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# THE EFFECTS OF LIQUIDITY AND SHARE RESTRICTIONS ON HEDGE FUND PERFORMANCE IN BULL AND BEAR MARKETS

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Abstract

Hedge funds are increasingly becoming a popular alternative investment vehicle. They are much more flexible and can freely choose from a pool of investment strategies due to their limited regulations. This gives them the flexibility to exploit opportunities in order to generate high returns at low risk. In order to have access to the freedom and flexibility to engage in different investment strategies, hedge funds often impose share restrictions in the form of lockup, redemption notice period and redemption frequency period to limit the ease with which investors can have access to their investment (limited liquidity).

In this study, we evaluate the effects that share restriction could have on the performance of hedge funds in both crisis and non-crisis periods. We find that consistent with previous studies hedge fund performance is positively related with share restrictions. That is, funds that impose stricter share restriction have a better performance in terms of returns and alphas. This is especially seen in the non-crisis period where funds that are more illiquid are able to generate and illiquidity premium for investors to reward them for limiting their investment. However, in the crisis period we find out that this illiquidity premium changes into an illiquidity discount. We also find that funds that impose stricter share restrictions are more volatile and are more likely to take on more risky investment in order reap an illiquidity premium.

Our results show a positive correlation between the three share restrictions. Thus, in our study we find that funds that impose one share restriction are more likely to impose the others. Hedge funds with stricter share restriction mostly invest in illiquid assets. We find that the underperformance of illiquid funds during the crisis was majorly driven by styles consisting mostly of illiquid funds such as relative value and event driven styles.

We also investigate the performance of funds with an asset-liability mismatch- funds holding a combination of illiquid asset portfolios and weak share restrictions. Our findings suggest that funds that have an asset-liability mismatch perform particularly poorly during the crisis and that there are possibilities to prevent an asset-liability mismatch by ensuring a proper alignment of share restrictions with asset portfolio liquidity.

This study contributes to previous academic studies by investigating whether after the crisis period hedge funds yielded comparatively high returns as prior to the crisis period. We compare hedge funds returns from before, during and after the crisis to see if during the period preceding the crisis hedge funds continued reaping high return as they did prior to the crisis. We do this to prevent generalizing the effect of share restrictions on hedge fund performance to all market conditions. The results from our contribution shows that just like most industries the hedge fund industry did not earn as high returns as they did before the crisis (even though they had positive returns). It seems that they were struck severely by the financial crisis and have been unable to pick up quickly to where they were (in terms of returns) prior to the financial crisis.

Keywords Liquidity, liquidity risk, share restriction, financial crisis, hedge fund performance

Additional information

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# 1 INTRODUCTION

The main purpose of this research is to examine the effects of liquidity and share restrictions on hedge fund performance in bull and bear markets. Since the early 90's, the hedge fund industry has become a popular choice for many investors. It is seen as an alternative investment vehicle as compared to the traditional mutual fund industry. Although both hedge funds and mutual funds aim at diversifying and properly managing investors' money, hedge funds, however aim at generating absolute return even during economic downturns which is highly unlikely for mutual funds to imitate. No wonder an increasing number of endowments, insurance companies and pension funds are investing more into hedge funds now a days. According to Hedge fund Research, by the end of the year 2012 hedge funds asset under management had grown to a record of $2.25 trillion from $4.88 billion in the year 2000.This record setting figure together with the existing strategy mix of most hedge funds has done well in setting them apart from other funds and made them more attractive to both institutional investors and high-net worth individuals.

Although the use of hedge funds as an alternative investment channel is growing rapidly, there are still many areas of the industry that is loosely regulated. Hedge funds are generally more composed of offshore funds than onshore funds. The main reason behind this imbalance is because of the tax benefit and loose regulatory environment associated with offshore funds. For instance, Liang and Park (2007) found that offshore hedge funds in the Lipper TASS database managed about 39% more assets than onshore funds. Since these offshore funds are not US based and thus are not subject to the regulations of the Securities and Exchange Commission (SEC), they are otherwise free from regularly disclosing information on their standard performance (their trading strategies or their portfolio holdings) because most hedge funds report voluntarily to data collectors. However, there are certain criteria's of institutional investment managers that must still report to SEC. For instance the SEC act of 1934 which was amended in 1975 to enact Section 13(f) stipulates that, ''every Manager which exercises investment discretion with respect to accounts holding Section 13(f) securities, as defined in rule 13f-1(c), having an aggregate fair market value on the last trading day of any month of any calendar year of at least $100,000,000 shall file a

report on Form 13F with the Commission within 45 days after the last day of such calendar year and within 45 days after the last day of each of the first three calendar quarters of the subsequent calendar year.'' (Security Exchange Act 1963:13F) For each 13(f) security, the manager is required to report the name of the security issuer, title of the issue, Committee on Uniform Security Identification Procedures (CUSIP) number, fair market value, and amount of the security (Aragon and Martin, 2012).

Generally, hedge funds are more flexible and can freely choose from a pool of investment strategies due to low regulations. This gives them the flexibility to exploit opportunities in order to generate high returns at low risk. For instance, they can take both long and short positions, use arbitrage strategies, buy and sell undervalued securities, trade derivative securities or bonds. Hedge funds engage in different strategies but they typically aim at reducing volatility and risk while trying to generate positive returns in both bull and bear market conditions. This was however not the case during the recent financial crisis. In 2008 hedge funds generated negative returns and saw an increase in the withdrawal of funds. In fact hedge funds have been mentioned alongside banks and other firms as one of the driving forces of the financial crises (Lysandrou 2012). According to the Federal Reserve Bank of San Francisco, just like banks and other big companies, hedge funds played a major role in amplifying the systematic risk existing in the financial market. Academic studies suggest that during crises, hedge fund returns become more correlated and the overall industry experiences poor performance (Lysandrou 2012). However, based on the findings from these studies, it is difficult to provide a verdict in favor or against hedge funds' role in propagating systemic risk. The main challenge is that there are multiple parties, along with hedge funds, involved in crises. These parties include service providers (prime brokers, auditors, administrators, etc.), investors, and other financial institutions trading simultaneously. On one hand, since hedge funds choose to be leveraged, one can argue that they are responsible to some extent in triggering crises when they are forced to deleverage and unwind their positions. On the other hand, one can argue that prime brokers that are regulated should have been more judicious in providing margin financing to funds.

Previous studies provide different conclusions concerning the impact of imposing share restrictions on funds' performance. The results have however been mixed and inconclusive. For instance, Aragon (2007) finds that funds with the lockup restriction outperform other funds without lockup restrictions by 4-7% per year. He asserts that fund managers are able to reap positive returns by imposing restrictions (lockup) that allow them to invest in more illiquid assets. In the same line, Schaub and Schmid (2012) agree that hedge funds reap most of their returns in the form of illiquidity premium from bearing illiquidity risk[1]. Liang (1999) also finds a positive relation between the length of lockup periods and average hedge fund returns. Agarwal, Daniel, and Naik (2009) find that funds with a higher degree of managerial discretion[2] deliver superior performance, because they have more freedom to engage in various arbitrage strategies. Hombert and Thesmar (2009) studies the role of share restrictions based on past performance and find that funds that impose share restrictions outperform funds without share restriction preceding a poor performance. They argue further that funds with share restrictions can afford to underperform in the short run while holding on to lucrative arbitrage opportunities.

Other studies, on the other hand argue that imposing share restrictions come at potential cost to investors. Ang and Bollen (2008) find that in certain situations share restriction can be costly to hedge fund investors. They theoretically evaluate the indirect costs that investors may face as a result of share restrictions by estimating the chances that an investor withdraw his or her investment as a real option and treats lockup and notice periods as an exercise restrictions. Joenvaara and Tolonen (2008) find that funds with lockup restrictions underperform those without lockup restriction because fund manager that have the lockup restriction tend to engage in more risky venture (excessive risk takers).

We think that it is essential to evaluate share restrictions in the light of the financial crises because; firstly, the implication of applying share restrictions is two faced. It either works in favor of the fund managers or then it can have a potentially negative

[1] Holding illiquid assets in a portfolio is seen as risky and thus hedge funds should be greatly compensated for their risk taking ability.
[2] Proxied by longer lockup, notice, and redemption periods

effect on the investors since managers can invest in illiquid assets without the fear of investor requesting to withdraw their investments easily. Investors, on the other hand may rather be faced with the hardship of sticking to a poor performing manager. The adverse effect of being stuck with a poor performing manager is even more pronounced during crisis period. Secondly, many studies have been able to evaluated the effect of share restriction on hedge fund performance but have not done so diligently because the results gotten from these studies are one sided cannot be generalized to all market conditions. Thus, there is a need to examine the relationship between hedge fund performance and share restriction separately for both crisis and non-crisis period.

In this study we evaluate the effect of share restrictions on hedge fund performance in both crisis and non-crisis period. We also examine whether share restrictions are used to prevent the possibility of an asset liability mismatch and, therefore, are significantly related to the hedge funds' asset portfolio liquidity as measured by the smoothing parameter of Getmansky, Lo and Makarov (2004). For this reason we also examine the joint effect of share restriction and asset portfolio liquidity on hedge funds performance in both bull and bear market conditions. Next we evaluate the performance of funds that hold illiquid assets and yet have weak share restrictions in both crisis and non-crisis periods.

This study contributes to previous academic studies by investigating whether after the crisis period hedge funds yielded comparatively high returns as prior to the crisis period. We compare hedge funds returns from before, during and after the crisis to see if during the period preceding the crisis hedge funds continued to reap as high return as they did before the crisis. We do this to prevent generalizing the effect of share restrictions on hedge fund performance to all market conditions. There should be a clear difference between the effects of share restrictions on hedge fund performance in different market conditions including the post crisis period.

The results from our contribution shows that just like most industries the hedge fund industry did not earn as high returns as they did before the crisis (even though they had positive returns). It seems that they were struck severely by the financial crisis and

have been unable to pick up quickly to where they were (in terms of returns) prior to the financial crisis. According to a recent article, hedge funds even made negative returns four consecutive months in 2015. This was the longest period of negative returns recorded ever since the financial crisis of 2007–2008. (Roche, 2015).

Our main findings are as follows. First, we show that funds that impose stricter share restrictions reap higher returns and alphas in the non-crisis period. In order words, such funds generate an illiquidity premium as a compensation for limiting investor's liquidity. However, in the crisis period, we find a negative relationship between share restriction and fund performance such that the illiquidity premium turns into an illiquidity discount. Second, our results show a positive correlation between the three share restrictions. Thus, in our study we find that funds that impose one share restriction are more likely to impose the others. Hedge funds with stricter share restriction mostly invest in illiquid assets. We find that the underperformance of illiquid funds during the crisis was majorly driven by styles consisting mostly of illiquid funds such as relative value and event driven styles. Our results also suggest that asset portfolio liquidity is positively related to hedge fund performance in the crisis period but negatively related to fund performance during the non-crisis period. We also find that funds that impose stricter share restrictions are more volatile and are more likely to take on more risky investment in order reap an illiquidity premium. We find particularly poor performance for funds with an asset-liability mismatch (especially during the crisis) and a possibility to prevent an asset-liability mismatch by properly align share restrictions with asset portfolio liquidity.

The rest of the study is organized as follows. This section presents the purpose of this study and the empirical hypotheses. Section 2 provides a comprehensive review of recent academic literature. Section 3 describes the data and methodology used in this study. Specifically the section identifies some data biases as well as the methodology for measuring share restriction, asset portfolio liquidity and liquidity risk to enhance further analyses. Section 4 provides empirical results of the study. Section 5 provides the conclusions from our findings.

## 1.1 Aim of the study and hypotheses

The main purpose of this study is to investigate the effect of liquidity and share restrictions on hedge fund performance in both bull and bear markets. The moving average model proposed by Getmansky et al. (2004) is considered as a proxy for the average liquidity level of a hedge fund's portfolio. In addition, we use lockup period, redemption notice period, redemption frequency period as proxies for share restrictions. Like Schaub and Schmid (2012), we show that share restrictions can be proxies for asset liquidity. We also try to figure out whether the abilities of hedge funds with strict share restriction to generate illiquidity premium are strongly affected by financial downturns.

It is only rational that investors expect to reap higher returns from assets whose returns depend largely on aggregate liquidity. Pastor and Stambaugh (2003), empirical study investigates whether expected returns are related to systematic liquidity risk in returns. That is, if the market-wide liquidity can be priced, thus yielding a premium. They find that stocks whose returns are more exposed to market-wide liquidity risk[3] have higher expected return. (Pastor and Stambaugh, 2003)

Amihud and Mendelson (1986) employing different liquidity measures to conduct an empirical studies to examine the relation between expected returns and the level of liquidity. They find in the stock returns that illiquid stocks tend to have higher average returns than liquid stocks.

According to Brunnermier and Pedersen (2009), an arbitrageur's possibility to implement an arbitrage is contingent on both the funding liquidity in the market and the market liquidity of an asset. This is because when a trader finds it hard to obtain funding, they become reluctant to implement capital intensive positions in high margin securities. This lowers market liquidity and increases volatility in the market. They

[3] As measured by their liquidity betas

find that during market downturns, funding and market liquidity makes it difficult for arbitrageurs to implement their strategies.

An arbitrage is the act of taking advantage of the price difference between the sale and purchase of the same or similar security in two different markets (Sharpe and Alexander 1990). This definition implies riskless and low capital intensive trade. However, in most real world situations arbitrageurs trade in bond and equity markets. Most real world arbitrageurs invest people money leading to the rise of an agency problem especially during the crisis period where, in the light of capital constraints arbitrageurs may be unable to invest when price levels are below fundamental value but rather may be forced to sell securities cheap; causing a further reduction in prices. (Mitchell, Pedersen and Pulvino 2007, Shleifer and Vishny 1997)

Mitchell, Pedersen and Pulvino (2007) studies the convertible bond market in 2005 and finds that convertible hedge funds were faced with large capital withdrawal due to past low returns of 2014. In order to satisfy the need of investors who wanted to redeeming their capital the hedge funds had to sell their convertible bonds (illiquid in nature) at comparatively lower prices. This caused the prices of convertible bonds to fall relative to its fundamental value and this led to further redemption and more selling of the bonds. According to Mitchell et al. (2007), the illiquidity of convertible bonds is likely the reason for the illiquidity discount reaped by such funds during highly volatile times in crisis periods. This problem is also explained by Brunnermier and Pedersen (2009) as a liquidity spiral which surfaced after the collapse of the Lehman brothers in September 2008.

Nonetheless, according to a study by Khandani and Lo (2009) hedge funds recorded an illiquidity premium of 3.96% per annum. However, they find that the hedge funds that contribute the most to this illiquidity premium are Convertible Arbitrage and Fixed Income Arbitrage, with premiums of 9.91% and 7.08%, respectively. Surprisingly the Managed Futures category (CTA) which are usually among the most liquid of hedge funds also recorded an illiquidity premium of about 4.91%. This suggests that there is a significant variability in liquidity among the managed future category (CTA).

Moreover, Aragon (2007) argues that share restrictions allow fund managers to efficiently manage illiquid assets so that investors of such illiquid assets can reap benefits in the form of illiquidity premium. To support his argument he finds that the excess returns of hedge funds with lockup periods are approximately 4% to 7% per annum higher than those of funds without lockup periods. His findings are consistent with what has been found in other studies, stating that there exists a positive relationship between share restrictions and hedge fund performance. (Bali, Gokcan and Liang 2007, Liang and Park 2007, Agarwal, Daniel and Naik 2009).

However, Ang and bollen (2010) find that illiquidity costs increase as the lockup and redemption notice periods increase and that illiquidity costs can increase up to 10% above the initial investment if the fund managers initiates discretionary liquidity restrictions in the form of restriction gates. More so, they find that these illiquidity cost rises as the volatility increases. Therefore, in high volatility crisis period the illiquid premium changes into illiquidity discounts. Thus the primary hypothesis for this study is established as follows:

H1: Hedge funds that impose strict share restrictions generate higher returns during non-crisis period and reap illiquidity discounts during crisis periods due to the holdings of illiquid assets.

In order to prevent hedge funds from collapsing and also protect the interest of investors, hedge funds raised gates during the recent financial crisis of 2007–2008 to increase their cash holdings. They also reduced investments made into risky assets (Liu and Mello 2011). Some hedge funds were even forced to sell assets at unreasonable prices in order to meet investor's pressure for redemption, while others were forced to "raise gates" in order to prevent redemption for a set period of time (Liu and Mello 2011). We will expect that funds that impose stricter share restrictions will invest more in illiquid assets so as to properly manage their liquidity risk exposure. However, Teo (2011) finds that this is not always the case as funds still hold illiquid assets portfolios despite having weak share restrictions. This situation leads to an asset-liability mismatch where by, the trade-off between the types of assets held (liquid or illiquid) and the type of restriction put in place cannot work together to reduce the

funds exposure to liquidity risk. We consider different combinations of asset portfolio liquidity and share restrictions in both bull and bear markets to find out if our second hypothesis holds:

H2: Hedge funds with an asset-liability mismatch, suffer particularly poor performance in a crisis.

# 2 LITERATURE REVIEW OF HEDGE FUND PERFORMANCE

## 2.1 Overall hedge fund performance

Literature has attributed the overall performance of hedge funds to many factors such as the funds characteristics and strategies, the skill of the fund manager and the state of the economy. Empirical evidence provided by Liang (1999) on the performance of hedge funds indicates that funds with water marks significantly outperform their counterparts (funds without watermark). He also finds that on the average hedge funds returns are positively related to the size of the fund, the lockup provision and incentive fees. According to Liang (1999) hedge funds engage in dynamic trading strategies and because these different strategies have a low correlation with each other, funds are generally characterized by low systematic risk. Compared to mutual funds hedge funds provide better risk-returns trade off. Thus hedge fund strategies are believed to provide better investment prospect for investors.

Kosowski, Naik and Teo (2007) use a bayesian and bootstrap approach to find out if hedge funds provide alpha. Their empirical results show that the *t*-statistics of alpha, used for the purpose of ranking hedge funds managers performance cannot be attributed to luck, but that asset selection skill may be the driving force of performance and persistence.

Agarwal and Naik (2000) contribute to the existing literature on performance persistence among hedge funds by examining whether hedge funds performance persistence is short-term or long-term in nature. Using a database that covers both offshore and onshore hedge funds they examining whether persistence is sensitive to the length of return measurement intervals. They use quarterly, half-yearly and yearly returns and find that persistence among hedge fund managers is short-term in nature and decreases as one approaches yearly returns.

Unlike mutual funds, which constantly measure themselves against their appropriate benchmarks and comment on their performance based on their benchmarks, hedge funds performance can be measured in more than one way. However, the

heterogeneous nature of hedge funds have raised criticism concerning the performance measures applied in earlier studies. Therefore it is important to know the specific characteristics of hedge funds and their implications in terms of performance measurement before analyzing hedge fund returns. (Géhin 2004)

## 2.1 Liquidity risk and liquidity premium

Unlike mutual funds, hedge fund investors are more concerned about liquidity. That is, how easily investor can retrieve their money. Liquidity provisions in hedge funds may vary, however already invested funds are more difficult to withdraw from at any time. This is because many hedge funds apply lockup period which is a period during which investors are not allowed to redeem their capital.

Liquidity is the ease with which assets can either be bought or sold on a market without having a negative impact on the asset price. The whole concept of liquidity involves the use of illiquid assets to enjoy illiquidity rents. When hedge funds invest in illiquid assets they take on more liquidity risk and therefore must be compensated in terms of higher returns as a result of the risk involved in holding illiquid assets. Amihud and Mendelson (1986) predicts that there should be a positive relationship between illiquidity and required rates of return because investors will only be attracted to invest in illiquid assets if the illiquid asset offers a higher expected return as opposed to the liquid assets. Financial theory also suggests that liquidity risk should be priced since liquidity varies gradually over time. (Chorida, Roll and Subrahmanyam 2001, Acharya and Pedersen 2005). Sadka (2010), finds that funds that load positively on liquidity risk perform better than funds that load negatively on liquidity risk by about 6.5% on average between the years 1994–2009.

As the name implies illiquid assets are hard to get rid of due to uncertainty in the value of the asset or a mere lack of an appropriate market at the said time. Liquidity risk refers to the inability for an asset to be immediately sold at a conducive price without creating losses. Liquidity risk is mostly borne by hedge funds that hold large volumes of illiquid assets.

Hedge funds are majorly faced with two forms of liquidity. The first one is market liquidity and the other one is fund liquidity. Market liquidity has to do with the ease with which instruments used in the various investment strategy be converted into cash at a reasonable value. On the other hand, fund liquidity refers to how fast investor can withdraw itself from a certain fund investment given the terms and conditions. (Brunnermeier and Pedersen 2009). Although market liquidity and fund liquidity interacts with each other to affect funds' performance, they each have a different impact on hedge fund performance. Tiwari, Sa-Aadu and Ilerisoy (2015) finds that hedge fund returns were higher for funds with high market liquidity exposure and low funding liquidity exposure, and were lower for funds with low market liquidity exposure and high funding liquidity exposure.

In the wake of the recent financial crisis, global Institutional investors have placed more importance on liquidity, meaning that they are willing to sacrifice their chances of earning high returns in exchange for more liquidity when they invest into hedge funds. (Sourbès 2012)

A study by Preqin (an alternative asset database) revealed that since 2007 long-short funds that allowed investors to redeem their capital every three months generated a total return of 58% (Sourbès 2012). However comparing this return with long-short funds that allow investors to easily access their capital by means of the funds daily and weekly redemption clauses, they find total returns of 28% for daily redemption and 36% for weekly redemption over the same time period. Preqin also stressed that hedge funds that provided less liquidity to its investors have more volatile returns and have the largest drawdowns during economic downturns. The survey also revealed that the number of hedge fund investors looking for liquidity was diminishing. Also, because illiquid fund have been found to perform better, they have now become more attractive to investors that have long-term investment horizons and can afford to invest into funds with longer lock up period. Furthermore, the data company also stated that investors were more willing to accept longer lockup periods for illiquid strategies that were mainly dealing with illiquid assets. (Sourbès 2012)

The use share restrictions allows most hedge fund managers to properly manage illiquid assets. For this reason it is assumed that hedge funds will invest more in illiquid assets. A negative relationship between the use of share restrictions and asset portfolio liquidity has been identified by several studies (Aragon 2007, Liang and Park 2007, Khandani and Lo 2011) meaning that hedge fund that impose stricter share restrictions have less liquidity in their asset portfolios, and by properly managing these illiquid assets hedge funds are able to generate some illiquidity premium. But, some studies report that hedge funds do not always apply share restrictions as a way to manage their liquidity risk. In fact, some studies have found that hedge funds with weaker share restrictions are extremely exposing themselves to liquidity risk by investing in less liquid assets, this refers to the asset-liability mismatch. (Teo 2011.)

Some hedge funds portray to have more liquidity in their underlying assets than they actually have. As already mentioned, gates allow hedge funds to limit the proportion of the funds capital that an investor can withdraw at any point in time. However, Teo (2011) mentions that hedge funds that are particularly faced with agency issues are more likely to take on more liquidity risk thereby worsening the existing asset-liability mismatch. Also, the presence of short-term financing (leverage) and a combination of rather illiquid assets can expose hedge funds to possibly significant liquidity risk (Kambhu, Schuermann and Stiroh 2007).

According to Teo (2011), agency problems to some extent are the reason behind funds exposure to excess liquidity risk. Hedge funds that are faced with agency problems where the motives of both the agents (hedge funds) and principal (investors) are not aligned breeds more risk taking attitudes. Such hedge funds are known to take on more liquidity risk because of the potential benefit of higher returns that lay ahead which can also be a motivating factor for more investors to invest capital into the fund. Hedge funds that are often faced with agency problems, tend to take on more liquidity risk so as to generate remarkable returns and appeal to investors. (Teo, 2011)

A study of equity returns has provided a considerable amount of evidence in support of liquidity premium (Brennan and Subrahmanyam 1996, Amihud 2002, and Hasbrouck 2009). However, on the issue of liquidity risk premium the results of the

findings are mixed. For instance, Pastor and Stambaugh (2003), Sadka (2006) and Korajczyk and Sadka (2008) find evidence that equities can yield liquidity premium since liquidity risk can be priced in equities. On the other hand, other studies reach different conclusions. While Acharya and Pedersen (2005) find little signs of a liquidity risk premium, Hasbrouck (2009) finds no proof of the existence of liquidity risk premium. Watanabe and Watanabe (2008) find that only liquidity betas calculated during a high liquidity beta regime are priced in the cross section of stock returns.

## 2.2 Share restrictions

Share restriction is a major tool being used by hedge funds to limit the amount of capital that investors can withdraw at a time. These restrictions come in the form of lock up period; which specifies the time period within which an investor cannot have access to the funds capital. Redemption notice period is required by most hedge fund managers. It is the period when managers are notified of any potential capital withdrawal prior to it been withdrawn. This notice period allows most hedge fund to prepare for liquidating in an orderly manner and to prevent selling assets at very unfavorable prices (Pulvino, 1998). Redemption frequency period is the amount of time needed before an investor can redeem his/her money from the fund. This limits redemption to only certain periods in time. There is also the minimum amount of investment, which is usually required for investing in hedge funds. Thus hedge funds are known to be accessible to high net worth individuals as well as wealthy institutional investors.

Several studies have been conducted to analyze the effects of share restriction on hedge fund performance. Most of these studies have found a positive relationship between the application of share restrictions and hedge fund performance. Liang (1999) finds that funds that apply longer lockup period reap higher average return. Aragon (2007) argues that the 4–7% higher returns can be explained by the funds lockup provision. This means that funds are able to reap illiquidity rents through the use of share restrictions which enables them to adequately manage illiquid assets. Liang and Park (2007) also affirm this and state that offshore funds reap a higher illiquidity premium than onshore funds. Owning to the fact that offshore funds are less regulated than

onshore funds, offshore funds can afford to hold larger amounts of illiquid assets and thus reap higher illiquidity premium. Agarwal et al. (2009) argues that funds that implement all three (longer lockup, notice and redemption periods) share restrictions have greater managerial discretion and are able to deliver better performance.

Ang and Bollen (2010) examines how a risk averse investor can redeem his or her money as a real option. They imply that there are some cost attached to the use of share restrictions by evaluating how often investors can withdraw their capital as a real option. However they identify in their study that the liquidity cost is way below the illiquidity premium reported in the study of Aragon (2007). Since long lockup and redemption notice period have a positive effect on illiquidity cost, Ang and Bollen (2010) also find that if fund managers can in some way temporarily interrupt redemption and raise gates then the illiquidity cost can be worth as much as 10% of the initial capital invested. They find further that these illiquidity costs also increase more in unstable market conditions. As a result of their study, the findings of Liang (1999), Aragon (2007), Liang and Park (2007), and Agarwal et al. 2009 may not be persistent during economic downturns (crisis period).

Another method by which investor's liquidity can be restricted apart from imposed share restrictions is the imposition of discretionary liquidity restrictions (DLRs). Aiken, Clifford and Ellis (2015) study hedge funds that imposed discretionary liquidity restrictions (DLRs) on investor shares during the financial crisis. According to Aiken et al. (2015), share restrictions are imposed to ensure that under normal economic conditions hedge funds can invest in illiquid assets without the fear of being faced with the pressure of selling illiquid assets at fire sale prices due to the redemption needs of investors. However, during bad market conditions especially the financial crisis of 2007–2009 hedge funds were faced with withdrawals requests that could no longer be controlled by ordinary share restrictions. In order to reduce the level at which investors were withdrawing their capital, fund managers enacted discretionary mechanisms such as outright suspension, restriction gates and side pockets (Aiken et al. 2015). Outright suspension is the most severe DRL and completely prevents investors from redeeming their capital until the funds operations are in order. Restriction gates on the other hand are less severe and allows only a maximum amount to be redeemable (say 10%). Side

pockets are specially created vehicles used by hedge funds to provide interest to investors after separating illiquid and liquid assets from the main fund and sharing those assets to investors as payments in kind. The side pockets own and manage the assets and can be illiquid for as long as the assets are wind down in an orderly manner. Although DLRs are thought to be able to extend a funds life and ensure that investors do not suffer liquidity runs (by ensuring that assets are sold at fair value after the market for managers to stabilizes), it however makes it difficult to redeem capital from poorly performing funds. Thus creating liquidity cost for investors.

## 2.3 Financial crisis

Since the initiation of hedge funds in the 90's there has been quite a number of financial crises apart from the recent financial crisis of 2007–2008. There were other prominent crises in the past such as the European currency crisis in the 1990's, the Russian crisis and the collapse of Long-Term Capital Management (LTCM) in 1998 and the burst of the dot-com bubble in 2000. Hedge funds are known to be the big players in the market, working against all odds to generate absolute return all year round and in all market conditions. The downside to this attract story however, is that markets are generally imperfect and are prone to economic crashes and bubbles. This raises question as to whether hedge funds were part of the key players in the market that contributed to these bubbles.

As established earlier, hedge funds have loose regulation governing the ways by which they investment. They have a pool of investment styles to choose from. According to Strömqvist (2009) hedge fund commonly adopt the arbitrage strategy by trying take advantage of any mispricing within the market. This can have both positive and negative effect on the financial markets. For instance, when statistical or economic models are able to figure out any sort of mispricing in assets the gains are accrued to the hedge funds. Investors that buy undervalued assets and sell overvalued assets tend to help improve pricing by driving prices back to their fundamental value; this process contributes towards building market efficiency. The freedom that hedge funds enjoy in their investment style also helps to improve liquidity within the financial system. Because hedge fund investments are considered more active than other investment it

is believed that there will be constant transaction of assets either by buying or selling. Unlike other traditional investment companies hedge funds are becoming more rampant in new market and most especially, they can afford to invest in illiquid assets. However the flexibility that they enjoy comes with some level of risk especially in the case of highly leveraged funds. Although leveraging may increase the profit making ability of the hedge fund, it also increases the chances of a funds failure. This is because leveraging is known to amplify both loses and gains (Barbarino 2009). Lenders of highly leveraged funds face high level of risk and any subsequent failure of the fund may have a rippled effect throughout the entire financial system. Additionally, the use of derivatives in hedge fund investments also involves some amount of risks. By using derivatives hedge funds with a small capital contribution can take on large positions in the market, which can also secure extra leverage for the manager. (Athanassiou 2012)

According to Ang, Gorovyy, Inwegen and Gregory (2011: 26), hedge funds' leverage decreased before the crisis. They find that "hedge fund leverage is counter-cyclical to the leverage of listed financial intermediaries and decreases prior to the start of the financial crisis in mid-2007. Hedge fund leverage is lowest in late 2008 when the market leverage of investment banks is highest".

A study on hedge fund liquidity in the light of the Lehman bankruptcy found that stocks that were held by funds owned by Lehman were greatly affected by a decline in market liquidity after bankruptcy than for stock that were not connected to Lehman funds. (Aragon and Strahan 2012). More so, The Federal Reserve Bank of San Francisco in their new research blame hedge funds as being key contributors towards the global financial crisis of 2007–2008 since they transfer risk in like manner as banks and other financial institutions do.

Even though, hedge fund have been blamed to some extent for the financial crisis, they however seem to have also suffered severely at the hand of a downturn in the economy. Consequently, Dai and Shawky (2013) used Fund of hedge Funds (FoHFs) performance as a proxy for general hedge fund performance and compared its performance during the financial crisis. They found the financial crisis to have had a

significant negative effect on FoHFs performance and it was the largest funds that suffered the most. FoHFs are known to be highly diversified but it was found that being highly diversified could not even rescue them from poor performance during the crisis. More so, Strömqvist (2009) finds in her study on hedge fund and financial crisis that hedge funds have suffered more problems in handling the recent crisis than they did handling previous crisis.

Investors are often in need of liquidity and accurate prices mostly during financial crisis. During this period hedge funds tend to cut their arbitrage positions and hoard cash. They become less aggressive in taking on risk and thus limit their arbitrage opportunities by hoarding cash. (Liu and Mello 2011). Liu and Mello (2011), asserts that insufficient arbitrage trading can cause financial markets to undergo a series of continuous deterioration that can prolong a financial crisis further.

# 3 DATA AND METHODOLODY

## 3.1 Lipper TASS data base

This study makes use of the Lipper Hedge Fund Database (hereafter TASS) which is a leading hedge fund data vendor. The database consists of information on individual funds. Fund-of-funds are excluded from our sample because they invest in hedge funds that use share restrictions and also because fund-of-funds by themselves impose share restriction. The sample contains information on single-manager funds. The TASS database consists of information for a total of 10,067 hedge funds from the period of December 1993 to September 2013. The database consist of both "alive" and "defunct" funds. Defunct hedge funds are either liquidated, restructured, merged with other hedge funds, or stopped reporting. The database has a total of 3,132 alive funds and 6,935 defunct funds. The database includes two files: the fund return file which includes all reported monthly returns of each fund and the information file which includes other fund specific information such as the funds strategy description, domicile, fees, share restrictions, currency denomination, management fees, incentive fees and some other supplementary details.

Hedge funds report voluntarily to all databases. For this reason many hedge fund data bases suffer from many data biases such as survivorship bias, backfilling bias, self-selection bias, stale price and illiquidity bias, and the multi-period sampling bias. These biases may influence hedge funds performance and risk measures. In this study we try to reduce the occurrence of these biases when estimating the performance and risk measure of hedge funds.

According to Liang (2000) and Fung and Hsieh (2000), survivorship bias can affect the performance measures of hedge funds. Consequently, we follow literature and base the analyses on a sample period from January 1994 to September 2013. We expect that in our sample every single fund would have at least two years of return observations. This condition reduces our sample to a total of 8,811 hedge funds with 2,903 alive funds and 5,908 defunct funds.

Since minimum investments are not all quoted in U.S. dollar, and because we need a uniform and common currency for all funds, we exclude all funds that do not quote their minimum investment in U.S dollar. Excluding these fund further reduces our study sample to a total of 5,639 hedge funds with 1,398 alive funds and 4,241 defunct funds.

Table 1 presents the number of alive, dead, combined hedge funds in our TASS database sample. Every fund is expected to have at least 24 months return observations. The TASS database consists of 10 main strategies that funds in the database: *No* describes the number of alive, defunct and combined funds of each strategy. The relative size of each strategy are reported in percentages.

Table 1 clearly depicts that the funds are not evenly distributed among the 10 strategies. The Long short strategy group (2,059) seems to be overwhelmingly the most popular strategy in the TASS universe whiles the short bias strategy seems to be the least popular strategy among funds in the TASS database.

**Table 1. Number of funds in alive, dead and combined hedge funds**

| Strategy | Number Of funds in | | | | | |
|---|---|---|---|---|---|---|
| | Alive | | Dead | | Combined | |
| | No | % | No | % | No | % |
| All Funds | 1,398 | 100.00 | 4,241 | 100.00 | 5,639 | 100.00 |
| CTA | 141 | 10.09 | 413 | 9.74 | 554 | 9.82 |
| Emerging Markets | 193 | 13.81 | 437 | 10.30 | 630 | 11.17 |
| Event Driven | 103 | 7.37 | 422 | 9.95 | 525 | 9.31 |
| Global Macro | 84 | 6.01 | 266 | 6.27 | 350 | 6.21 |
| Long/Short | 488 | 34.91 | 1,571 | 37.04 | 2,059 | 36.51 |
| Market Neutral | 56 | 4.01 | 280 | 6.60 | 336 | 5.96 |
| Multi-strategy | 148 | 10.59 | 340 | 8.02 | 488 | 8.65 |
| Others | 113 | 8.08 | 146 | 3.44 | 259 | 4.59 |
| Relative Value | 68 | 4.86 | 327 | 7.71 | 395 | 7.00 |
| Short Bias | 4 | 0.29 | 39 | 0.92 | 43 | 0.76 |

Every single fund is required to have at least two years of return observations and all returns reported in US denomination. The sample covers January 1994 through September 2013. No describes the number of funds in each category. The relative size of funds from the total number of funds is reported in percentages.

## 3.2 Data biases

### 3.2.1 Survivorship bias

Survivorship bias occurs when databases exclude all poorly performing funds such that only active and well performing funds are included into the database. This action may have a negative impact on the accuracy of performance measures and make them

upwardly biased. Therefore it is very important to include both active and defunct funds into all databases. According to Fung and Hsieh (2004), because inactive hedge funds are seen as being of little interest to investors, hedge fund databases mostly keep and give access to information on alive funds. This suggests that funds that have stopped reporting or have terminated their operations are removed from the database. The issues of survivorship bias raise because disappearing funds typically perform worse than alive funds. Liang (2000) studies the HFR and TASS databases and finds signs of survivorship bias of 2.24% per annum. Before January 1994 TASS only kept track of surviving funds, leading to a survivorship bias in the database. However, from January 1994 onwards the TASS database contains not only alive but also defunct funds. Our investigation period for this study begins in January 1994, and thus, the effect of survivorship bias in our sample is mitigated.

### 3.2.2 Backfill bias

When fund managers choose not to report fund performance to a database immediately at its' inception, but rather choose to "backfill" the database later when they have established a track record of success with a fund they raise issues of backfilling bias within the database. Backfill bias is typically controlled by excluding the first one or two years of returns from the return histories of funds (Ackermann, McEnally, Ravenscraft 1999), because the first two years are most likely to contain the largest backfilled return observations.

Agarwal and Naik (2005) mention that when a hedge fund enters a database, its past performance history prior to its inception date may suddenly be added to the database, which then creates a backfill bias. Subsequently, when a data vendor backfills a fund's performance, the fund's return within the database will be upwardly biased. Many new funds start with an "incubation" period to accumulate a track record (Fung and Hsieh 2004). It is argued that funds that perform well enter new database to seek new investors. On the other hand, funds may stop their operations or stop reporting to the vendor if their performance is not good enough to have access to external capital investments. Backfill bias can drive an upward bias in reported returns (Agarwal and Naik 2005, Fung and Hsieh 1997).

Within the TASS database backfill bias is introduced as a result of fund manager's being able to backfill returns when they enter the database. However, TASS also reports the date a fund enters the database. Unfortunately, this is not reported for all fund that enter the database so we follow common practice and exclude the first 12 months of observations (Fung and Hsieh 2000). But in order to test the sensitivity of our results to the backfill bias we do not exclude assumed backfilled data from first sample but we exclude it in our second sample.

### 3.2.3 Multi-period sampling bias

In this research, hedge funds are required to have at least 24 months of observations in order for them to be to be included in the sample. This condition introduces a multi-period sampling bias into our sample. Agarwal and Naik (2005) assert that in academic research a requirement of a minimum of 24-month or 36-months of returns is needed in order for a particular hedge fund to be included in a study sample. However, multi-period sampling bias has been found to be small when the 36-month minimum return history is applied (Fung and Hsieh 1997). Ammann, Yakov and Haim (2011, 2012) also studies the magnitude of this bias and finds it to be very small. Although in our study sample we make sure that we include only those funds with at least two years of observations, we believe that multi-period sampling bias is not likely to create significantly biased results in our analyses.

### 3.2.4 Performance smoothing

Hedge funds are mostly known to hold illiquid assets in their portfolios. However, obtaining the current price of such illiquid assets is difficult, therefore, managers tend to estimate the current value of these securities based on previous prices. But this procedure introduces an issue of serial correlation in the funds returns such that if we ignore this issue we stand the chance of getting uneven or incorrect estimates of hedge fund performance. (Jagannathan, Malakhov and Novikov 2010)

Serial correlation is an issue in hedge fund returns that has been comprehensively studied by a number of researcher such as Getmansky et al. (2004) and Loudon,

Okunev, and White (2006). Performance smoothing can either be manager or factor driven. While some authors have identified intentional smoothing as one of the main sources of serial correlation in hedge funds. Other authors argue that the autocorrelation is not necessarily due to intentional smoothing. Getsmansky et al. (2004) model reveals two different instances that can lead to observed serial correlation in returns. There is the manager-driven scenario where, a fund that is exposed to a risk factor that is not serially correlated can have serially correlated returns due to smoothing by the manager. There is also the factor-driven serial correlation where by a fund that is exposed to a risk factor can have serially correlated returns without intentional smoothing. For instance, Edelman, Fung and Hsieh (2013) particularly find that the observed serial correlation in the monthly returns in their study sample is mainly factor-driven rather than manager-driven.

Unlike hedge funds mutual funds are less subject to this kind of biases in returns because mutual funds are more liquid funds which are highly regulated and require regular disclosure of information about the fund's holdings. Chandar and Bricker (2002) find in their research that performance smoothing is more prominent in the hedge fund industry than the mutual fund industry because they tend to have limited regulations. However, we find that the possibility of performance smoothing does not seem to affect the main findings of this study. Our results remain robust.

### 3.3 Share restrictions

Most hedge funds are characterized by restrictions that limit the redemption right of their investors such as lockup provisions, redemption frequency and redemption notice periods. In this study we measure fund liquidity for investors by means of three main share restrictions: the lockup period, the redemption notice period, and the redemption frequency period. As explained previously, the lockup period specifies the time period within which an investor cannot have access to the funds capital. The redemption notice period is a period of notice required by most managers from investors prior to them redeeming any capital from the hedge fund. The redemption frequency period is the amount of time needed before an investor can redeem his/her money from the fund. Although the lockup period expires, the redemption notice period and the redemption

frequency period exists throughout the lifespan of an investor's investment. (Schaub and Schmid 2012)

Schaub and Schmid (2012) find an endogeneity problem in the TASS database because the database is known to report the most recent characteristics of hedge funds. If funds change their share restrictions due to economic crisis it is not always captured by the database. Thus, a fund's performance can affect the choice of share restrictions. Schaub and Schmid (2012) analyze their study sample for traces of endogeneity bias by comparing share restrictions of funds in the TASS database ending December 2008 with share restrictions of funds in a previous version of the TASS database ending September 2005. They find that 88% of funds that are alive as of September 2005 did not change any share restriction in the course of the recent financial crisis. Only 7% of all active funds reinforce at least one share restriction. 4% of all live funds weaken at least one restriction. 1% of funds reinforces at least one restriction while weakening another. Therefore, they do not find a strong issue of endogeneity in their sample. Hedge funds cannot easily "raise gates" during financial crisis because hedge funds are normally regulated by a limited partnership agreement, which can only be adjusted under certain circumstances and with the approval of majority of the limited partners. According to Aragon (2007) and Agarwal et al. (2009) general partners who wishes to change share restrictions must either create an extra class of shares or then start a new fund entirely. Aragon (2007) also shows that the impact of the endogeneity bias in databases is limited. Schaub and Schmid (2012) compare the liquidity of the asset portfolio of funds across investment styles and find the most liquid portfolios to be CTA (managed future) funds, global macro funds, and equity market neutral funds. They find that convertible arbitrage managers, fixed income arbitrage managers, and event driven managers invest more in illiquid assets. Hence, it is obvious that the managers that invest more in illiquid assets impose more severe share restrictions.

In table 2 (panel A) we presents the summary information about the share restrictions for our hedge fund sample. Panel A shows that approximately 28% of all funds impose lockup provisions. The lock up period ranges from 1 month to 90 months (7.5 years). From the table we can see that the lockup provision is heavily centered around one year (20.34%). This means that most funds that initiate a lockup provision usually

impose it for one year within which time investors can hardly have access to their invested capital. The table also shows the redemption frequency period (in months) across the hedge fund sample. There were 216 missing values (out of a total of 5639 funds), meaning that the redemption frequency of 216 funds are unknown. The redemption frequency of the hedge funds in this sample are more centered around one month (51.13%). This limits redemption to only once a month. We can also see that a total of 87.89% of hedge funds impose redemption notice period of which we find a heavy cluster around 15-30 days period. Compared to the lockup provision and the redemption frequency it seems that the redemption notice period (RNP) is the most popular share restriction imposed.

Panel B shows the summary statistics of hedge funds' liquidity proxies for share restrictions within investment styles. We try to examine if the proxies show variation across investment styles. The resulting table consist of data sample from the TASS database from January 1994 to September 2013 covering a total of 5639 single funds for lockup, redemption notice period provision and redemption frequency provision with the exception of 216 missing funds for the redemption frequency provision

From the table we can see that share restrictions differ significantly across hedge fund strategies. When comparing lockup periods, redemption notice periods, and redemption frequency periods across strategies, we find similar results as Schaub and Schmid (2012), that, CTA funds, global macro funds, and equity market neutral funds are the most liquid funds for investors whereas event driven funds, long/short equity hedge funds, multi-strategy and relative value funds are more illiquid.

**Table 2 Summary statistics of the measure of share restrictions**

| Panel A. Summary information about the share restrictions for the hedge fund sample | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lockup period | | | | | | | | | | | |
| Months | 0 | 1 | 3 | 6 | 9 | 12 | 18 | 24 | 30 | 60 | 90 |
| Number | 4,059 | 34 | 60 | 164 | 6 | 1147 | 10 | 107 | 43 | 8 | 1 |
| Percent | 71.98 | 0.6 | 1.06 | 2.91 | 0.11 | 20.34 | 0.18 | 1.9 | 0.76 | 0.14 | 0.02 |
| Redemption frequency | | | | | | | | | | | |
| Months | 0 | 0.03 | 1 | 3 | 6 | 12 | 24 | 36 | Missing | | |
| Number | 2 | 301 | 2883 | 1863 | 150 | 215 | 4 | 5 | 216 | | |
| Percent | 0.04 | 5.34 | 51.13 | 33.04 | 2.66 | 3.81 | 0.07 | 0.09 | | | |
| Redemption notice period | | | | | | | | | | | |
| Days | 0 | 0-15 | 15-30 | 31-45 | 46-60 | 61-75 | 76-90 | 91-120 | 120-365 | | |
| Number | 683 | 711 | 2282 | 667 | 620 | 43 | 22 | 549 | 62 | | |
| Percent | 12.11 | 12.61 | 40.47 | 11.83 | 10.99 | 0.76 | 0.39 | 9.74 | 1.1 | | |

Panel B. Summary statistics of the fund restriction variables

| Strategy | Lockup period | | | Redemption frequency | | | Redemption notice period | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | Mean | Std | N | Mean | Std | N | Mean | Std |
| All funds | 5,639 | 0.295 | 0.574 | 5,423 | 0.189 | 0.218 | 5,639 | 0.098 | 0.087 |
| CTA | 554 | 0.045 | 0.214 | 513 | 0.085 | 0.066 | 554 | 0.028 | 0.038 |
| Emerging Markets | 630 | 0.229 | 0.630 | 595 | 0.156 | 0.202 | 630 | 0.100 | 0.093 |
| Event Driven | 525 | 0.497 | 0.773 | 514 | 0.316 | 0.328 | 525 | 0.146 | 0.098 |
| Global Macro | 350 | 0.155 | 0.410 | 331 | 0.112 | 0.088 | 350 | 0.062 | 0.057 |
| Long/Short | 2,059 | 0.352 | 0.552 | 2,005 | 0.215 | 0.235 | 2,059 | 0.096 | 0.073 |
| Market Neutral | 336 | 0.224 | 0.449 | 330 | 0.141 | 0.112 | 336 | 0.082 | 0.060 |
| Multi-strategy | 488 | 0.268 | 0.574 | 463 | 0.168 | 0.180 | 488 | 0.116 | 0.109 |
| Others | 259 | 0.534 | 0.805 | 245 | 0.228 | 0.223 | 259 | 0.166 | 0.129 |
| Relative Value | 395 | 0.252 | 0.478 | 388 | 0.178 | 0.158 | 395 | 0.109 | 0.077 |
| Short Bias | 43 | 0.252 | 0.411 | 39 | 0.205 | 0.213 | 43 | 0.071 | 0.055 |

Every single fund is required to have at least two years of return observations. We only include funds that report their returns in US dollar. The sample covers January 1994 through September 2013. N describes the number of funds in each category. Std describes the standard deviation for each strategy.

## 3.4 Fund portfolio liquidity

According to Getmansky et al. (2004), several authors have studied the persistence of hedge fund performance over different time periods and have found that performance persistence may be indirectly linked to serial correlation. Getmansky et al. (2004) identifies four other potential sources of serial correlation in hedge fund returns, namely; inefficient markets, time-varying expected returns, time-varying leverage and

managerial incentive fees. After considering each of these alternative reasons, Getmansky et al. (2004) conclude that the most likely explanation for serial correlation in the context of hedge fund returns is smoothed returns and the illiquid nature of most hedge funds. Getmansky et al. (2004) mentions that although illiquidity and smoothed returns are two different phenomena, it is important to consider them together since one facilitates the other. (Getmansky et al. 2004).

According to Getmansky et al. (2004), the methods for determining the monthly market yield for illiquid securities may also cause serial correlation in returns. One method introduced by Lo (2005) of how to value illiquid securities is by linearly extrapolating from the recent transaction price which usually yields a price path mimicking straight line. Returns calculated in this manner tend to be much smoother with lower volatility and higher serial correlation than the actual economic returns (Getmansky et al. 2004).

Even if a hedge fund manager who holds illiquid securities does not apply any form linear extrapolation there is still a chance that the funds returns might be exposed to serial correlation (smoothed returns). According to Getmansky et al., this is possible because fund managers might get the market prices of assets from brokers or dealers that engage one way or the other in linear extrapolation. By doing this the managers is unconsciously downward-biasing price volatility.

A measure of a fund's average asset illiquidity is useful in determining whether a fund imposes restrictions and if restrictions are linked with underlying asset illiquidity. An easy way to calculate average asset illiquidity would be to look directly at the illiquidity of the fund's portfolio. However, this kind of information is absent for most hedge funds. Therefore, we use the method developed by Getmansky et al. (2004) to provide a proxy of the level of liquidity of hedge funds' portfolios.

Getmansky et al. (2004) proposes a proxy for fund asset illiquidity, by differentiating between a fund's reported returns and its' economic returns; they assume that a hedge funds true economic return is unobserved. This is due to the serial correlation found in hedge fund returns which is as a result of the illiquid assets they hold and smooth

returns. Getmansky et al. (2004) provides substantial information about the sources of serial correlation in hedge fund returns and finds that this serial correlation is mainly due to the illiquidity of the hedge fund assets as well as their return smoothing. Early research reports that hedge fund return smoothing can either be intentional or unintentional. We examine the funds' reported returns since economic returns are eventually incorporated into reported returns. The funds reported return in period t ($R^o_t$) satisfies:

$$R_t^o = \theta_0 R_t + \theta_1 R_{t-1} + \ldots + \theta_k R_{t-k,} \quad (1)$$

$$\theta_j \in [0, 1], j=0, 1 \ldots k, \quad (2)$$

$$1 = \theta_0 + \theta_1 + \ldots + \theta_{k,} \quad (3)$$

In accordance to Getmansky et al. (2004), $R_t$ is the fund's economic return in period $t$. The parameters $\theta_j$ are interpreted as the speed at which information is reflected into reported returns. For example, the smoothing parameter ($\theta_0$) measures the liquidity of the hedge funds' portfolios. A larger $\theta_{0,}$ depicts frequent asset pricing, and more liquid portfolios.

Accordingly, we use a second order moving average process (MA (2)) and estimate the fund-level parameters using the maximum likelihood estimation. Aragon (2007), Liang and Park (2007) have used a similar method in past research to measure asset liquidity (Aragon 2007, Liang and Park 2007, Khandani and Lo 2011).

The table below presents the summary statistics for the maximum likelihood estimates of $\theta_0$, $\theta_1$ and $\theta_1$ as defined in equation (1), (2) and (3). The estimates are not available for all funds; the estimation of the GLM (2004) do not converge for all funds. Out of an initial 5639 hedge funds in the sample only 5614 funds converged while the remaining 25 funds do not converge. However, we do not drop the 25 funds from our sample so as to prevent any possible biases when we go further into our analyses.

Table 4 presents the mean and standard deviation of the maximum likelihood estimates of $\theta_0$, $\theta_1$ and $\theta_1$ for the 5614 funds that converged. Five out of the ten main strategy of the fund category on average seem to exhibit relatively smaller mean values of parameter $\theta_0$: Emerging markets (0.783), Event driven (0.752), Multi-strategy (0.780), Others (0.728) and Relative value (0.715). The mean value of relative strategy (0.715) for $\theta_0$ implies that on average only (approximately) 71.5% of the hedge fund's true current monthly return would be reported, while the remaining 28.5% will be spread over the next two months. This explanation is according to the given constraint in equation (3).The estimates 0.199 and 0.086 for $\theta_0$ and $\theta_1$ suggest that on average, the current reported return also includes 19.9% of last month's true return and 8.6% of the true return two months ago. Since the mean of $\theta_0$ is relatively low, the reported averages suggest a notable amount of illiquidity in the assets that hedge funds in this category hold in their portfolio. Comparing the liquidity of the asset portfolio of funds across investment styles we find that CTA funds, global macro funds, and equity market neutral funds hold the most liquid portfolios, while relative value strategy funds, emerging market funds, multi-strategy funds and event driven funds invest in more illiquid assets. We also find that more liquid funds exhibit lower risk as measured by the standard deviation. This is possible because when the need arises, liquid funds can easily sell their liquid assets at reasonable prices without having to face the risk of making a loss. A close comparison of panel B of table 2 and table 3 give some insight and backing to the claim that managers that invest into more illiquid assets are also those imposing the most rigorous share restrictions. From an asset-liability perceptive this is reasonable. On a more general note, we find that the implication of our results on relative value strategies, event driven and emerging market strategies are in line with the results reported by Getmansky et al. (2004). As measured by the standard deviation these funds exhibit higher risk as compared to the other fund categories.

**Table 3. Summary statistics of maximum likelihood estimates**

| Strategy | N | Theta0 ($\theta_0$) | | Theta1($\theta_1$) | | Theta2($\theta_2$) | |
|---|---|---|---|---|---|---|---|
| | | Mean | Std | Mean | Std | Mean | Std |
| All Funds | 5,614 | 0.809 | 0.137 | 0.124 | 0.108 | 0.068 | 0.083 |
| CTA | 551 | 0.897 | 0.116 | 0.064 | 0.088 | 0.038 | 0.073 |
| Emerging Markets | 627 | 0.783 | 0.121 | 0.143 | 0.097 | 0.074 | 0.084 |
| Event Driven | 523 | 0.752 | 0.133 | 0.165 | 0.108 | 0.083 | 0.079 |
| Global Macro | 347 | 0.867 | 0.117 | 0.081 | 0.091 | 0.053 | 0.076 |
| Long/Short | 2,055 | 0.827 | 0.120 | 0.108 | 0.094 | 0.065 | 0.083 |
| Market Neutral | 336 | 0.833 | 0.135 | 0.106 | 0.108 | 0.061 | 0.084 |
| Multi-Strategy | 485 | 0.780 | 0.147 | 0.142 | 0.115 | 0.078 | 0.085 |
| Others | 255 | 0.728 | 0.155 | 0.179 | 0.121 | 0.093 | 0.096 |
| Relative Value | 392 | 0.715 | 0.151 | 0.199 | 0.125 | 0.086 | 0.084 |
| Short Bias | 43 | 0.873 | 0.103 | 0.096 | 0.102 | 0.031 | 0.060 |

Every single fund is required to have at least two years of return observations. We only include funds that report their returns in US dollar. The sample covers January 1994 through September 2013. N describes the number of funds in each category.

## 3.6 Performance measure

To measure hedge fund performance, we use monthly excess returns and alphas. Monthly alphas are estimated by the Fung and Hsieh (2004) seven-factor model. The monthly excess returns are regressed on the excess returns of the seven-factors to determine the risk-adjusted performance. The factor model covers some of the most important asset classes hedge funds invest in such as equities, bonds and credit, currencies and commodities.

According to Fung and Hsieh, the seven-factor model can be modelled as:

$$r_t^i = \alpha^i + \sum_{k=1}^{K} \beta_k^i F_{kt} + \varepsilon_t^i,$$

where $r_t^i$ is excess return (in excess of the risk free rate) on an individual hedge fund $i$ for month $t$, $\alpha^i$ is alpha performance measure or abnormal performance of hedge fund $i$ over the regression time period, $\beta_k^i$ is the factor loading of hedge fund $i$ on factor $k$ during the regression period, $F_{kt}$ is the return for factor $k$ for month $t$, and $\varepsilon_t^i$ is the error term.

The Fung and Hsieh factors are comprised of the excess return on the S&P 500 index (SNPMRF); a small minus big factor (SCMLC) constructed as the difference between the Wilshire small and large capitalization stock indices; the yield spread of the U.S. 10-year Treasury bond over the 3-month Treasury bill, adjusted for duration of the 10-year bond (BD10RET); the change in the credit spread of Moody's BAA bond over the 10-year Treasury bond, also appropriately adjusted for duration (BAAMTSY), and the excess returns on portfolios of look back straddle options on currencies (PTFSFX), commodities (PTFSCOM), and bonds (PTFSBD), which are constructed to replicate the maximum possible return from trend following strategies on their respective underlying assets. These seven factors have been used in different academic research and have been proven by Fung and Hsieh (2004) as being able to considerable explain hedge fund returns.

### 3.7 Liquidity risk measure

Liquidity is a wide and vague concept that makes it possible to trade large quantities of assets at a relatively low cost without having an impact on prevailing prices (Pastor and Stambaugh 2003). Different ways of measuring liquidity risk have been discussed in several past literature (Pastor and Stambaugh 2003, Acharya and Pedersen 2005, Sadka 2006).

To proxy for hedge funds systematic liquidity risk exposure we estimate the beta of a fund's return with respect to the Pastor and Stambaugh (2003) aggregate monthly innovation in liquidity measure (PS measure). We employ this measure because it is known to be the most suitable series used to measure liquidity risk as it is based on the

co-movement between returns and the shocks in liquidity (Teo 2011). The liquidity measure is derived from averaging individual stock measures estimated with daily stock data. The individual stocks are however, only listed on the New York Stock Exchange (NYSE) and the Amex, so this raises some concerns since hedge funds are known to invest in more than just US equities. Despite this confusion there is some evidence that since liquidity is correlated across stock markets, bond markets and countries it is relatively easily for the PS measure to provide a general state of liquidity regardless of the market domicile.

Monthly hedge fund excess returns are regressed on the returns of the market-wide traded liquidity factor. We include the Fung and Hsieh (2004) seven-factor model to account for risk that are not directly associated with liquidity. The higher the liquidity risk beta, the higher is the exposure to market-wide liquidity risk.

$$r_{i,t}=\beta^{0}_{i}+\beta^{L}_{i}L_t+\beta^{snp}_{i}SNPMRF_t+\beta^{scm}_{i}SCMLC_t+\beta^{bd10}_{i}BD10RET_t + \beta^{baa}_{i}BAAMTSY_t + \beta^{ptfd}_{i} PTFSBD_t + \beta^{ptfx}_{i} PTFSFX_t + \beta^{ptfcom}_{i}PTFSCOM_t + \varepsilon_{i,t},$$

Where $r_t^i$ represents the funds $i$'s excess return, SNPMRF denotes the excess return on the S&P 500 index. *SCMLC* represents the payoff on a small minus big factor. An explanation of the factors has already been presented in the previous section. $\beta^{L}_{i}$ represents the assets co-movement with aggregate liquidity that is separate from its co-movement with other frequently used factors.

According to Schaub and Schmid (2012), a substantial downward movement in market-wide liquidity occurred during the Asian crisis, the Russian crisis and the subsequent collapse of Long-Term Capital Management (LTCM), the burst of the dot-com bubble, the collapse of Bear Sterns, and the bankruptcy of Lehman Brothers.

### 3.8 Crisis Measure

In our data we identify the crisis period as years 2007 and 2008 (July 2007 to December 2008). These are the years of the recent financial crisis. Schaub and Schmid (2013) define the crisis periods in a similar manner. Non-crisis period on the other

hand are all other periods in our data sample outside the crisis period (01/1994–06/2007 and 01/2009–09/2013). Instead of dividing our data into two periods we divide it into three periods, namely; the period before the crises, the period during the crisis and the period preceding the crisis. For robustness, we test the sensitivity of our results to a different definition of crisis. We conduct the analysis again with other definitions of the crisis period. This time we use the period of the burst of the technology bubbles (March 2000–December 2001) and the collapse of Long-Term Capital Management (July 1998–December 1998).

# 4 ILLIQUIDITY PREMIUM AND SHARE RESTRICTIONS OF HEDGE FUNDS

## 4.1 Liquidity and share restrictions

As established previously hedge funds apply restrictions such as lockup provision, redemption frequency, redemption notice periods and high minimum investment amounts in order to limit the extent to which an investor can withdraw his or her investment.

Liang (2007) uses the first-order serial correlation coefficient of hedge fund returns to proxy for asset illiquidity and finds positive and statistically significant correlation coefficients between five share restrictions (notice period, lockup, redemption frequency, subscription frequency and minimum investment) and asset liquidity. However, he finds that among all five share restrictions, the redemption notice period is the strongest share restriction variable explaining the illiquidity of assets in a hedge fund portfolio. Based on this empirical evidence and looking at panel A of table 2 can we see that the redemption notice period is the most popular share restriction imposed in most hedge funds (87.89%) of hedge funds impose redemption notice period). The redemption notice period seems to be the strongest restriction used to limit an investor's liquidity[4]. Thus, hedge funds impose share restrictions (especially RNP) because they invest in illiquid assets (Funds that impose more share restrictions are associated with a greater level of illiquidity).

In the following table 4 we replicate the work of Liang (2007) to show that share restrictions are correlated with each other and are also highly correlated with asset liquidity (especially RNP). This time we proxy for asset illiquidity with the method developed by Getmansky et al. (2004) where $(1-\theta_0)$ measures the degree to which the fund's returns are serially correlated.

[4] Schaub and Schmid ( 2012) makes it known that this is possible because lockup periods expire and the redemption frequency period only limits redemption to a certain periods in time

**Table 4. Correlation matrix of asset liquidity and share restrictions**

| | Lockup period | Redemption frequency | Redemption notice period | Asset liquidity |
|---|---|---|---|---|
| Lockup period | 1 | | | |
| Redemption frequency | 0.319** | 1 | | |
| | (<.0001) | | | |
| Redemption notice period | 0.285** | 0.285** | 1 | |
| | (<.0001) | (<.0001) | | |
| Asset liquidity | 0.040** | 0.045** | 0.106** | 1 |
| | (<.0001) | (<.0001) | (<.0001) | |

This table presents the correlation coefficients between asset liquidity and share restrictions. The sample period is from January 1994 to September 2013. ** represents 5% significance level.

Table 4 shows positive and statistically significant (at 5% level) correlation coefficients between asset illiquidity (proxied by Getmansky et al. (2004) measure) and share restrictions (Lockup period, redemption frequency and redemption notice period). All three share restrictions are highly and positively correlated to asset illiquidity. This means that all three share restrictions can serve as a good proxy for asset illiquidity.

The results from this table are similar to the results reported by Liang (2007). Although all three share restrictions are highly correlated to asset liquidity the redemption notice period (0.106) is more highly correlated to asset liquidity as compared to the lockup (0.040) and redemption frequency (0.045) period. This means that redemption notice period is the strongest share restriction variable that can express the level of illiquidity of an asset portfolio. According to Schaub and Schmid (2012), redemption notice periods seem to be the most essential restriction for hedge funds that are exposed to liquidity risk.

To further examine the existing relationship between asset portfolio and share restriction, we divide our sample into two portfolios based on high or low share restrictions and compare the three share restrictions with each other. We examine whether funds that impose a particular share restriction are likely to impose the others.

We include the means of asset portfolio liquidity and liquidity risk examine whether funds that impose higher share restrictions are the ones that invest more in illiquid assets and expose themselves to excessive liquidity risk.

In Panel A of table 5 we consider the lockup period by splitting the funds into portfolios depending on whether they have a lockup provision or not, we divide them into; lockup=1 and no-lockup=0. In panel B we divide our sample funds into low or high redemption notice based on the median value (0.082). High redemption notice represents the fund observation with redemption notice period above the median (0.082) while low redemption notice period is the category for observations with redemption notice period equal to or below the median (0.082). We do the same in panel C and D for redemption frequency period and $\theta_0$ parameter respectively. We divided the fund observations into high or low redemption frequency based on the median (0.083). Likewise, we divide $\theta_0$ into their subgroups based on the fund observations being below or above the median (0.846).

Panel A shows that funds that impose a lockup provision on average have longer redemption notice periods and allow less frequent redemptions. We also see that funds with Lockup=1 invest more in illiquid assets and because lockup is associated with a higher mean liquidity beta of 0.019, it means that funds with stricter share restrictions are more exposed to excessive liquidity risk[5] than funds with weaker share restrictions. We arrive at similar conclusions for redemption notice period and redemption frequency periods. The table 5 shows that share restrictions are highly correlated and that illiquid funds tend to rely on severe share restrictions. For instance, the average length of redemption notice period and redemption frequency days is considerably longer for funds that impose a lockup period than for funds that do not impose a lockup period. While hedge funds with a lockup period require a notice period of 52 days, those fund without lockup period requires 30 days. Likewise, funds with lockup period all redemption every 104 days while fund with no lockup allow redemption every 55 days. The results in Table 5 also show that more severe share restrictions are associated with lower smoothing parameters (investments made into less liquid asset portfolios).

[5] As measured by the liquidity beta

All this goes to prove that, in general, funds which plan to invest in more illiquid assets impose more stringent share restrictions so as to have an appropriate assets-liabilities tradeoff and prevent an asset-liability mismatch. This result is consistent with what has been found in previous studies (Aragon 2007, Schaub and Schmid 2012).

**Table 5. A comparison of liquid and illiquid funds, the liquidity risk of funds and funds holding liquid and illiquid asset portfolios**

Panel A: Lockup

| *Lockup* | N | Mean notice Period (in days) | Mean redemption frequency (in days) | Mean theta($\theta_0$) | Mean liquidity Beta |
|---|---|---|---|---|---|
| All | 5,639 | 36 | 69 | 0.809 | 0.018 |
| 1 | 1,580 | 52 | 104 | 0.782 | 0.019 |
| 0 | 4,059 | 30 | 55 | 0.819 | 0.018 |
| Difference | 2,479 | 22 | 49 | -0.037 | 0.001 |

Panel B: Redemption notice period

| *Notice Period* | N | Mean lockup (in days) | Mean redemption frequency (in days) | Mean theta($\theta_0$) | Mean liquidity Beta |
|---|---|---|---|---|---|
| All | 5,639 | 103 | 69 | 0.809 | 0.018 |
| High notice | 1,963 | 172 | 100 | 0.77 | 0.019 |
| Low notice | 3,676 | 65 | 52 | 0.829 | 0.018 |
| Difference | 1,713 | 107 | 48 | -0.059 | 0.001 |

Panel C: Redemption frequency period

| *Redemption frequency* | N | Mean lockup (in days) | Mean notice Period(in days) | Mean theta($\theta_0$) | Mean liquidity Beta |
|---|---|---|---|---|---|
| All | 5,639 | 103 | 36 | 0.809 | 0.018 |
| High redemption | 5,120 | 110 | 39 | 0.804 | 0.016 |
| Low redemption | 519 | 19 | 8 | 0.852 | 0.009 |
| Difference | 4,601 | 91 | 31 | -0.048 | 0.007 |

Panel D: Theta0

| $\theta_0$ | N | Mean lockup (in days) | Mean notice Period(in days) | Mean redemption frequency (in days) | Mean liquidity Beta |
|---|---|---|---|---|---|
| All | 5,639 | 103 | 36 | 69 | 0.018 |
| Low $\theta_0$ | 3,273 | 114 | 40 | 76 | 0.024 |
| High $\theta_0$ | 2,366 | 86 | 29 | 60 | 0.010 |
| Difference | 907 | 28 | 11 | 16 | 0.014 |

The table reports summary statistics on the main share restrictions variables, Liquidity beta and theta0 for two portfolios based on whether the fund has a lockup period or not (Panel A), whether the fund has a high or low redemption notice period (Panel B), whether it has a high or low redemption frequency period (Panel C), and for two portfolios based on the smoothing parameter which is used as a measure whether the fund has a high or low asset portfolio liquidity (Panel D). *Lockup* is a dummy variable which equals one if the fund has a lockup provision. *Notice days* represents the length of the redemption notice period such that high redemption notice represent the fund observation with redemption notice period above the median (0.082) while low redemption notice period is the category for observations with redemption notice period equal to or below the median . *Redemption days* is the length of the redemption frequency period such that high redemption frequency represent the fund observation with redemption frequency period above the median (0.082) while low redemption frequency period is the category for observations with redemption frequency period equal to or below the median in days. *Theta (θ0)* is obtained from a maximum likelihood estimation of the MA (2) model of observed returns as proposed by Getmansky et al. (2004). High $\theta_0$ represent the fund observation with theta0 above the median (0.084) while Low $\theta_0$ is the category for observations with theta0 equal to or below the median.

## 4.2 An analysis of share restrictions and asset portfolio liquidity

In this section, we analyze the effect of the relationship between fund liquidity for investors (as proxied by lockup, redemption frequency and redemption notice period) and fund portfolio liquidity on hedge funds performance in all market conditions. We separate the market condition into bull (01/1994–06/2007; 01/2009–09/2013) and bear markets (07/2007–12/2008). We compare the performance between funds with share restrictions and funds without share restrictions as well as between funds holding illiquid and funds holding liquid assets in their portfolios both in the pre-crisis period, the crisis period and post-crisis period by looking at the resulting alphas and returns. We calculate excess returns for each fund and estimate the alphas for each fund based on the Fung and Hsieh (2004) seven-factor model. The excess returns are regressed on the excess returns of the seven factors to determine risk-adjusted performance for each subgroup. However, because of the small number of observations for the crisis period we assume that the betas from the factor model are constant. Thus, we calculate the alpha for each fund as the sum of the intercept and the residual. The alphas measure the risk-adjusted performance of the subgroups.

We divide the three share restrictions into strict and weak restriction and also divide asset liquidity ($\theta_0$) into low and high asset liquidity. First, we divide the Lockup restriction into lockup if the lockup dummy is equal to 1 else we categorize it as no-lockup. In the same manner, we divide the redemption notice period into two groups based if the notice period is above or below the median. High redemption notice represents the fund observation with redemption notice period above the median (0.082) while low redemption notice period is the category for observations with redemption notice period equal to or below the median (0.082). We also divide $\theta_0$ into their subgroup based on the fund observations being below or above the median (0.846). Likewise, the fund observations with redemption frequency period is divided into high or low redemption frequency based on the median (0.083).

From table 6 we can deduce some proof for hypothesis 1 since in the period before the crisis, funds with lockup periods significantly outperform funds without lockup periods (Panel A). We find that the excess returns of hedge funds with lockup

provision are 4.1% per annum higher than returns of funds without lockup period. This result is consistent with Aragon (2007) which finds the excess return of funds with lockup restrictions to be approximately 4%–7% higher than their counterparts. The alpha of funds with lockup provision is 3.6% per annum higher than the alpha of funds without lockup period. However, during the financial crisis, we find that hedge funds with lockup provisions perform significantly worse than hedge funds without lockup provision. Lockup funds significantly underperform no-lockup funds by approximately -3.2% per annum in returns and 1.4% in alpha. These findings are consistent with our first hypothesis that fund that impose strict share restrictions reap an illiquidity premium in the form of higher returns during the non-crisis period. However during crisis period, the illiquidity premium changes into an illiquidity discount. The results for the redemption notice periods and redemption frequency periods shown in panel B and C respectively, present similar conclusions as seen in panel A. We find that funds with a redemption notice period above the median yields a 3.5% return premium and an alpha of 3.8% over funds with a redemption notice period equal to or below the median in the pre-crisis period. On the other hand, during the financial crisis, hedge funds with longer redemption notice period, significantly underperform funds with shorter redemption notice period by -5.3% per annum in returns and -4.5% in alpha per annum. Similarly, we find that funds with a higher redemption frequency period outperform funds with a lower redemption frequency period prior to the crisis period by 2.8% returns per annum and 2.6% in alpha per annum. During the crisis, the funds with longer redemption frequencies significantly underperform funds with shorter redemption frequencies by -7.1% and -4.6% per annum in returns and alpha, respectively.

The results reported in Panel D shows the performance differences between funds with smoothing parameters above and below the median. We find that before the crisis period, funds with a smoothing parameter equal to or below the median significantly outperform funds with a smoothing parameter above the median by 1.4% in returns and 1.2% in alpha. In the crisis period, however, hedge funds with less liquid asset portfolios underperform funds with more liquid asset portfolios by -1.2% and -0.4% per annum in returns and alpha respectively.

We also report results from the period preceding the crisis (2009/01–2013/09) and find illiquidity premium for funds that hold stricter share restrictions. When comparing the illiquidity premium for the period after the crisis with the period before the crisis we find that the illiquidity premium seems to be relatively higher after the crisis as opposed to before the crisis for high redemption notice period and high redemption frequency period. This interesting finding may mean that, by imposing strict share restrictions hedge funds are able to recuperate quickly after a crisis without lingering too long in losses. The results presented in Table 6 suggest that both stringent share restrictions and illiquid asset portfolios provide higher returns (illiquidity premium) during non-crisis (which includes both pre-crisis and post-crisis periods) periods but yield lower returns (illiquidity discounts) during crisis periods. We share the same view with Liang (2006) that asset illiquidity is the main source of share illiquidity premium.

**Table 6. Univariate comparisons of returns between illiquid and liquid funds and between funds holding illiquid and liquid asset portfolios**

Panel A: Performance difference between funds with and without lockup periods

| | Before Crisis | | | | During Crisis | | | | After Crisis | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lockup | No-lockup | Diff | *t*-values | Lockup | No-lockup | Diff | *t*-values | Lockup | No-lockup | Diff | *t*-values |
| Returns | 0.125 | 0.084 | 0.041 | 8.88** | -0.131 | -0.099 | -0.032 | -2.19** | 0.110 | 0.076 | 0.035 | 4.33** |
| Alphas | 0.095 | 0.060 | 0.036 | 11.52** | 0.039 | 0.053 | -0.014 | 0.88 | 0.214 | 0.155 | 0.058 | 2.36** |

Panel B: Performance difference between funds with redemption notice periods above and below the median

| | Before Crisis | | | | During Crisis | | | | After Crisis | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | High notice period | Low notice period | Diff | *t*-values | High notice period | Low notice period | Diff | *t*-values | High notice period | Low notice period | Diff | *t*-values |
| Returns | 0.120 | 0.085 | 0.035 | 17.36** | -0.140 | -0.087 | -0.053 | -7.88** | 0.091 | 0.048 | 0.043 | 10.41** |
| Alphas | 0.098 | 0.060 | 0.038 | 13.82** | -0.004 | 0.041 | -0.045 | -0.23 | 0.038 | -0.013 | 0.051 | -2.41** |

Panel C: Performance difference between funds with redemption frequency periods above and below the median

| | Before Crisis | | | | During Crisis | | | | After Crisis | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | High redemption period | Low redemption period | Diff | *t*-values | High redemption period | Low redemption period | Diff | *t*-values | High redemption period | Low redemption period | Diff | *t*-values |
| Returns | 0.105 | 0.077 | 0.028 | 11.32** | -0.151 | -0.080 | -0.071 | -2.18** | 0.093 | 0.048 | 0.046 | 5.90** |
| Alphas | 0.076 | 0.050 | 0.026 | 9.12** | 0.002 | 0.048 | -0.046 | 0.97 | 0.033 | -0.014 | 0.046 | 0.89 |

Panel D: Performance differences between funds with smoothing parameters above and below the median

| | Before Crisis | | | | During Crisis | | | | After Crisis | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low theta0 | High theta0 | Differ | *t*-values | Low theta0 | High theta0 | Diff | *t*-values | Low theta0 | High theta0 | Diff | *t*-values |
| Returns | 0.099 | 0.084 | 0.014 | 45.73** | -0.124 | -0.112 | -0.012 | -33.44** | 0.100 | 0.072 | 0.028 | 40.66** |
| Alphas | 0.073 | 0.060 | 0.012 | 29.32** | 0.028 | 0.033 | -0.004 | 1.12 | 0.025 | 0.015 | 0.010 | 8.80** |

The table reports the performance difference between portfolio sorts of share restrictions and asset portfolio liquidity. The portfolios are sorted based on lockup period (Panel A), redemption notice period (Panel B), redemption frequency period (Panel C), and smoothing parameter (Panel D). “Lockup = 1” refers to fund observations with a lockup provision, while “Lockup = 0” refers to fund observations without lockup provision. “High notice period” refers to fund observations with redemption notice periods above the median, “Low notice period refers to fund observations with redemption notice periods equal to or below the median. “High redemption period” refers to fund observations with redemption frequency periods above the median, “Low redemption period refers to fund observations with redemption frequency periods equal to or below the median “High theta0” refers to fund observations with smoothing parameters above the median, “Low theta0” refers to fund observations with smoothing parameters equal to or below the median. The returns are excess returns. The alphas are based on the Fung and Hsieh (2004) seven-factor model. Both the returns and alpha present in the table are annualized. The table reports results for before the crisis (left side) during the crisis (middle) and after the crisis (right side) separately. Funds in our sample are required to have at least 24 monthly observations. ** denotes statistical significance at the 5% level. *Diff* represents the difference between the two portfolios. The values are annualized.

We have already established the fact that illiquid funds underperform during the crisis, but we would like to know what the driving force behind the occurrence was. In Table 7 we compare the performance of both liquid and illiquid portfolios during the crisis period. The idea that hedge funds use restrictions in order to generate illiquidity premium is not valid in all market conditions. Although all fund reap loses in bull market conditions, we find particularly that fund that use strict share restrictions perform much worse than funds with low or no share restrictions in place. These loses may pertain more to certain fund styles. We try to find whether the underperformance of illiquid funds is concentrated to certain styles, especially those that consist of more illiquid funds. To do this, we again split our sample funds into two portfolios of liquid and illiquid funds by eight main strategies. We consider CTA funds, emerging markets, event driven, global macro, long/short, market neutral, multi-strategy and the relative value category. We compute excess returns and alphas for each of the 8 fund styles for both illiquid and liquid portfolios. The division of the theta0 ($\theta_0$) into liquid and illiquid portfolio is based on the median value (0.846) of theta where a value greater than the median is classified into the liquid group while the values equal to or less than the median are classified as illiquid. The fund excess returns are regressed on the excess returns of the Fung and Hsieh (2004) seven-factor model by fund strategy to get the alphas for each strategy.

Our findings presented in table 7 reveals that the overall underperformance of illiquid funds during the crisis was on average driven more by styles which consist of more illiquid funds. Looking at table 7 we find that the negative returns are mostly clustered around emerging markets, event driven, multi-strategy and relative value funds. On average the difference between illiquid funds and liquid funds in each category are not strongly significant, but we find the difference between liquid and illiquid funds for the most illiquid strategies (relative value and event driven) to be statistically significant. Hence, table 7 suggests relative value and event driven strategies were the most important strategies that drove the illiquid funds to underperform during the crisis. Therefore, the underperformance of illiquid funds during the crisis was majorly driven by styles which consist mostly of illiquid funds.

**Table 7. Concentration of the underperformance of illiquid funds**

Comparing liquid and illiquid portfolio performance during the crisis

| | N | Theta0 | Returns | | | Alphas | | |
|---|---|---|---|---|---|---|---|---|
| Strategy | | Mean | Illiquid funds | Liquid funds | Diff | Illiquid funds | Liquid funds | Diff |
| All funds | 3304 | 0.824 | -0.045 | -0.062 | 0.017 | 0.036 | 0.018 | 0.018 |
| | | | | | (-1.88) | | | (-0.93) |
| CTA | 275 | 0.869 | 1.273 | 0.150 | 1.123 | 0.114 | 0.105 | 0.009 |
| | | | | | (1.65) | | | (1.00) |
| Emerging Markets | 408 | 0.813 | -0.209 | -0.236 | 0.028 | 0.046 | 0.046 | 0.000 |
| | | | | | (-1.54) | | | (0.40) |
| Event Driven | 295 | 0.798 | -0.196 | -0.140 | -0.056 | -0.018 | -0.015 | -0.003 |
| | | | | | (-2.61) | | | (-0.40) |
| Global Macro | 184 | 0.855 | 0.072 | 0.030 | 0.042 | 0.059 | 0.065 | -0.007 |
| | | | | | (1.10) | | | (0.92) |
| Long/Short | 1192 | 0.833 | -0.172 | -0.122 | -0.050 | 0.028 | 0.055 | -0.026 |
| | | | | | (-1.70) | | | (0.53) |
| Market Neutral | 176 | 0.839 | -0.052 | -0.043 | -0.010 | 0.024 | 0.037 | -0.014 |
| | | | | | (-1.27) | | | (0.70) |
| Multi-strategy | 384 | 0.810 | -0.079 | -0.089 | 0.009 | 0.026 | 0.017 | 0.009 |
| | | | | | (-1.43) | | | (0.35) |
| Relative Value | 197 | 0.779 | -0.150 | -0.154 | 0.003 | -0.158 | -0.018 | -0.140 |
| | | | | | (-2.15) | | | (-0.43) |

The table represents a Comparison of performance between liquid and illiquid portfolio during the crisis. N represents the number of funds in each style category. The returns are the excess return of each main style. The fund excess returns are regressed on the excess returns of the Fung and Hsieh (2004) seven-factor model by fund strategy to get the alphas for each strategy. *Diff* represents the difference between the two portfolios. The values are annualized.

To further investigate the effect of share restrictions and asset portfolio liquidity on hedge fund performance in both bull and bear markets we turn to look at a multivariate analysis which allows us to evaluate the relative effect when other fund characteristics are controlled.

We run two panel regressions. One with excess returns as the dependent variable and another with Fung and Hsieh (2004) seven-factor model alpha as the dependent variable. The alpha is calculated for each fund based on the seven-factor model. We also create a crisis dummy variable which either takes a value of 1 if it is with the crisis period of July 2007– December 2008, or takes a value of zero if otherwise. We include the three share restriction, asset portfolio liquidity, liquidity beta and an interaction term of the crisis dummy variable with the share restrictions, liquidity beta as well as the asset portfolio liquidity. Lastly we include five control variables as independent variables[6].

The results from our multivariate analyses is reported in table 8 panel A and B. In panel A the table has a total of 10 columns. Columns 1 to 5 represents the alpha from the Fung and Hsieh (2004) seven-factor model and in columns 6 to 10 we report the funds excess returns. We see from the table that the crisis dummy variable is always significantly negative throughout all 10 columns. Thus, during the crisis hedge funds record both negative returns and alphas. Columns 1 to 10 show a positive and significant relationship between share and hedge fund performance (alphas and returns) except for the positive but insignificant return recorded for the redemption frequency period in column 10. This is in line with Aragon (2007) findings of an illiquidity premium for funds with lockup provision and redemption notice periods in bear markets. This also supports our findings of illiquidity rents in the periods prior to the crisis for funds that impose share restrictions. We find additionally that the interaction terms between the crisis dummy variable and the three share restrictions are significant but negatively related to alphas and returns in all columns. This connotes an illiquidity discount. Thus, the previous non-crisis illiquidity premium changes into illiquidity discount in the crisis period such that illiquid funds perform poorly in both absolute returns and on a risk-adjusted basis. These findings reinforces the results from our univariate analyses and is consistent with our first hypothesis.

In the last columns of the reported alphas and excess returns (columns 5 and 10 respectively) we run the regression with all the independent variables simultaneously.

[6] The control variable are fund age, fund size, incentive fees, personal capital and management fees.

We find that the redemption notice period records the highest significantly positive non-crisis performance and lowest significantly negative crisis performance. According to Schaub and Schmid (2012) it is not suppressing to find a strong relationship between share restriction and hedge fund performance since lockup provisions expire and redemption frequency periods only restrict redemptions to a certain point in time. Thus, redemption notice periods tend to be the strongest share restriction.

Table 8 panel A also shows the coefficients of the smoothing parameter to be constantly negative and significant throughout columns 6 to 10. This indicates that funds that hold more illiquid assets in their portfolios outperform funds that hold liquid assets in their portfolios in terms of returns in the non-crisis period. On the other hand, we find however that the coefficient on the interaction term between the smoothing parameter and the crisis dummy to be significantly positive. This implies that there exist a significantly positive relationship between asset portfolio liquidity and alphas and returns during the crisis. Thus, in the crisis period lower asset portfolio liquidity is associated with lower hedge fund performance in terms of returns and alphas.

In the same table we see that the coefficients of the liquidity beta is significantly positive in all columns. This implies that funds with a higher market-wide liquidity risk exposure outperform funds with lower liquidity risk exposure in the non-crisis period. In order word there exists a positive relationship between liquidity risk exposure and hedge fund performance. This finding is in line with the results found in previous studies by Sadka (2010), Kessler and Scherer (2011), and Teo (2011) that hedge fund returns are significantly positively related to the factors of liquidity risk exposure in the non-crisis period. However, the coefficient on the interaction term between the liquidity beta and the crisis dummy is highly significant and negative in all columns. This implies that there exist a significantly negative relationship between liquidity risk exposure and hedge fund performance during the crisis. Thus, in the crisis period funds with higher exposure to market-wide liquidity risk are associated with lower performance. Thus we see that illiquid fund which are more susceptible liquidity risk exposure tend to underperform its counterpart in terms of returns and alphas during the crisis period.

In panel B of table 8 we run another panel regressions. This time we estimate the regression with volatility as the dependent variable[7]. In the same manner we create a crisis dummy variable which either takes a value of 1 if it is with the crisis period of July 2007– December 2008, or takes a value of zero if otherwise. We include the three share restriction, asset portfolio liquidity, liquidity beta and an interaction term of the crisis dummy variable with the share restrictions, liquidity beta as well as the asset portfolio liquidity. Lastly we include the five control variables.

Columns 1 to 5 in panel B represents the fund volatility. We find an opposite reaction for the crisis dummy variable which changes to be significantly positive throughout all the 5 columns. This means that during the crisis hedge funds take on more volatility– they are more risky ventures in bad economic times. Columns 2 to 5 show a positive and significant relationship between share restrictions and volatility. This implies that in the non-crisis period funds that impose share restrictions are more likely to take on more risky investment in order to see an increase in returns. Share restrictions provides greater managerial discretion that often enables funds to invest in illiquid assets and to properly manage their investments.

Table 8 panel B also shows the coefficients of the smoothing parameter to be constantly negative and significant throughout all columns. This indicates that in the non-crisis period funds that hold more liquid assets in their portfolios have lower volatility and hold less risky securities than funds that hold illiquid assets in their portfolios. We also find that the coefficient on the interaction term between the smoothing parameter and the crisis dummy to be highly significant and negative. This implies that there exist a significantly negative relationship between asset portfolio liquidity and volatility during the crisis. Thus, in the crisis period lower asset portfolio liquidity is associated with higher volatility.

In the same panel B we see that the coefficients of the liquidity beta is significantly positive in all columns. This implies that funds with a higher market-wide liquidity

[7] We proxy for volatility with the standard deviations estimated from fund returns for each fund. This measures risk.

risk exposure have higher volatility than funds with lower liquidity risk exposure in the non-crisis period. Also, the coefficient on the interaction term between the liquidity beta and the crisis dummy is significant and positive. This implies that there exist a significantly positive relationship between liquidity risk exposure and volatility during the crisis. Thus, in the crisis period funds with higher exposure to market-wide liquidity risk (as measured by the liquidity beta) have higher volatility and more risky.

In summary, a quick review of the results in this section confirm our first hypothesis, the findings of Aragon (2007) and Schaub and Schmid (2012) that in bear markets hedge funds are able to earn an illiquidity premium. However, during the crisis period the illiquidity premium turns into an illiquidity discount. Thus, the huge impact of share restrictions on the funds' performance prior to the crisis is insufficient to efficiently manage illiquid assets during a severe market downturn. Rather, strict share restrictions tend to worsen the funds' performance during the crisis period. Also, funds that impose stricter share restrictions are more volatile and are more likely to take on more risky investment in order reap an illiquidity premium.

**Table 8. Panel regressions of alphas, returns and volatility on asset portfolio liquidity and different measures of fund liquidity**

| Panel A | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Dependent Variables | | | | | | | | | |
| | Alphas | | | | | Returns | | | | |
| Independent Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Intercept | -0.066** | -0.076** | -0.087** | -0.061** | -0.082** | 0.081** | 0.064** | 0.044** | 0.012** | 0.034** |
| | (-37.117) | (-42.657) | (-47.708) | (-33.871) | (-44.604) | (6.147) | (4.837) | (3.243) | (5.339) | (2.450) |
| Crisis | -0.024** | -0.019** | -0.009** | -0.021** | -0.008** | -0.804** | -0.782** | -0.792** | -0.754** | -0.752** |
| | (-7.675) | (-5.934) | (-2.678) | (-6.769) | (-2.408) | (-35.101) | (-33.109) | (-31.046) | (-31.749) | (-29.126) |
| Theta0 | -0.007** | 0.0003 | 0.008** | -0.006** | 0.008** | -0.116** | -0.103** | -0.090** | -0.110** | -0.086** |
| | (-5.598) | (0.255) | (5.512) | (-4.594) | (6.000) | (-11.611) | (-10.251) | (-8.764) | (-10.983) | (-8.332) |
| Crisis*Theta0 | 0.038** | 0.034** | 0.028** | 0.036** | 0.027** | 0.795** | 0.780** | 0.788** | 0.755** | 0.754** |
| | (9.973) | (9.051) | (7.073) | (9.538) | (6.890) | (28.224) | (27.438) | (26.879) | (26.607) | (25.739) |
| Liquidity Beta | 0.095** | 0.094** | 0.097** | 0.103** | 0.102** | 0.111** | 0.108** | 0.113** | 0.107** | 0.106** |
| | (62.782) | (62.081) | (63.780) | (67.106) | (66.814) | (9.704) | (9.509) | (9.883) | (9.318) | (9.194) |
| Crisis*Liquidity Beta | -0.196** | -0.196** | -0.197** | -0.230** | -0.230** | -0.913** | -0.911** | -0.912** | -0.902** | -0.899** |
| | (-37.527) | (-37.580) | (-37.709) | (-43.638) | (-43.819) | (-23.330) | (-23.282) | (-23.316) | (-22.826) | (-22.749) |
| Lockup | | 0.017** | | | 0.013** | | 0.028** | | | 0.021** |
| | | (46.859) | | | (33.994) | | (10.163) | | | (7.328) |
| Crisis*lockup | | -0.008** | | | -0.005** | | -0.033** | | | -0.025** |
| | | (-6.898) | | | (-3.910) | | (-3.980) | | | (-2.866) |
| Notice period | | | 0.098** | | 0.073** | | | 0.168** | | 0.129** |
| | | | (45.441) | | (32.277) | | | (10.414) | | (7.591) |
| Crisis*notice | | | -0.063** | | -0.052** | | | -0.058** | | -0.209** |
| | | | (-10.832) | | (-8.523) | | | (-6.862) | | (-3.815) |
| Redemption | | | | 0.017** | 0.006** | | | | 0.033** | 0.013 |
| | | | | (24.733) | (8.151) | | | | (6.239) | (0.511) |
| Crisis*Redemption | | | | -0.002** | 0.002 | | | | -0.089** | -0.085** |
| | | | | (-3.639) | (0.944) | | | | (-5.008) | (-4.467) |
| Control Variables | | | | | | | | | | |
| Fund size | 0.003** | 0.003** | 0.003** | 0.004** | 0.003** | -0.001 | -0.001 | -0.002** | -0.001 | -0.002** |
| | (38.1118) | (37.288) | (31.912) | (39.370) | (35.094) | (-0.849) | (-1.053) | (-2.265) | (-1.354) | (-2.444) |
| Fund age | 0.013** | 0.013** | 0.014** | 0.011** | 0.011** | 0.016** | 0.016** | 0.016** | 0.015** | 0.016** |
| | (44.685) | (44.838) | (46.161) | (35.625) | (38.169) | (7.101) | (7.105) | (7.449) | (6.694) | (7.345) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Personal Capital | 0.001** | 0.001 | 0.001** | 0.001** | 0.001** | 0.005 | 0.004 | 0.005 | 0.004 | 0.005 |
| | (2.811) | (1.936) | (2.947) | (3.332) | (3.694) | (1.879) | (1.759) | (1.896) | (1.790) | (1.920) |
| Management Fee | 0.326** | 0.440** | 0.426** | 0.409** | 0.521** | 0.371** | 0.545** | 0.546** | 0.528** | 0.715** |
| | (14.054) | (18.921) | (18.326) | (17.128) | (21.846) | (2.141) | (3.126) | (3.134) | (2.955) | (3.992) |
| Incentive Fee | 0.227** | 0.211** | 0.215** | 0.230** | 0.214** | 0.132** | 0.109** | 0.111** | 0.135** | 0.108** |
| | (74.134) | (69.005) | (70.325) | (71.683) | (66.604) | (5.771) | (4.751) | (4.855) | (5.614) | (4.480) |

| Panel B | | | | | |
|---|---|---|---|---|---|
| | Dependent Variables | | | | |
| | Volatility | | | | |
| Independent Variable | 1 | 2 | 3 | 4 | 5 |
| Intercept | 0.063** | 0.062** | 0.145** | 0.027** | 0.098** |
| | (8.483) | (8.233) | (18.848) | (3.586) | (12.641) |
| Crisis | 0.314** | 0.307** | 0.330** | 0.334** | 0.342** |
| | (24.216) | (22.990) | (22.919) | (25.098) | (23.707) |
| Theta0 | -0.436** | -0.437** | -0.379** | -0.419** | -0.375** |
| | (-77.008) | (-76.615) | (-65.123) | (-74.497) | (-65.250) |
| Crisis*Theta0 | -0.367** | -0.362** | -0.380** | -0.361** | -0.369** |
| | (-23.008) | (-22.516) | (-22.973) | (-22.738) | (-22.557) |
| Liquidity Beta | 0.813** | 0.812** | 0.808** | 0.771** | 0.767** |
| | (126.438) | (126.380) | (126.109) | (119.429) | (118.996) |
| Crisis*Liquidity Beta | 0.226** | 0.227** | 0.231** | 0.400** | 0.404** |
| | (10.225) | (10.252) | (10.450) | (18.081) | (18.294) |
| Lockup | | 0.003** | | | 0.017** |
| | | (1.984) | | | (10.733) |
| Crisis*lockup | | 0.009** | | | 0.021** |
| | | (2.033) | | | (4.349) |
| Notice period | | | 0.374** | | 0.377** |
| | | | (41.131) | | (39.701) |
| Crisis*notice | | | 0.032** | | 0.052** |
| | | | (1.908) | | (2.027) |
| Redemption | | | | 0.049** | 0.072** |
| | | | | (16.834) | (23.415) |
| Crisis*Redemption | | | | 0.075** | 0.076** |
| | | | | (7.466) | (7.186) |
| Control Variables | | | | | |
| Fund size | -0.045** | -0.045** | -0.043** | -0.047** | -0.044** |
| | (-119.273) | (-119.282) | (-112.681) | (-123.675) | (-117.663) |
| Fund age | 0.041** | 0.041** | 0.039** | 0.042** | 0.039** |
| | (32.577) | (32.579) | (31.102) | (33.691) | (31.305) |
| Personal Capital | 0.049** | 0.048** | 0.049** | 0.045** | 0.044** |
| | (34.703) | (34.586) | (34.768) | (32.439) | (31.624) |
| Management Fee | 2.838** | 2.861** | 2.438** | 3.472** | 3.301** |
| | (28.906) | (28.989) | (24.797) | (34.656) | (32.924) |
| Incentive Fee | 0.064** | 0.060** | 0.113** | 0.202** | 0.218** |
| | (4.934) | (4.648) | (8.704) | (15.015) | (16.129) |

The table reports a panel regressions of alphas, returns and volatility on asset portfolio liquidity and different measures of fund liquidity. In panel A the dependent variable is either an alpha based on the Fung and Hsieh (2004) seven-factor model (Columns 1–5) or excess returns (Columns 6–10). In panel B the dependent variable is volatility (Columns 1–5) as measured by the standard deviation of fund returns. Crisis is a dummy variable which equals one if the observation is within the time period from July 2007 to December 2008. Theta0 is a measure for the funds' asset portfolio liquidity (Getmansky et al. 2004). Liquidity beta is the measure of the funds exposure to market-wide liquidity risk. Lockup is a dummy variable which equals one if the respective fund has a lockup provision. In

our analysis funds are required to have at least 24 month of observations. The t-values (in parentheses) ** denotes the 5% statistical significance level. The values reported are annualized.

### 4.3 Asset-liability mismatch and hedge fund performance

In bear markets, illiquidity premium turns into illiquidity discounts. This might be as a result of funds selling assets at fire sale prices or an asset-liability mismatch. As studied by Teo (2011) hedge funds do not always use share restrictions to prevent an asset-liability mismatch. Some hedge funds tend to hold more illiquid assets in their portfolio relative to the restrictions they put in place.

In this section we turn to look at the relation between share restrictions and fund portfolio liquidity and their combined effect on hedge fund performance. In this respect we consider the effect of an asset-liability mismatch on hedge fund performance. To do this we form four groups of hedge funds based on share restrictions (specifically, the redemption notice period, as it has been established to be the strongest share restriction) and fund portfolio liquidity. We construct them as follows: hedge funds with liquid investments and strong share restrictions; hedge funds with liquid investments and weak share restrictions; hedge funds with illiquid investments and strong share restrictions; hedge funds with illiquid investments and weak share restrictions. As defined previously, illiquid investments refers to funds with smoothing parameters equal to or below the median and liquid investments refers to funds with smoothing parameters above the median. Also weak restrictions refers to hedge funds with redemption notice periods below the median while strong restrictions refers to hedge funds with redemption notice periods above the median.

Table 9 presents the univariate analyses of the four groups of hedges funds based on asset portfolio liquidity and share restrictions. The descriptive of the four group of hedge funds with respect to lockup, redemption notice period as well as redemption frequency are reported in the table. We also report the performance of all four groups in returns and alphas for both crisis and non-crisis periods[8]. We use excess returns in

[8] The non-crisis period includes both the period prior to the crisis and the period after the crisis.

this analyses and the alphas are calculated for each fund based on the Fung and Hsieh (2004) seven-factor model. We find that our results in table 9 are consistent with the result found in table 5 on the issue of correlation that exists between the three share restrictions. We find the two groups of funds with strict share restriction (redemption notice periods above the median) to be more likely to have lockup periods as well longer redemption frequency periods. Consequently, the returns and alpha for the non-crises period are much higher for the two groups with strict share restriction (redemption notice periods above the median). This confirms our findings from the hypothesis 1 that funds with stricter restriction perform better in the non-crisis period (both before and after the crisis). However, strict share restriction tend not to do much for hedge funds in term of returns in the crisis period as we find that the two groups with illiquid investments have the worst perform during the crisis period. Thus, the results from table 9 suggest that share restrictions are the driving force for both higher returns and alphas in the non-crisis period than asset portfolio liquidity. Nevertheless, it seems that asset portfolio liquidity becomes the main driving force behind both lower returns and alphas during the crisis period. We find specifically that funds with the combination of illiquid investments and weak share restrictions (asset-liability match) tend to perform particularly worse in the crisis period. This under performance can be due to the fact that during the crisis period investors tend to withdrawal their capital from funds. This withdraw spree is much pronounced for fund with weak share restrictions that are unable to limit investors ability to easily redeem capital. Coupled with this fact, such funds that also tend to invest in more illiquid asset will be forced to sell their assets at fire sale prices in order to meet investor redemption. They are put in an uncomfortable position where they have to sell highly illiquid asset at ridiculously low prices at the detriment of the company.

Thus, funds with illiquid investments and strong share restrictions (better asset-liability mismatch) perform best in the non-crisis period. However, having a better asset-liability match does not seem to help improve their performance in the crisis since they perform almost as bad as the fund with an asset-liability mismatch. Nonetheless, funds with the combination of illiquid investments and weak share restrictions (asset-liability mismatch) perform particularly poorly during the crisis periods. Apart from the performance measured by the alphas and returns, the Sharpe

ratios tells a similar story. The Sharpe ratio uses the standard deviation to measure a funds risk-adjusted returns such that the higher the funds Sharpe ratio the better the funds returns have been in relation to the risk it has taken. We see that the Sharpe ration is highest for both funds with illiquid investments and strong share restrictions and funds with a combination of illiquid investments and weak share restrictions in the non-crisis period. This means that the security in question in these funds particularly outperforms the risk-free rate. In the crisis period the Sharpe ratios are more negative for the two groups of funds. However, those funds with illiquid investments and strong share restrictions have a more negative Sharpe ratio, which means that the fund performs worse in relation to the risk it takes on. This makes sense since during the crisis period funds with more illiquid assets are faced with the risk of not finding an appropriate buyer for their assets when the need arises. They are mostly left with the option of selling their assets at fire sale prices which is unprofitable.

This analyses is univariate and thus it does not take into consideration other essential determining factor of hedge fund performance besides share restrictions and asset portfolio liquidity. We conduct a multivariate analysis similar to that of table 8[9]. This time around, we assign four dummy variables to each of the four group indicator variables (liquid investments, weak restrictions; liquid investments, strong restrictions; illiquid investments, weak restrictions; illiquid investments, strong restrictions). If a funds smoothing parameter is above the median (high $\theta_0$–liquid investment) we assign to it a value of 1 else it gets the value 0. Likewise if the funds redemption notice period is above the median (high notice period–strong restrictions) we assign to it a value of 1 else it get the value 0. In addition, we include the share restrictions, theta0, the interaction term of the crisis dummy variable with the share restrictions as well as theta0 and the five control variables to account for other important determinants of the performance of hedge funds.

Unlike table 8 we estimate one model for both returns and alphas. We run a panel regression of all the independent variables (simultaneously) on the funds excess return as well as on the alpha from the Fung and Hsieh (2004) seven-factor model. The

[9] We exclude the liquidity beta from this regression

dependent variable in Columns 1 is the alpha from the Fung and Hsieh (2004) seven-factor model and in Columns 2 is the funds' excess returns. Because of the complexity of this model (interaction between two dummy variables) we try to estimate the model by mimicking the procedure laid down by Schaub and Schmid (2012). So we estimate the pooled OLS regression with strategy fixed effects as they do in their paper. To do this we construct broad style categories as Agarwal, Daniel & Naik (2009) because there are not many funds in all main strategies (for instance short bias strategy has only 43 funds out of the total 5639 funds in our sample).

Our results from this estimation shows statistically significant and negative coefficients for both returns and alphas of funds with the interactions: Crisis*[illiquid investments, weak restrictions] and Crisis*[illiquid investments, strong restrictions]. This suggests that funds with illiquid securities underperform funds with liquid securities during the crisis periods. However we find that funds that have illiquid investment but weak restrictions perform much poorer during the crisis. These group of funds are those with an asset-liability mismatch. The multivariate analyses confirms the results from the univariate analysis that hedge funds that have an asset-liability mismatch perform particularly poorly during the crisis period.

Although funds with a better asset-liability mismatch (illiquid investments, strong restrictions) reap negative returns they tend to perform relatively better than those with an asset-liability mismatch (illiquid investments, weak restrictions) during the crisis period. One reason for this occurrence may be due to the presence of stricter share restriction which prevent easy redemption. This helps in a way for funds with illiquid investment and strong restrictions to manager their illiquid assets through the use of restrictions such as lockup provisions, longer redemption notice and less frequent redemption periods. Thus, they are able to reap better but negative returns and alphas than the funds in the category of – illiquid investments, weak restrictions.

**Table 9. Univariate comparisons of four groups of hedges funds based on asset portfolio liquidity and share restrictions**

| | # funds | Mean lockup days | Mean notice days | Mean redemption days | Theta | Before Crisis | | | During Crisis | | | After Crisis | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Returns | Sharpe | Alpha | Returns | Sharpe | Alpha | Returns | Sharpe | Alpha |
| All funds | 5,639 | 111 | 36 | 74 | 0.811 | 0.015 | 1.701 | 0.067 | -0.105 | -1.570 | 0.033 | 0.091 | 1.700 | 0.026 |
| Liquid investments Weak restrictions | 1,770 | 63 | 18 | 50 | 0.921 | 0.078 | 1.260 | 0.057 | -0.008 | -0.113 | 0.063 | 0.063 | 1.059 | 0.014 |
| Liquid investments Strong restrictions | 609 | 177 | 65 | 102 | 0.909 | 0.103 | 1.839 | 0.076 | -0.040 | -0.614 | 0.068 | 0.082 | 1.525 | 0.025 |
| Illiquid investments Weak restrictions | 1,906 | 80 | 21 | 62 | 0.717 | 0.095 | 1.794 | 0.063 | -0.180 | -2.611 | 0.016 | 0.106 | 2.027 | 0.020 |
| Illiquid investments Strong restrictions | 1,354 | 196 | 69 | 110 | 0.690 | 0.111 | 2.860 | 0.085 | -0.176 | -2.991 | -0.002 | 0.124 | 2.847 | 0.048 |

This table reports comparisons of four groups of hedges funds based on asset portfolio liquidity and share restrictions. Liquid investments refers to funds with smoothing parameters above the median. Illiquid investments refers to funds with smoothing parameters below or equal to the median. Strong restrictions refers to funds with redemption notice periods above the median. Weak restrictions refers to funds with redemption notice periods below or equal to the median. Funds in our analysis are required to have at least 24 month of observations. The returns are the excess returns for each of the four groups. The alphas are based on the Fung and Hsieh (2004) seven-factor model. The sharpe is calculated for funds in each group by dividing the excess returns by the standard deviation. The values reported are annualized.

**Table 10. Panel regressions of alphas and returns on indicator variables for hedge fund groups based on asset portfolio liquidity and share restrictions**

| | Dependent Variable | |
|---|---|---|
| | Alphas | Returns |
| Independent Variable | 1 | 2 |
| Intercept | -0.037** | 0.098** |
| | (-20.937) | (6.770) |
| Crisis | -0.030** | -0.453** |
| | (-6.714) | (-17.858) |
| Liquid investments, Weak restrictions | -0.009** | -0.030** |
| | (-15.734) | (-6.257) |
| Crisis*[Liquid investments, Weak restrictions] | 0.008** | 0.207** |
| | (4.760) | (14.686) |
| Liquid investments, Strong restrictions | -0.005** | -0.009 |
| | (-7.899) | (-1.611) |
| Crisis*[Liquid investments, Strong restrictions] | 0.009** | 0.068** |
| | (4.350) | (3.998) |
| Illiquid investments, Weak restrictions | -0.012** | -0.013** |
| | (-16.924) | (-2.327) |
| Crisis*[Illiquid investments, Weak restrictions] | -0.014** | -0.060** |
| | (-7.152) | (-3.792) |
| Illiquid investments, Strong restrictions | -0.002** | 0.006 |
| | (-2.801) | (1.275) |
| Crisis*[Illiquid investments, Strong restrictions] | -0.010** | -0.051** |
| | (-5.683) | (-3.625) |
| Theta0 | 0.013** | -0.040** |
| | (7.267) | (-4.293) |
| Crisis*Theta0 | 0.037** | 0.288** |
| | (6.886) | (10.490) |
| Lockup | 0.013** | 0.020** |
| | (32.902) | (6.012) |
| Crisis*lockup | -0.004** | -0.027** |
| | (-3.386) | (-2.792) |
| Notice period | 0.052** | 0.053 |
| | (15.065) | (1.747) |
| Crisis*notice | 0.018** | 0.118 |
| | (2.041) | (1.413) |
| Redemption | 0.007** | 0.013** |
| | (9.506) | (2.124) |
| Crisis*Redemption | 0.007** | -0.061** |
| | (2.882) | (-2.982) |
| Control Variables | | |
| Fund size | 0.003** | -0.003** |
| | (36.392) | (-4.229) |
| Fund age | 0.002** | -0.003 |
| | (14.748) | (-1.110) |
| Personal Capital | 0.002** | 0.005 |
| | (6.983) | (1.654) |
| Management Fee | 0.621** | 0.976** |
| | (25.325) | (4.602) |
| Incentive Fee | 0.210** | 0.060** |
| | (64.493) | (2.118) |

The table reports the panel regressions of alphas and returns on indicator variables for hedge fund groups based on asset portfolio liquidity and share restrictions. The results from this regressions is done with strategy fixed effects. The dependent variable is either an alpha based on the Fung and Hsieh (2004) seven-factor model (Column 1), or excess returns (Column 2). Crisis is a dummy variable which equals one if the observation is within the time period from July 2007–December 2008. The four group indicator variables (Liquid investments, Weak restrictions; Liquid

investments, Strong restrictions; Illiquid investments, Weak restrictions; Illiquid investments, Strong restrictions) are based on the following dummies: Liquid investments refers to funds with smoothing parameters above the median. Illiquid investments refers to funds with smoothing parameters equal to or below the median. Strong restrictions refers to funds with redemption notice periods above the median. Weak restrictions refers to funds with redemption notice periods below the median. Theta0 measures the funds' asset portfolio liquidity and is obtained from a maximum likelihood estimation of the MA (2) model of observed returns as proposed by Getmansky et al. (2004). Lockup is a dummy variable which equals one if the respective fund has a lockup provision. The five control variables are summarized in Appendix 1. Funds in our analysis are required to have at least 24 month of observations. The t-values (in parentheses). ** represents the 5% statistically significant level. The values reported are annualized.

## 4.4 Robustness checks

In this section we check the robustness of the results from our main findings to see if they remain valid when modified. First we correct for backfill bias in the data. We exclude the first 12 months of returns from each fund because the first two years are known to most likely contain the largest backfilled return observations. Consistent with our findings, we find that during the crisis hedge funds record both negative returns and alphas and that generally, there exist a positive relationship between share and hedge fund performance in the non-crisis period. The positive relation between share restrictions and hedge fund performance in the non-crisis period turns negative in the crisis period which is an indication that illiquid funds suffer from poor performance during crisis periods, both in absolute returns as well as on a risk-adjusted basis. Thus, funds that impose strict share restrictions generate higher returns during non-crisis period and reap illiquidity discounts during crisis periods.

We also find our results on asset-liability mismatch to be robust to our main findings that the funds that hold illiquid asset in their portfolios and yet impose weak restriction perform particularly worse in the crisis period. We explained that this might be due to the fact that manages would have to sell assets at ridiculous prices in order to meet investors redemption needs. The results of the robustness tests remain relatively similar to those reported in our main findings in tables 8 and 10.

Next we consider the effect of other crisis period on our main findings. We rerun the analysis with other definitions of the crisis period. The first alternative measure employed was the collapse of Long-Term Capital Management (LTCM) from July

1998 to December 1998. The second alternative measure was the technology from March 2000 to December 2001. We find our results to be robust to our findings. The results for the different definitions of the crisis period are similar to results for our original definition (July 2007– December 2008 financial crisis) in both hypothesis.

# 5 CONCLUSION

The purpose of this study was to examine the effect of liquidity and share restrictions on hedge fund performance. We measure liquidity in two form. Firstly, by the liquidity level of fund portfolios (Getmansky et al. 2004) and also by Pastor and Stambaugh (2003) market-wide liquidity risk measure. We begin by evaluating in a univariate and multivariate setting the effect that share restrictions may have hedge fund performance in both crisis and non-crisis periods. The outcome of this analysis shows that, funds that impose stricter share restrictions record both higher returns and alphas in non-crisis periods. On the other hand, in the crisis we find that funds that impose stricter share restrictions record both lower returns and alphas. Therefore, we find that funds generate an illiquidity premium in the form of higher returns in the non-crisis period to compensate for limited liquidity. However, in the crisis period, this illiquidity premium turns into an illiquidity discount. Hence, share restrictions are positively related to hedge fund performance. In one of our contribution to previous studies we find that the hedge fund did not earn as high returns as they did before the crisis (even though they had positive returns). It seems that they were struck severely by the financial crisis and have been unable to pick up quickly to where they were (in terms of returns) prior to the financial crisis. The effects of the financial crisis can be seen in the lower returns.

Also, we find that funds that impose one share restriction are likely to impose the other restrictions and that such funds mostly invest in illiquid assets. This is because share restriction allows for greater managerial discretion and prevent easy capital redemption by investors. By applying share restriction (limiting investor's redemption) managers are in a better position to apply arbitrage and speculative investment strategies with longer investment horizon in order to reap higher returns.

We also investigate the separate and joint effect of illiquid asset portfolios, liquidity risk and share restrictions on hedge fund performance in both crisis and non-crisis periods. By doing this we are able to evaluate the separate effect of asset portfolio liquidity and share restrictions on hedge fund performance as well as examine their joint effect on fund performance. Our results show a significantly positive relation

between asset portfolio liquidity and hedge fund alphas and returns during the crisis. We also find a significantly negative relationship between liquidity risk exposure and hedge fund performance in the crisis period. But in the non-crisis period we find a positive and significant relationship between liquidity risk exposure and hedge fund performance. Our results are in line with research that evaluate the effect of market-wide liquidity on hedge fund performance and finds that in hedge fund returns generally display negative return shocks in times when liquidity declines.

Second, we investigate whether funds that hold illiquid assets in their portfolios and also impose weak share restriction (asset-liability mismatch) suffer very badly in the crisis period. Our results show that funds with an asset-liability mismatch suffer particularly poor performance in the crisis period. We also find that funds hold more illiquid securities underperform funds that hold more liquid securities during the crisis periods. However, the funds that have illiquid investment but weak restrictions perform much poorer during the crisis. We find that fund managers can prevent an asset-liability mismatch by ensuring that the trade-off between the types of assets held (liquid or illiquid) and the type of restriction put in place works together to reduce the funds exposure to liquidity risk.

In conclusion, the results from our study differ a bit from previous studies (like Schaub and Schmid 2012) because our data sample is much larger (1994/01–2013/09) and also takes into account the era preceding the crisis which most paper do not show. In general, we find that imposing stricter share restrictions is positively related to hedge fund performance during the pre-crisis and post crisis period but this does not hold during the crisis as we find a negative relationship between share restriction and fund performance. Hedge funds with stricter share restriction mostly invest in illiquid assets. The underperformance of illiquid funds during the crisis was majorly driven by styles which consist mostly of illiquid funds such as relative value and event driven styles. Asset portfolio liquidity is positively related to hedge fund performance in the crisis period but negatively related to fund performance during the non-crisis period. We find particularly poor performance for funds with an asset-liability mismatch during the crisis. Our results are robust and can be generalized to most crisis periods.

The result of this thesis is beneficial for both institutional and individual investors. Stringent share restriction periods potentially indicate types of strategies or investment a particular hedge fund invests in. Although hedge funds use share restrictions as a way to limit investor's redemption with the possibility of generate high returns, there is also the odds that they can also reap significantly high losses as can be seen from the underperformance of illiquid funds (relative value strategy) in the recent financial crisis of 2007–2008. This bring to light the importance of the use of appropriate financial risk management tools to help reduce the impact of a funds liquidity risk exposure especially during economic downturns.

For further studies it would be interesting to find out or study the ways in which the illiquidity discounts reaped during the crisis period can be mitigated. Schaub and Schmid (2012) already finds the use of high incentives fees as one way to help overcome the illiquidity discounts observed in the crisis period. More research can be done in this area as Schaub and Schmid (2012) findings cannot necessarily be generalized to all situations.

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**APPENDIX 1**

**Control Variables**

| Variable | Description |
|---|---|
| Fund Size | This represents the natural logarithm of the funds asset under management in USD. |
| Fund Age | This represents the natural logarithm of the fund age in months. |
| Personal Capital | This represents a dummy variable which equals one if the manger holds shares in the fund. |
| Management Fee | This represents the funds management fee in percentage. |
| Incentive Fee | This represents the funds incentive fee in percentage. |