AG432: Financial Quantitative Methods

A Discussion of the Factors Driving Hedge Fund Liquidation

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Question 1 Literature Review: The Relationship between Hedge Fund Flow & Liquidation Risk

Introduction

A hedge fund is a financial institution that privately manages the funds deposited by investors with the aim of making a return. They are less regulated by the Securities Exchange Commission (SEC), and not at all by the Federal Deposit and Insurance Commission (FDIC), than other financial institutions such as banks and mutual funds, allowing them to take on more risk such as running lower liquidity coverage ratios and short selling. This, coupled with complex trading strategies found within financial institutions means hedge funds can often offer higher returns to an investor than banks and mutual funds. As a result they occupy a unique position in financial markets providing liquidity and risk pooling. Though, contrarians argue that the relative free reign given to hedge funds encourages risky behaviour and compounds systematic risk, creating instability in the financial system (Billio et al, 2011). Hedge fund liquidations can have ramifications throughout the financial system e.g. LTCM's $3.6 billion bailout of September 1998 by the US Federal Reserve because the liquidation of the fund's positions would cause a financial crisis (Edwards, 1999). Thus this report finds it important and aims to discuss the relationship between hedge fund flow and liquidation risk as well as to explain factors affecting the probability of hedge fund collapse using a Logistic Regression Function.

Hedge Fund Flow

Hedge Fund Flow is a measure of the cash coming into a hedge fund e.g. investor deposits and cash exiting the fund e.g. investor redemptions. Though correlated, it is not directly a measure

of fund performance but is rather a measure of investor sentiment because confident investors deposit more readily than withdraw.

Although, Fund flow is not a perfect measure of investor sentiment for a number of reasons that must be considered before understanding the relationship with liquidation risk. Firstly it is a lagged indicator often collated quarterly meaning that it reflects past investments, not future ones. Relying solely on fund flow data will result in investors missing early opportunities or managers having outdated beliefs of investor sentiment. Rational Expectations Theory provides a counter argument to this as it posits that investors are forward looking thus their decisions are a function of their beliefs of the future given the information available (Lucas and Sargent, 1981). This reduces the concern of the data release lag because at least to some degree, fund flow data from the current period will reflect investor sentiment in a future period.

A related issue is, like all other financial and economic data, fund flows are liable to have noise. This is the random deviation from the mean / true fund flow level. As a result multiple periods of data is required to make any meaningful analysis or draw conclusions about trends in sentiment. The industry solution to this is to categorise funds based on their characteristics such as size and strategy and cross-sectionally estimate a trend as opposed to doing so in time series. The Morningstar Category classifications were introduced in 1996 (awgmain.morningstar.com, n.d.) for this purpose which reduced the need for historic data. Categorisation also aided in identifying the drivers behind changes in sentiment as e.g. if commodity funds see flows fall and technology fund see a flow increase in the same period a more detailed picture of what is attracting investor attention is achieved.

A minor concern is conflation of real changes to fund flows due to sentiment and changes due to routine rebalancing of the fund's portfolio.

Liquidation

Liquidation is where a hedge fund sells all its assets and distributes the proceeds to secured creditors and investors, which can be forced, i.e. the management have no other choice, or voluntary. Alternatively, to protect the investors and safeguard the stability of the underlying markets funds can be merged and investments transferred to another similar fund that assume the positions of the failed. Funds can be pushed to liquidation for a number of reasons as shown below, summarised into internal and external factors.

Internal

Poor performance ranking as one of the primary causes of fund liquidation as investors choose not to buy into a fund that isn't doing well, causing the fund flows to worsen, leaving managers with less funds to invest to try to remedy the issue. This quickly becomes a vicious cycle of divestment until the fund collapses. (Smith, 2022).

Operational risks are risks associated with the everyday operation of a hedge fund such as key managers leaving, misrepresentation of investments or unauthorised trading that can destabilise the firm. Evidence suggests approximately 50% of fund failure are due to operational issues (Gutiérrez de Rozas, 2023).

Literature shows that fund size, measured by Assets Under Management (AUM), is inversely related to likelihood of liquidation (Becam, Gregoriou and Gupta, 2018). This is because funds can take advantage of economies of scale as fixed costs are a smaller proportion of a large fund's balance sheet, it has more capital to allocate productively. Gupta et al, also find that different factors drive the collapse of small funds than that of larger ones. Smaller funds are more sensitive to market risk while larger funds face the biggest risk from operational risk.

External

Market Risk describes the risk funds face from adverse movements in financial markets. Market risk can come in many forms such as funds in niche, low volume, low liquidity markets according to Smith in 2022, making them vulnerable, as they are often invested in short term fads, or an unknown industry that there is a risk the concept will never gain traction with investors. This report extends the concept to include engaging in future and leverage trading as they are used as methods of mitigating market risk.

The rapid divestment described in the Poor Performance section is known as a redemption run which is another external factor affecting a hedge fund through the channel of fund flows. It leads to failure due to significant falls in fund flows. Agarwal et al. (2018). Fund managers attempt to control for this with policy gate provision, which requires investors to provide notice in advance of withdrawal and limiting the value of withdrawals (Investopedia, n.d.).

Poor Initial Years for a fund significantly hampers the probability of success. Investors have come to expect large abnormal returns in the inception years of a fund for managers to prove their skill. If a fund does not grow to investor expectations during its first three years, it is likely to close shown by 38% of funds closing within their first 3 years of operation (Svea Herbst-Bayliss, 2020). Although it is still possible for well-established funds to fail. E.g. 2016, after 28 years of operation, Perry Capital announcing the closure of its flagship fund.

Liquidation Risk & Fund Flow's Relationship

Evidently many of the factors affecting the probability of liquidation for a fund operate through the channel of Fund flow. If not the extreme case of redemption runs such as Peloton following the 2008 mortgage-backed securities (MBS) crisis where concerns of the high weighting of MBS in its portfolio, investors put in redemption notices en masse (NY Times International Business, 2008). Then through a steady divestment in the case of Cathie Wood's ARK

Transparency ETF (CTRU). Founded in December 2021, focusing on companies scoring high on transparency and ethical standards. However, the fund struggled to attract significant investor interest. By July 2023, ARK announced its liquidation due to insufficient AUM and low trading volume (Ricketts, 2024).

Though consistent negative fund flows can be the cause of fund failures, due to flows being a signal or proxy for the investor sentiment it is just the symptom of the larger issue of divestment. If this is happening to individual funds within a category, it can be interpreted as poor performance or an erosion of trust in the future of the fund. If this happens across an entire category, the divestment can be interpreted as a shift in investor focus away from the category.

Low to negative fund flows arise in light of bad news regarding internal or external factors to failure. So though they signal a fund's failure and aid it, as managers are put under pressure by the reduction in tradable funds, flows have more of an inverse signalling relationship with failure as opposed to a causal as they change in response to a more structural underlying issue.

The impact of fund flow on liquidation risk was worsened by the implementation of the Volcker Rule that restricts banks and other bank-like entities' involvement with hedge funds. Implemented in April 2014, the legislation prohibits banks from engaging in proprietary trading of risky investment instruments i.e. owning shares in hedge and private equity funds (Bowe, Kolokolova and Yu, 2019). This greatly reduced the liquidity available as a core investor base for hedge funds was effectively removed.

Question 2 Regression: The Factors Affecting the Probability of Hedge Fund Failure

Data Discussion:

The data provided is complete with no missing values and includes 752 live and 2248 liquidated hedge funds. The dependent variable of concern being Event, which =1 if liquidated and 0 if the fund is still running. 7 other fund characteristics were given as independent variables namely, AveRet (*Rets*), Volatility (*Vol*), Assets Under Management (*AUM*), Fund Flow (*Flow*), Leverage (*Lev*), Futures (*Fut*), Redemption Period (*Red*). Summary statistics and distributions of which can be found in Figures 2 and 3.1 to 3.8 respectively.

Assets under management was logged to obtain a linear relationship with the dependent variable in order to have a more reliable parameter estimate. The Redemption period variable was also split into short redemption period (<30 days) and long redemption period (30 > x <45days) to achieve a high-level understanding of redemption period effects as opposed to the marginal effect of days. The small group of very long redemption periods (<45days) were excluded from the model to avoid the issue of multicollinearity.

Model Specification

Due to the binary nature of the dependent variable (Y = 1, if fund failed and Y=0 if still alive), a Logistic regression function was used. This differs from an ordinary least squares model (OLS) as the independent variables (input) map to a value between 0 and 1 that is the probability of the Y=1 i.e. the probability of fund collapse. The logistic regression function itself is a generalised least squares model that allows for the dependent to follow a Binomial distribution as opposed to a Normal distribution as with on OLS. Due to the nature of the logistic function, the model has no concept of a sum of the squared residuals to minimise to fit the data optimally, thus it was estimated using Maximum Likelihood Estimation. This is where

a logit function is fit then the logged likelihood of observing each data point given the line is calculated, then the line is incremented. Repeating this process results in a likelihood function. (PennState: Statistics Online Courses, n.d.). The logit function that maximises the logged likelihood of observing the data is then selected as the final model. The output of which can be seen below.

$$log\left(\frac{p(Y=1)}{1-p(Y=1)}\right) = \beta_1 Rets + \beta_2 Vol + \beta_3 AUM + \beta_4 Flow + \beta_5 Lev + \beta_6 Fut + + \beta_7 SRed + \beta_8 LREd$$

$$log\left(\frac{p(Y=1)}{1-p(Y=1)}\right) = 3.56 Rets + 5.39 Vol + 0.03 AUM - 0.35 Flow + 0.68 Lev + 0.27 Fut + 0.77\ SRed - 1.18 LREd$$

As shown in Figure 1 all parameter estimates are significant at a 5% level except that of Average Returns and Fund Flow. The positive coefficient on all but two parameters suggests that increases in average returns, volatility, assets undermanagement trading with futures, leverage and short redemption periods are associated with an increase in the logged likelihood and thus odds of liquidation. This is a positive correlation as opposed to the negative correlation seen with flows and long redemption periods, where the negative coefficients suggests increases in these parameters are associated with a fall in the probability of liquidation.

Results & Interpretation

Shown by the significance column of Figure 1, Average Return and Fund Flow were not significant at a 5% level. Which suggests they are not relevant to consider when determining whether a fund will succeed or fail. But this low T-value is due to the proportionally large standard errors. This means that there is large variation in the estimate i.e. funds collapsing with higher than average return or flow, and vice versa. With standard error as a denominator to the T value calculation this reduces the significance of the estimate. Funds can fail for a

number of factors aside from return and flows, consistent with the findings of the literature review thus it was decided not to remove the variables from the model as practice would suggest, because they may provide further validation in a case that is clearer cut.

Average returns, a proxy for fund performance having a positive coefficient is contrary to intuition and the literature as a well performing fund and manager will attract the attention of more investors and decrease the probability of default. One possible explanation for this is that high return e.g. growth funds also operate riskier than value funds. To make this clearer the Average returns could be transformed into a risk adjusted return variable by dividing it by the volatility.

Volatility's positive coefficient is in line with expectation and literature as investors are proven to be risk averse so higher risk on the returns are not favoured and increases the logged likelihood of fund collapse.

AUM's positive coefficient is contrary to expectation and literature as argued above, the higher proportion of tradable funds with large funds allows them to outperform smaller funds. This is made evident with new funds that start with less than $25 million, only 40% survive. Goldman Sachs research suggests their average lifespan is 36 months, while three-quarters of the funds that launched with $1 billion or more in AUM are still in operation. (Svea Herbst-Bayliss, 2020). Yin C, in his 2016 paper on the optimal size of hedge funds, reports a positive relationship between fund managers' compensation and fund size, and finds that managers allow fund size to grow beyond optimal size for performance to maximize their private compensation. This is an example of the Principal-Agent Problem that potentially explains the positive coefficient seen in the model as a fund grows bigger the incentives of managers and investors misalign, resulting in increased risk of failure.

Following this, (Getmansky, 2012) arguing that there is an optimal fund size that maximizes returns, based on her findings of a positive but concave relationship between fund size and performance as an excessively large fund faces liquidity challenges and capacity constraints, which can diminish its performance (Perold and Salomon Jr, 1991). Thus suggesting that investors should prefer funds close to their optimum size.

Fund flows negative coefficient is in line with intuition and literature as it is thoroughly discussed in Question 1 that positive shocks to the fund effect flows positively as inflows increase and outflows decrees, meaning that it is inversely correlated with liquidation risk.

As mentioned in the Question 1 section leverage and futures trading are used as ways of enhancing returns and mitigating market risk, thus this report generalises them into market risk strategies. The derivative nature of these make them difficult to manage and understand the risk structure of, therefore only very experienced managers should be trusted to manage them appropriately. Micheal Malquarti in his 2024 article in the Hedge Fund Journal coined them to be in the ‘Hedge Fund Bermuda Triangle’ alluding to their complex nature and ease of quickly spiralling out of control. Thus the positive coefficients seen on these in the model is in line with expectations.

Redemption notice period describes how long in advance the investor must notify managers of an intended withdrawal. Generally translating to how much time managers have to prepare for a withdrawal. The longer the period the more time investors have to seek additional funding if necessary to compensate for the increase in fund outflows. The positive coefficient seen on short notice periods and negative on the long is in line with intuition and literature in that a longer notice period starts to function as a form of credit allowing the fund to adapt and

maintain liquidity in times of crisis. It also deters investors from panic redemptions as when taking into account the time value of money and discount rates, the present value of a panic withdraw may be lower than to keep the funds invested until information is more certain.

Conclusion & Recommendations

Evidently Fund Flows play a role in determining the welfare of a hedge fund. Many other, both internal and external shocks transmit their effect on the probability of liquidation through the channel of fund flows. By decreasing the incoming flows or increasing the outgoing redemptions as seen with market risk and redemption runs respectively. Although it is difficult to isolate the marginal causal effect of flows on probability of failure due to the vast set of covariates as shown by the insignificant estimate of Figure 1. This suggests flows should be looked at alongside other significant factors such as Redemption period, Volatility, Risk Adjusted Returns, Leverage & Futures use and AUM when determining the risk of failure. With operational risk accounting for half of fund liquidations it is important to also consider it. But due to the unpredictability and often secretive nature of it, it would be difficult to include in a model.

Given the findings there are other variables affecting hedge fund failure not in the data set that would improve the model if considered. Firstly a variable for fund strategy i.e. Growth / Value / Mixed Strategy fund as it is an endogenous variable that if included could explain some of the variation in the Average Return variable and increase the significance of its beta estimate. A Time of year / business cycle of fund collapse would include the effect of Market Conditions as during recessions liquidity is low for many financial institutions. The Morningstar Category of the funds would be a beneficial variable to explore as it would elucidate the industries where failure rates are higher. Literature also suggest that the factors predicting the collapse of small

funds are different from that of the large. Thus for robustness, it is recommended that future researchers should estimate different models for large, medium and small funds.

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Appendix:

Figure 1: Logistic Regression Parameter Estimate Outputs

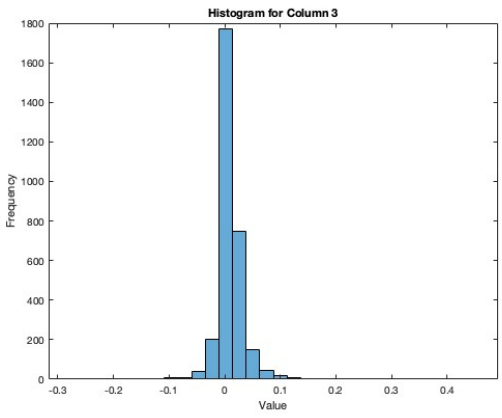
Parameter	Coefficients	Standard Errors	T Value	Critical Value	Significant
AveRet	3.5621	2.014	1.7686	1.96	FALSE
Volatility	5.3929	1.0219	5.2771	1.96	TRUE
AUM	0.027	0.0028	9.7479	1.96	TRUE
Flow	-0.3521	0.3893	-0.9043	1.96	FALSE
Leverage	5.3929	1.0219	5.2771	1.96	TRUE
Futures	0.027	0.0028	9.7479	1.96	TRUE
Short Redemption	0.7663	0.0705	10.8729	1.96	TRUE
Long Redemption	-1.1781	0.0803	-14.6714	1.96	TRUE

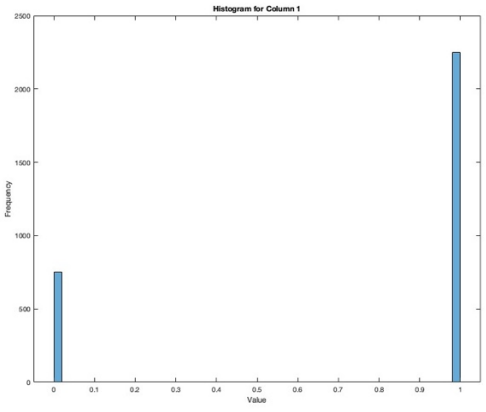
Figure 2: Variable Summary Statistics

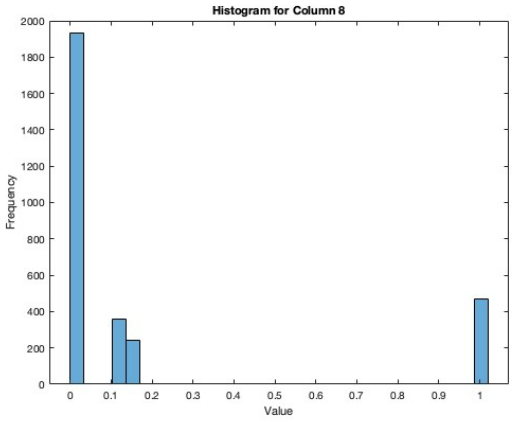
Variable	Mean	Median	StdDev	Min	Max
Event	0.74933	1	0.43347	0	1
AveRet	0.010536	0.0082082	0.02599	-0.26935	0.4535
Volatility	0.037228	0.025501	0.039959	0	0.54154
AUM	16.494	16.63	1.9018	3.0185	22.462
Flow	0.040439	0.0060993	0.10903	-0.24684	1.8854
Leverage	0.54767	1	0.49781	0	1
Futures	0.1818	0	0.35516	0	1
Redemption Period	33.854	30	31.14	0	300

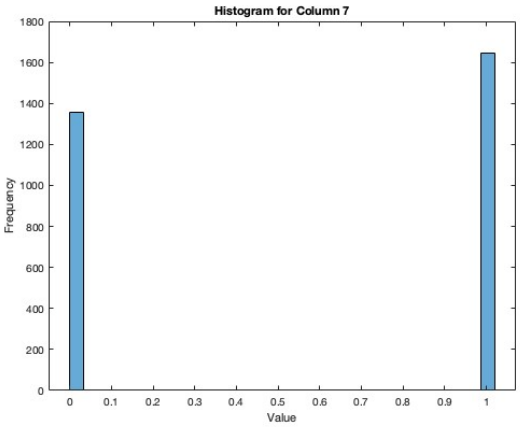
No. Failed	2248
No. Alive	752

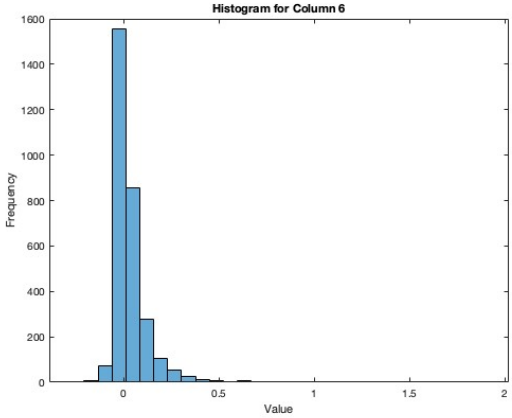
Figures 3.1-3.8: Data Distributions

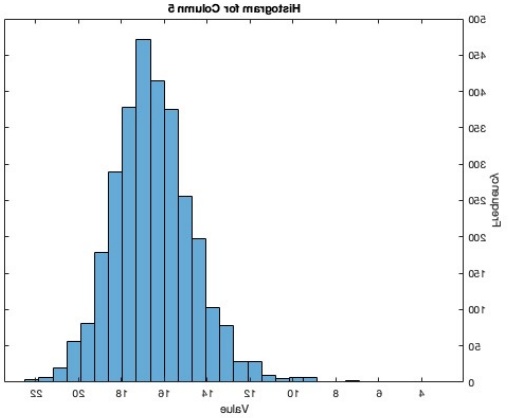


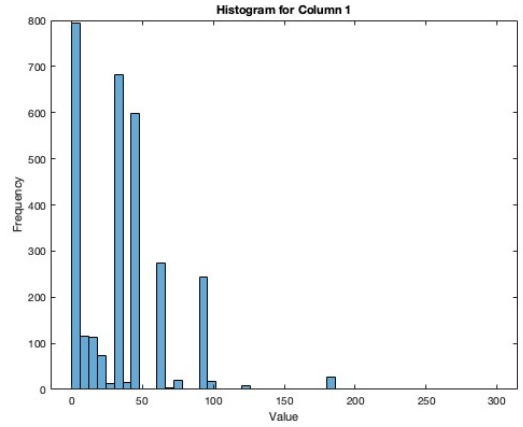


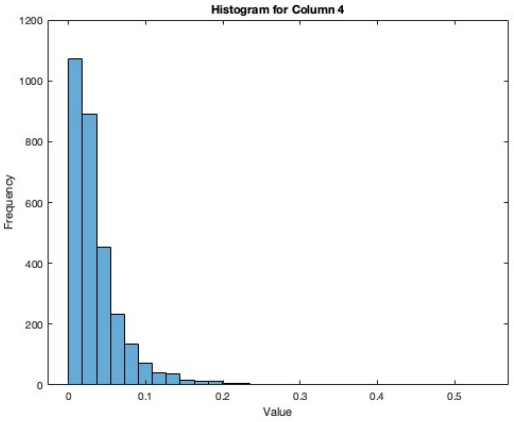

Histogram for Column 8
Frequency
Value


Histogram for Column 7
Frequency
Value


Histogram for Column 6
Frequency
Value


Histogram for Column 5
Value


Histogram for Column 1
Frequency
Value


Histogram for Column 4
Frequency
Value

```
Mydata = xlsread('AG432 Project Data.xlsx');

Y = Mydata(:,2); % This is dependent variable for hedge fund project data

X = Mydata(:,3:end); % This is independent variables
```

```
%% Data Discussion & Descriptive Statistics
for i = 2: size(Mydata,2)...

covarmatrix = cov(Mydata)
display(covarmatrix)
```

```
%% Now conducting logit regerssion

[Para, STDE] = Logit(Y,X);

% Calculate t-values

T = Para./STDE

% Get fitted values
y_hat = X * Para;

% AIC
Full_Model_AIC = Aic(Y,y_hat,size(Para,1))

%dropping the first column seems to increase AIC
```

```
%% Dropping Insignificant Parameters From the Model
% (RESULTS EXCLUDED FROM PROJECT SUBMISSION)
Y = Mydata(:,2);
X = Mydata(:, 4:end);

[Para, STDE] = Logit(Y,X);

T = Para./STDE

y_hat = X * Para;

% AIC
Tweaked_Model_AIC = Aic(Y,y_hat,size(Para,1))
```