*, I added ten medium sized funds to the sample. I took ten funds from the 50^{th} percentile of asset values. With this addition, I created an indicator variable (*medium*) that equals one if the fund is medium sized and zero if it is large or small.

The characteristics of the funds are summarized below in *Table 2*. As seen in the table, the total asset value for each size category varies greatly, along with the number of securities that each size fund invests in. When observing the minimum and maximum for the number of securities invested in for each size group, there seems to be a large distribution for each category. When looking at the mean, there is a clear difference between the amounts of different securities that the different size categories choose to invest in. Both the *Size* and *Invested* demonstrate that the larger the fund, the more the manager invests.

Table 2. Summary Statistics for Fund Groups

This table reports the summary statistics for the funds in my sample. The *Size* variable in this table reflects the asset values in dollars. The *Invested* variable reflects the number of individual securities that the fund invests in. For each size category, the summary statistics are calculated among the 10 funds in the sample.

Summary Statistic	*Small*	*Medium*	*Large*
Mean Size	94,947,294	363,193,872	5,410,824,506
Median Size	95,057,039	362,974,865	5,384,232,876
Maximum Size	95,681,998	364,745,778	5,498,970,953
Minimum Size	94,226,801	361,812,720	5,363,026,346
Mean Invested	38	112	481
Median Invested	41	49	447
Maximum Invested	88	379	1,191
Minimum Invested	1	13	22
Number in Sample	10	10	10

4. Empirical Strategy

4.1 Model

The goal of my paper is to understand the determinants of the probability that a fund invests in a certain security or not. I used a probit model with continuous variables for liquidity risk, an indicator variable for fund size and interaction terms between size and liquidity risk. The probability that a manager invests in a certain stock is given by:

$$\Pr(Y_i = 1) = \Pr(\beta X_i + \varepsilon_i > 0) = \Phi(\beta X_i)$$

My two outcomes of interest are invest or not invest, and Φ is the standard normal cumulative density function.

In my study, I analyze the marginal effects produced by the probit model. Marginal effects differ for binary and continuous variables. A binary variable is one that can only take on values of one or zero. In my study, *Large* and *Medium* are binary variables. The marginal effects of binary variables represent discrete changes. A discrete change describes how $\Pr(Y_i = 1)$ changes as the binary variable changes from 0 to 1 while all other variables are held constant. In my models, these discrete changes describe the change between *Large* (1) and *Small* (0) and *Medium* (1) and *not Medium* (0).

The following formula represents the marginal effect for a binary variable with X_K as a binary variable:

$$Marginal\ Effect\ X_K = \Pr(Y = 1|X, X_K = 1) - \Pr\ (Y = 1|X, X_K = 0)$$

My study also has multiple continuous variables (*Turnover, Amihud, LTurnover, MTurnover, LAmihud, MAmihud*). A continuous variable has an infinite possible number of values that it can take on which differs from a binary or discrete variable that can only take on specific values. The marginal effect for a continuous variable is an instantaneous rate of change that represents the change of $\Pr(Y_i = 1)$ with a change in the value of the continuous variable while all other variables are held constant.

The following formula represents the marginal effect for a continuous variable, X_K, where $\Phi(XB)$ is the probability density function value for $\Pr(Y_i = 1)$ and b_K is the probit regression coefficient for X_K:

$$Marginal\ Effect\ X_K = \ \Phi(XB) * b_K$$

4.2 Effect of Turnover Rate and Fund Size

My first two specifications look at Turnover Rate as a measure of liquidity. By including fund size, stock liquidity and interaction terms between size and liquidity, it allows me to observe how different sized funds might react to liquidity risk and how the risk impacts their decision to hold a certain stock or not. I will be able to test my hypothesis that large funds are less likely to hold illiquid stocks than smaller funds. More specifically, I seek to prove that large funds are less likely to hold stocks with a lower turnover rate. *Specification 1* and *Specification 2* are demonstrated by the following formulas:

$$(1)\ Y_i = \alpha + \beta_1 Turnover_i + \beta_2 Large_i + \beta_3 LTurnover_i + \varepsilon_i$$

$$(2)\ Y_i = \alpha + \beta_1 Turnover_i + \beta_2 Large_i + \beta_3 Medium_i + \beta_4 LTurnover_i + \beta_5 MTurnover_i + \varepsilon_i$$

The main variable of interest is liquidity risk. In *Specification 1*, I include 10 small funds and 10 large funds, and liquidity risk is represented by *Turnover*. Further, this model includes two more explanatory variables. I include an indicator variable (*Large*) that is one if the fund is large and zero if the fund is small. In this specification, there is *LTurnover* which represents the interaction between the variables *Large* and *Turnover.*

In *Specification 1*, it should be that β_2 is positive because large funds are more likely to hold all stocks than a small fund. More specifically, when assessing my hypothesis, it should be the case that the sum of β_1 and β_3 is positive. A positive result indicates that with an increase in turnover, a large fund is more likely to hold the security. Since β_1 is the effect for small funds, it is not clear what the sign on the coefficient should be.

In *Specification 2*, I add 10 medium sized funds to the model. I continue using the indicator variable for *Large*, but I also add an indicator variable (*Medium)* that equals one in the fund is medium sized and zero if it is small or large. I also add the interaction term *MTurnover* which interacts the variables *Medium* and *Turnover*. *LTurnover* remains in the model, as well. These interaction terms in each specification are intended to provide insight into how fund size and the liquidity of the stock affect whether or not a manager invests in a stock.

In this specification, the same predictions hold as in *Specification 1*, but I also look into the medium sized funds. β_3 in this specification should also be positive, but potentially not as positive as β_2. It should also be that the sum of β_1 and β_5 is also positive, but not as positive as the sum of β_1 and β_4. These results should occur because a medium fund is still larger than a small fund, but the effect shouldn't be as large as the effect for a large fund since a medium fund is still smaller than a large fund. It is not clear whether β_1 should be positive or negative still.

4.3 Effect of Amihud Measure and Fund Size

In my final two specifications, I measure liquidity with the Amihud measure. All other variables in the specifications remain the same to determine how fund size and liquidity risk affect a manager's decision to invest in a stock or not. The specific hypothesis I test here is that large funds are less likely to hold stocks that have a higher Amihud measure. *Specification 3* and *Specification 4* are demonstrated by the following formulas:

$$(3)\ Y_i = \alpha + \beta_1 Amihud_i + \beta_2 Large_i + \beta_3 LAmihud_i + \varepsilon_i$$

$$(4)\ Y_i = \alpha + \beta_1 Amihud_i + \beta_2 Large_i + \beta_3 Medium_i + \beta_4 LAmihud_i + \beta_5 MAmihud_i + \varepsilon_i$$

Like the prior two specifications, I still seek to determine the impacts of liquidity risk and the size of the fund by including liquidity of the stock, size of the fund and interaction terms between the two. In *Specification 3*, I only include 10 small funds and 10 large funds, and their size is indicated by the *Large* variable that equals one if the fund is large and zero if the fund is small. Liquidity risk in both of these models is represented by *Amihud*. I multiply *Large* and *Amihud* together to create the interaction term, *LAmihud*.

As in the first two specifications, β_2 should still be positive. Since the Amihud measure works in the opposite way as the turnover rate, it should be the case that the sum of β_1 and β_3 is negative. A negative result indicates that with an increase in the Amihud measure, a large fund is less likely to hold the security. It is still not clear what the sign on β_1 should be.

As I did for *Specification 2*, I added 10 medium sized funds to *Specification 4*. I added the indicator variable (*Medium*) that equals one if the fund is medium sized and zero if it is large or small. I also interacted *Medium* and *Amihud* to create *MAmihud* in addition to the current interaction term, *LAmihud*.

In this specification, the same predictions hold as in *Specification 3*, but we also look into the medium sized funds. β_3 in this specification should also be positive, but still not as positive as β_2. It should also be that the sum of β_1 and β_5 is also negative, but not as negative as the sum of β_1 and β_4. These results should occur for the same reason that the effect for the Turnover rate shouldn't be as large. As in all specifications, it is still not clear whether β_1 should be positive or negative.

5. Results

Table 3 in the Appendix is the probit model's marginal effects for the specifications that include *Turnover* as the measure of liquidity. The results for *Specification 1* can be found in the first column. The summary statistics for *Specification 1* and *Specification 3* can be found in *Table* 5 in the Appendix, and the summary statistics for *Specification 2* and *Specification 4* can be found in *Table* 6 in the Appendix. Based off of the results in *Specification 1*, a one percentage point increase in the stock's Turnover Rate decreases the probability that a small fund invests in that stock by .0093 percentage points. This conclusion is based off of the marginal effect for the *Turnover* variable, β_1. For a large fund, a one percentage point increase in the Turnover Rate of the stock is represented by the sum of the marginal effects of *Turnover* and *LTurnover* ($\beta_1 + \beta_3$). This increase decreases the probability that a large fund invests in the stock by .0062 percentage points. A more general conclusion from this model is that a large fund is 8.23 percentage points more likely to invest than a small fund which is represented by the marginal effect for *Large* (β_2). For example, if the probability of a small fund investing in a particular stock is 1%, then the probability of a large fund investing is 1.0823%. The only statistically significant variables in this specification are *Turnover* and *Large*. The interaction term, *LTurnover*, is insignificant; however, for the purposes of my paper, I decided to interpret the coefficients.

Specification 2 also uses *Turnover* as the liquidity measure. All results for this specification can be found in Column 2 of *Table 3*. This model concludes that a one percentage point increase in the Turnover Rate of a stock decreases the probability of investment by .0083 percentage points for a small fund. This is represented by β_1. For a medium sized fund, a one percentage point increase in the Turnover Rate decreases the probability of investment by .0175 percentage points. This is calculated by taking the sum of the marginal effects for *Turnover* and *MTurnover* ($\beta_1 + \beta_5$). For a large fund the increase decreases the probability of investment by .0056 percentage points. This is the sum of the marginal effects for *Turnover* and *LTurnover* ($\beta_1 + \beta_4$). In general, a large fund is 10.3 percentage points more likely to invest than a small fund, while a medium sized fund is 3 percentage points more likely to invest than a small fund. For example, if the probability of a small fund investing in a particular stock is 1%, then the probability of a large fund investing is 1.103% and the probability of a medium sized fund investing is 1.03%. These values are represented by the marginal effects for *Large* (β_2) and *Medium* (β_3). In this specification, the interaction terms are insignificant; however, these conclusions still provide some insight into my hypothesis.

When observing these results, it makes sense that a large fund is more likely to invest since they have more money to invest than smaller funds; however, the conclusion that an increase in turnover ratio decreases the probability that a fund invests is in disagreement with my hypothesis that large funds do not invest in illiquid stocks as frequently as small funds. An increase in the turnover rate represents an increase in the liquidity of the stock, and this specification suggests that this increase in liquidity causes large funds to invest less.

In *Specification 3*, I used the Amihud Measure as the measure of illiquidity and only included small and large funds. Results for this specification can be found in Column 1 of *Table 4.* For a small fund, *Specification 3* concludes that a one percentage point increase in the Amihud Measure increases the probability that the fund invests by .0005 percentage points which can be seen with the *Amihud* marginal effect (β_1). For a large fund, a one percentage point increase in the Amihud Measure of a stock increases the probability of investment in that stock by .0009 which is the sum of the marginal effects for *Amihud* and *LAmihud* ($\beta_1 + \beta_3$). With the *Large* marginal effect (β_2), this model also concludes that a large fund is 8.26 percentage points more likely to invest than a small fund. For example, if the probability of a small fund investing in a particular stock is 1%, then the probability of a large fund investing is 1.0826%. *Specification 3* only had one statistically significant variable, *Large*. Like I did for *Specifications 1 and 2*, I chose to analyze the insignificant variables. The insignificance of the Amihud measure is consistent with the study done by Idzorek, Xion and Ibottson (2012) that was referenced in the literature review.

The results for this *Specification 4* can be found in Column 2 of *Table 4. Specification 4* concludes that a one percentage point increase in the Amihud Measure increases the probability that a small fund invests in a stock by .0004 percentage points which is the *Amihud* marginal effect (β_1). I also find that a one percentage point increase in the Amihud Measure increases the probability that a large fund invests by .0008 percentage points ($\beta_1 + \beta_4$) and that a medium sized fund invests by .0006 percentage points ($\beta_1 + \beta_5$). This model also finds that large funds are 10.38 percentage points more likely to invest than small funds based off of the *Large* marginal effect (β_2) and that medium sized funds are 2.90 percentage points more likely to invest than a small fund based off of the *Medium* marginal effect (β_3). For example, if the probability of a small fund investing in a particular stock is 1%, then the probability of a large fund investing is 1.1038% and the probability of a medium sized fund investing is 1.029%.

Like the specifications including Turnover for liquidity risk, the conclusions using the Amihud measure also do not fit my hypothesis. As previously stated for the prior specification, it makes sense that a large fund would be more likely to invest than a small fund, however, the remaining conclusions are not in line with my hypothesis that large funds tend to invest in more liquid stocks. My hypothesis is that an increase in the Amihud measure represents an increase in illiquidity, therefore a large fund would be less likely to invest with the increase of this measure. The conclusions drawn in this model prove this hypothesis to be incorrect.

No study looks into the specific holdings of a fund and whether or not they invest based off of these liquidity measures, therefore, my hypothesis was based off of previous literature on returns associated with liquidity risk and returns. While these conclusions are not in line with my main hypothesis, the conclusions found in my specifications could be due to the fact that large funds have a greater opportunity to lock up some of their funds in illiquid assets due to their long investment horizons and large size (Leyong and

Bok (2018)). Small funds do not have as much cash, therefore, they need many of their assets in liquid stocks that they are able to access when needed. In recent years, there has also been evidence suggesting that institutional investors are moving more into illiquid assets. A study by Towers Watson found that pension funds increased their illiquid holdings from 5% to 20% between 1995 and 2010, and the National Association of College and University Business Officers found that the proportion of illiquid investments in university endowment funds grew from 25% to 52% between 2002 and 2010 (Ang, Papanikolaou and Westerfield (2014)). This growth in the popularity of investment in illiquid assets could be due to the fact that fund managers are aware of this illiquidity premium discussed in the literature. While my paper does not look into the returns of the funds specifically, it could be that the outperformance found by Idzorek, Xion and Ibbotson (2012) outweighs the high transaction costs found by Dong, Feng and Sadka (2011). If this is the case, it would make sense for large funds to invest in more illiquid assets to realize this return.

6. Conclusion

Institutional investors have grown immensely over the past couple of decades. Since institutional investment is different than personal investment, it is interesting to look into what a manager looks for when picking stocks for his or her fund. Since these funds need to be able to quickly access cash for their clients, they must have a large portion of their assets tied up in liquid assets that they can rapidly process into cash. With large funds, it seems unlikely that they would invest in many illiquid assets due to the large price shift associated with a sizeable purchase of an illiquid stock.

Several studies prove that illiquid assets have higher returns than liquid assets in general (See Idzorek, Xiong and Ibbotson (2012), Amihud (2002) and Datar, Naik and Radcliffe (1998)), and it is also suggested that funds holding more illiquid assets outperform those holding fewer illiquid assets (Idzorek, Xion and Ibbotson (2012)). While these results are accurate, they may not be true when looking at small and large funds. It seems as if small funds outperform large funds that hold illiquid assets due to the high transaction costs incurred by a large fund (Chen, Hong, Huang and Kubik (2004)). These ideas are conflicting; one suggests that all funds should invest in illiquid stocks due to the illiquidity premium, but the other suggests that large funds should not invest in illiquid stocks due to the high transaction costs.

These previous studies look strictly at returns of funds and individual stocks, but in my paper, I look at the decision of whether a manager invests or doesn't invest in a particular stock based off of their fund's size and the liquidity risk associated with each individual stock. This provides insight into whether or not a manager considers liquidity risk when deciding whether or not to invest in a stock and how this liquidity risk affects their decision. To measure liquidity risk, I calculated the turnover rate and the Amihud measure for each particular stock. A higher turnover rate represents a stock that is more liquid while a higher Amihud Measure represents a stock that is more illiquid.

I ran a probit model with *Invest* as my dependent variable. *Invest* equals one if the manager chose to invest in the particular stock and zero if the manager chose to not invest in the stock. I ran four specifications with different combinations of fund size, the Amihud measure and the Turnover rate, along with interaction terms between these variables. The results from these models were opposite from what I had expected. I predicted that large funds would be less likely to invest in illiquid stocks; however, all models suggest that they would invest more with an increase in illiquidity.

While the results are surprising, they potentially fit with the previous literature that finds higher returns associated with illiquid investments (See Idzorek, Xiong and Ibbotson (2012), Amihud (2002) and Datar, Naik and Radcliffe (1998)). If a fund manager knows that they are more likely to outperform by holding more illiquid stocks, illiquidity may be a risk that they are willing to take. This result could also fit literature about high trading costs, but it could be that these high trading costs are not actually deterring large funds from holding these securities; they may be causing large funds to just hold onto the securities and not trade them as often.

In my study, many variables were insignificant, and the conclusions were not quite in line with my intuition. While my study does not provide a clear explanation for this discrepancy between my hypothesis and my results, there are potential ways to further the study and analyze this issue in the future. The main issue with my study is that I was only able to access information for stocks in the CRSP database. CRSP only holds data for securities traded in the NYSE (New York Stock Exchange) and the NASDAQ (National Association of Securities Dealers Automated Quotations). Relative to other types of investments such as Bonds, Real Estate and Private Equity, the public equities that are traded on these exchanges are often very liquid (Ang, Papanikolaou and Westerfield (2014)). Since illiquidity is relatively low for all of the stocks in my sample, this study can be furthered by incorporating data for these more illiquid investments.

Another potential test is to examine the holding periods for the illiquid securities in a large fund's portfolio and analyze if they are held longer than the liquid securities in the portfolio. Another approach is to see if these securities are held longer by small or large funds. If this test finds that large funds hold these securities longer than liquid securities and longer than small funds do, this would suggest that large funds have greater flexibility over holding periods than small funds. This would also be in line with the idea that large funds hold illiquid securities for longer to avoid paying the high transaction costs associated with trading.

My hypothesis was that large funds will invest less in illiquid stocks due to the significant price movement associated with their sizeable trades, but my results were not in agreement with my hypothesis. Since current literature doesn't look into the specific idea of investing in a stock or not based on liquidity risk, there isn't much to compare my results with. While my hypothesis was incorrect, this is not necessarily discouraging. It is very interesting that I encountered a counterintuitive result that leaves room for future research on the topic.

7. References

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8. Appendix

Table 3. Effect of Turnover Rate and Fund Size

This table reports the marginal effects with standard errors in parenthesis for *Specification 1* in Column 1 of the table and *Specification 2* in Column 2. All holdings data was collected from Thomson Reuters 13F filings. From there, specific stock data was collected from CRSP to calculate the Turnover Rate. In *Specification 1* I included 10 large funds from the 90th percentile of fund size and 10 small funds from the 10th percentile of fund size. In *Specification 2* I included 10 additional medium funds from the 50th percentile of fund size. The dependent variable for both specifications is an indicator variable, *Invest*, that equals one if the stock was held by the fund or zero if the stock was not held by the fund. For both specifications, *Turnover* is the stock specific turnover rate (calculation found in the Data section of the paper). *Large* is an indicator variable that equals one if the fund is large and zero if the fund is small or medium. *LTurnover* is an interaction term that multiplies *Large* and *Turnover* together. *Specification 2* includes two additional variables. Medium is an indicator variable that equals one if the fund is medium sized and zero if the fund is large or small. *MTurnover* is an interaction term that multiplies *Medium* and *Turnover.* P-Values: *10%; **1%.

Dependent Variable:	(1) Invest	(2) Invest
Turnover	-.00925**	-.00830**
	(.00556)	(.00506)
Large	.08231*	.10303*
	(.00161)	(.00260)
LTurnover	.00309	.00268
	(.00594)	(.00539)
Medium		.03016*
		(.00197)
MTurnover		-.00916
		(.00737)
# Observations	106,740	160,110
R-squared	.1123	.1030

Table 4. Effect of Amihud Measure and Fund Size

This table reports the marginal effects with standard errors in parenthesis for *Specification 3* in Column 1 of the table and *Specification 4* in Column 2. All holdings data was collected from Thomson Reuters 13F filings. From there, specific stock data was collected from CRSP to calculate the Turnover Rate. In *Specification 3* I included 10 large funds from the 90th percentile of fund size and 10 small funds from the 10th percentile of fund size. In *Specification 4* I included 10 additional medium funds from the 50th percentile of fund size. The dependent variable for both specifications is an indicator variable, *Invest*, that equals one if the stock was held by the fund or zero if the stock was not held by the fund. For both specifications, *Amihud* is the stock specific Amihud Measure (calculation found in the Data section of the paper). *Large* is an indicator variable that equals one if the fund is large and zero if the fund is small or medium. *LAmihud* is an interaction term that multiplies *Large* and *Amihud* together. *Specification 2* includes two additional variables. Medium is an indicator variable that equals one if the fund is medium sized and zero if the fund is large or small. *MAmihud* is an interaction term that multiplies *Medium* and *Turnover.* P-Values: *1%.

Dependent Variable	(1) Invest	(1) Invest
Amihud	.00046 (.00035)	.00042 (.00032)
Large	.08263* (.00131)	.10383* (.00223)
LAmihud	.00045 (.00039)	.00041 (.00036)
Medium		.02899* (.00170)
MAmihud		.00022 (.00041)
# Observations	106,740	160,110
R-squared	.1132	.1036

Table 5. Summary Statistics for Specifications with Small and Large Funds

This table reports the summary statistics for *Specification 1* and *Specification 3*. There are 20 funds in each of these specification, each with 5,337 stocks that they could've potentially been holding. This gives each specification 106,740 observations. The dependent variable for each specification is *Invest. Specification 1* includes *Turnover, Large* and *LTurnover*. *Specification 2* includes *Amihud, Large* and *LAmihud.*

	Number of Obs.	*Mean*	*Std. Dev*
Invest	106,740	.04874	.21531
Large	106,740	.50000	.50000
Turnover	106,740	.12815	.75375
LTurnover	106,740	.06407	.53682
Amihud	106,740	-.55975	7.8293
LAmihud	106,740	-.27987	5.5432

Table 6. Summary Statistics for Specifications with Small, Medium and Large Funds

This table reports the summary statistics for *Specification 2* and *Specification 4*. There are 30 funds in each of these specification, each with 5,337 stocks that they could've potentially been holding. This gives each specification 160,110 observations. The dependent variable for each specification is *Invest. Specification 2* includes *Turnover, Large, Medium, LTurnover* and *MTurnover*. *Specification 2* includes *Amihud, Large, Medium, LAmihud* and *MAmihud.*

	Number of Obs.	*Mean*	*Std. Dev*
Invest	160,110	.039504	.194792
Large	160,110	.333333	.471406
Medium	160,110	.333333	.471406
Turnover	160,110	.128186	.753757
LTurnover	160,110	.064070	.536820
MTurnover	160,110	.042729	.439957
Amihud	160,110	-.559749	7.82928
LAmihud	160,110	-.186583	4.52793
MAmihud	160,110	-.186583	4.52793