Skewness, kurtosis and convertible arbitrage hedge fund performance

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Abstract

Returns of convertible arbitrage hedge funds generally exhibit significant negative skewness and excess kurtosis. Failing to account for these characteristics will overstate estimates of performance. In this paper we specify the Residual Augmented Least Squares (RALS) estimator, a recently developed estimation technique designed to exploit non-normality in a time series' distribution. Specifying a linear factor model, we provide robust estimates of convertible arbitrage hedge fund indices risks demonstrating the increase in efficiency of RALS over OLS estimation. Third and fourth moment functions of the HFRI convertible arbitrage index residuals are then employed as proxy risk factors, for skewness and kurtosis, in a multi-factor examination of individual convertible arbitrage hedge fund returns. Results indicate that convertible arbitrage hedge funds' receive significant risk premium for bearing skewness and kurtosis risk. We find that 15% of the estimated abnormal performance from a model omitting higher moment risk factors is attributable to skewness and kurtosis risk.

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Returns of convertible arbitrage hedge funds generally exhibit significant negative skewness and excess kurtosis. Failing to account for these characteristics will overstate estimates of performance. In this paper we provide estimates of the risk premium convertible arbitrage hedge fund investor's receive for bearing skewness and kurtosis risk and provide robust estimates of convertible arbitrage performance.

Phillips, McFarland and McMahon (1996) amongst others highlight that the distributions of financial asset returns typically exhibit heavy tails. If the returns of a financial time series are non-normally distributed the Gauss-Markov conditions will not be satisfied and any explanatory variable coefficients estimated using OLS will be biased. Because least squares minimises squared deviations, it places a higher relative weight on outliers, and, in the presence of residuals that are non-normally distributed, leads to inefficient coefficient estimates.

A number of alternative robust estimation techniques have been specified to more efficiently model non-normal data. These include M-estimators, L-estimators and R-estimators. Bloomfield and Steiger (1983) demonstrate that Basset and Koenker's (1978) Least Absolute Deviations (LAD) estimator, from the L-estimator class has particularly useful properties in time series regression models and LAD is often specified as an alternative to least squares when the disturbances exhibit excess kurtosis. Phillips, McFarland and McMahon (1996) and Phillips and McFarland (1997) specify FM-LAD, a non-stationary form of the LAD regression procedure, due to Phillips (1995), to model the relationship between daily forward exchange rates and future daily spot prices. Results of both studies highlight the significant improvements in efficiency from robust estimation where series are non-normally distributed.

Several studies of hedge funds have highlighted non-normality in return distributions. Brooks and Kat (2001) and Kat and Lu (2002) discuss in detail the statistical properties of hedge fund strategy indices and hedge fund strategy portfolios respectively. Their findings indicate that the returns to several of these strategies are negatively skewed and leptokurtic. Convertible arbitrage clearly displays these characteristics with significantly negative skewness and positive kurtosis. These features of hedge fund returns are particularly important when assessing hedge fund risk. Investors have a preference for positively skewed assets so will require a risk premium for holding hedge funds which are negatively skewed.

Several studies attempt to address the non-normal distribution of hedge funds by including contingent claims as risk factors in a linear factor model specification. Agarwal and Naik (2004) and Mitchell and Pulvino (2001) incorporate short positions in put options, while Fung and Hsieh (2001) use positions in look-back straddles as risk factors and Hutchinson and Gallagher (2006) specify a simulated convertible bond arbitrage portfolio as a risk factor which shares the non-normal characteristics of convertible arbitrage fund returns. Gregariou and Gueyie (2003) Madhavi (2004) specify Sharpe ratios which have been adjusted to account for higher moments to assess hedge fund performance and Alexiev (2005) and Favre and Signer (2002) specify a VaR adjusted for higher moments. Kat and Miffre (2005) employ a conditional model of hedge fund returns which allows the risk coefficients and alpha to vary incorporating proxy risk factors for skewness and kurtosis.

Overall, existing academic studies find that convertible arbitrage hedge funds generate significant excess returns. Capocci and Hübner (2004) specify a linear factor model to model the returns of several hedge fund strategies and estimate that convertible arbitrage hedge funds earn an abnormal return of 5.2% per annum. Hutchinson and Gallagher (2006), estimate that convertible arbitrage hedge funds generate abnormal returns of 0.34% per month.

These findings suggest that financial markets exhibit significant inefficiency in the pricing of convertible bonds.[1] In this paper we investigate an alternative explanation for the large excess returns documented in previous studies. Convertible arbitrage hedge fund investors may be receiving a risk premium for bearing skewness and kurtosis risks which have not been fully adjusted for in previous studies.

To assess the risk premium received by hedge fund investors for bearing skewness and kurtosis risk we specify Im and Schmidt's (1999) Residual Augmented Least Squares (RALS) estimator, a recently developed estimation technique designed to exploit non-normality in a time series' distribution. The RALS estimator is particularly practical as it provides robust coefficient estimates without imposing any restriction on the distribution of returns, is easily estimated using two step OLS and the coefficients are interpretable as skewness and kurtosis risk premia. Previous empirical studies have demonstrated the increased efficiency in RALS coefficient estimates over OLS.[2] A linear factor model of convertible arbitrage hedge fund index risk is estimated employing this robust estimation technique which explicitly allows for non-Gaussian innovations. Third and fourth moment functions of the HFRI convertible arbitrage hedge fund index residuals are then employed as proxy risk factors, for skewness and kurtosis, in a multi-factor examination of individual hedge fund returns.

The remainder of the paper is organised as follows. Section 1 provides a review of RALS. Section 2 describes the convertible arbitrage risk factor model. Section 3 presents an analysis of

[1] Ammann, Kind and Wilde (2004) and King (1986) document evidence of convertible bond under pricing on the French and US convertible bond markets. Kang and Lee (1996) also find evidence of convertible bond under pricing at issue.

[2] See for example Taylor and Peel (1998), Sarno and Taylor (1999), Sarno and Taylor (2003) and Gallagher and Taylor (2000).

two benchmark indices of convertible arbitrage hedge fund performance. Section 4 presents results from estimation of individual convertible arbitrage hedge fund risk and performance. Section 5 provides a conclusion.

1. Residual Augmented Least Squares

In this section of the paper the RALS estimator, proposed by Im and Schmidt (1999), is reviewed. Given a multivariate linear regression model

$$y_t = \beta' z_t + u_t \tag{1}$$

Where z_t = (1, x_t')', x_t is a (k – 1) x 1 vector of time series observed at time t, while β' = ($\alpha\beta'$) where α is the intercept and β' is the (k – 1) x 1 vector of coefficients on x_t. Assuming the following moment conditions hold:

$$E[x'(y - x'\beta)] = 0 \tag{2}$$

$$E\{x \otimes [h(y - x'\beta) - K]\} = 0 \tag{3}$$

Where (2) is the least squares moment condition which asserts that x and u are uncorrelated and (3) refers to some additional moment conditions that some function of u is uncorrelated with x. $h(.)$ is a J x 1 vector of differentiable functions and K is a J x 1 vector of constants. Therefore, there are kJ additional moment conditions.

Excess kurtosis in the residual implies that the standardized fourth central moment of the series exceeds three, so that:

$$E(u_t^4 - 3\sigma^4) = E[u_t(u_t^3 - 3\sigma^2 u_t)] \neq 0 \tag{4}$$

implying that $u_t^3 - 3\sigma^2 u_t$ is correlated with u_t but not with the regressors since x_t and u_t are by assumption independent. Similarly when errors are skewed the standardised third central moment is non-zero so that:

$$E(u_t^3 - \sigma^3) = E[u_t(u_t^2 - \sigma^2)] \neq 0 \tag{5}$$

which implies that $u_t^2 - \sigma^2$ is correlated with u_t but not with the regressors (again since x_t and u_t are by assumption independent.)

Im and Schmidt (1999) suggest a two step estimator that can be simply computed from OLS applied by equation (1) augmented with the term (6).

$$\hat{w}_t = [(\hat{u}_t^3 - 3\hat{\sigma}^2\hat{u}_t)(\hat{u}_t^2 - \hat{\sigma}^2)]' \tag{6}$$

Where $\hat{u}_t$ denotes the residual and $\hat{\sigma}^2$ denotes the standard residual variance estimate obtained from OLS applied to equation (1). The resulting estimator is the residuals augmented least squares (RALS) estimator of β, β^*, and Im and Schmidt (1999) derives analytically its asymptotic distribution and showed how the covariance matrix of β^* can be consistently estimated. The inclusion of the RALS estimators is useful in obtaining a more efficient model estimate if the distribution of the error term is non-normal. Normality of the error term can be tested using the Jacque and Bera (1987) test statistic.

Im and Schmidt (1999) also provided a measure of the asymptotic efficiency gain from employing RALS as opposed to OLS through the statistic ρ^2 constructed as ρ^*/ρ where ρ^* is the residual variance from the RALS estimation and ρ is the residual variance from the OLS estimation (ρ^2 is small for large efficiency gains). This statistic shows that this gain can be substantial for a range of alternative non normal error distributions. The quantification of the efficiency gain and the ability to achieve it using the RALS estimation technique depends on the homoskedastic assumption that the third and fourth conditional moments do not depend on the regressors.

An advantage of the RALS methodology is that the RALS estimator coefficients are interpretable as risk factor weightings. Non-normality in the return distribution can be interpreted not only as a statistical issue but also as an issue of risk. Negative skewness is an undesirable risk characteristic for investors and investors should be compensated for holding an asset that exhibits negative skewness relative to an asset that is positively skewed. It is therefore possible to interpret the coefficients on the RALS term (6) as skewness and kurtosis risk factor coefficients. When evaluating the risk and return of individual hedge funds there are two potential approaches to interpreting the coefficient on the RALS term (6) as a risk factor. Firstly, Im and Schmidt's (1999) two step estimator can be computed from OLS applied by equation (1) augmented with the term (6) for each individual hedge fund, resulting in robust estimates of performance. The significance of the coefficients on (6) for each fund will highlight the non-normality in that fund's return distribution. However, the magnitude of coefficients across funds is not comparable as (6) will be different for each fund.

The alternative approach, which is employed in this paper, is to compute (6) from the residuals of OLS estimation of (1) with a benchmark of the strategy as the dependent variable. (6) then serves as benchmark skewness and kurtosis risk factors. Specifying these benchmark skewness and kurtosis factors in a linear risk factor model of individual fund performance, estimated by OLS, will provide robust estimates of performance and has the advantage of providing comparable estimates of skewness and kurtosis risk across funds.

2. Convertible arbitrage risk factor model

In this section of the paper details of the convertible arbitrage hedge fund indices are provided and the convertible arbitrage risk factors are defined. Descriptive statistics and cross correlations are also presented.

Two benchmark indices of convertible arbitrage hedge fund returns are employed: the CSFB Tremont Convertible Arbitrage Index and the HFRI Convertible Arbitrage Index. The CSFB Tremont Convertible Arbitrage Index is an asset weighted index (rebalanced quarterly) of convertible arbitrage hedge funds beginning in 1994 whereas the HFRI Convertible Arbitrage Index is equally weighted with a start date of January 1990.[3] Although the HFRI and CSFB Tremont indices now control for survivor bias HFRI did not include the returns of dead funds before January 1993.

Descriptive statistics and cross correlations for the convertible arbitrage indices and the convertible arbitrage risk factors are displayed in Table 1. All of the correlations cover the period January 1990 to December 2002 except for correlations with the CSFB Tremont Convertible Arbitrage Index which cover the period January 1994 to December 2002.

In Hutchinson and Gallagher (2006) several alternative linear factor models of convertible arbitrage returns are specified. Findings indicate that factors proxying for term structure risk, default risk and a delta neutral hedged convertible arbitrage risk factor are the most significant factors in explaining convertible arbitrage returns. DEF_t is the default risk factor, constructed as the difference between the overall return on a portfolio of long term corporate bonds (here the return on the CGBI Index of high yield corporate bonds from DataStream is used) minus the long term government bond return at month t (here the return on the Lehman Index of long term

[3] For details on the construction of the CSFB Tremont Convertible Arbitrage Index see www.hedgeindex.com. For details on the construction of the HFRI Convertible Arbitrage Index see www.hfr.com.

government bonds from DataStream is used). $TERM_t$ is the factor proxy for term structure risk at time t. It is constructed as the difference between monthly long term government bond return and the short term government bond return (here the return on the Lehman Index of short term government bonds from DataStream is used). The third factor, *CBRF*, is a factor proxy for convertible bond arbitrage risk. It is constructed by combining long positions in convertible bonds with short positions in the underlying stock.[4] Hedges are then rebalanced daily. These delta neutral hedged convertible bonds are then combined to create an equally weighted convertible bond arbitrage portfolio. $CBRF_t$ is the monthly return on this portfolio in excess of the risk free rate of interest at time t. Data used to construct *CBRF* are from DataStream and Monis. Table 1, Panel B presents descriptive statistics of the risk factors. The two market factors *DEF* and *TERM* have low standard errors, but of the two, only *DEF* produces a mean return[5] (0.60%) significantly different from zero at the 1% level.[6] *CBRF*'s mean return is a significant 0.33%[7] per month with a variance of 3.104. The mean return of *CBRF* is lower and the variance higher than the two convertible arbitrage hedge fund indices, *CSFBRF* and *HFRIRF*. *CBRF* is negatively skewed and has positive kurtosis as do the two hedge fund indices.

Table 1, Panel C presents the correlations between the two dependent variables, *CSFBRF* and *HFRIRF* and the explanatory variables. Both of the variables are highly correlated with a coefficient of 0.80. Both are positively related to *DEF* the default risk factor and *CBRF* the factor proxy for convertible bond arbitrage risk. *CBRF* is positively correlated with *DEF* and *TERM* is negatively correlated with *DEF*.

3. Analysis of hedge fund indices

In this section results are presented from estimating a linear factor model of convertible arbitrage indices return and risk initially with OLS and then with RALS. Given the distribution of the hedge fund indices is non–normal the OLS risk factor coefficient estimates are likely to be biased. As RALS explicitly incorporates skewness and kurtosis terms, estimation of the hedge fund indices' risk factor coefficients with RALS should lead to unbiased estimators. The coefficients on the RALS skewness and kurtosis terms should also provide evidence of the risk premium arbitrageurs are receiving for taking on skewness and kurtosis risk. Theory would suggest that arbitrageurs will need to be rewarded for holding portfolios with negatively skewed return

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[4] For details on the construction of CBRF see Hutchinson and Gallagher (2005) and Hutchinson and Gallagher (2006).

[5] Returns are logarithmic.

[6] In discussions in the text statistical significance indicates t-stats are significant from zero at least at the 10% level unless reported.

[7] At the 5% level.

distributions as negative skewness implies the probability of large losses is increased relative to a normal distribution.[8] Positive kurtosis indicates a relatively peaked distribution with more occurrences in the middle and at the extreme tails of the distribution. Theory would suggest that investors would view an investment with returns showing high positive kurtosis as unfavourable, indicating more frequent extreme observations.

In Table 2 the results of OLS estimation of the following linear multi-factor model of convertible arbitrage risk are presented.

$$y_t = \alpha + \beta_{CBRF} CBRF_t + \beta_{DEF} DEF_t + \beta_{TERM} TERM_t + \varepsilon_t \qquad (7)$$

Where y_t is the excess return on the convertible arbitrage index at time t, $TERM_t$ and DEF_t are term structure risk and default risk proxy factors at month t. $CBRF_t$ is the excess return on the simulated convertible arbitrage portfolio at time t. The results indicate that convertible arbitrage is significantly exposed to default and term structure risk and the convertible arbitrage risk factor. The significantly positive Jacque and Bera (1987) test statistics indicates that the residuals are non-Gaussian. Estimates of skewness and kurtosis of the factor model residuals are both significantly different from zero with negative skewness and positive excess kurtosis for all of the hedge fund indices. Q-Stats indicate the disturbance terms of the estimated models are first order autocorrelated.

Table 3 presents results of RALS estimation of the convertible arbitrage linear risk factor model (8). RALS is a two step estimator, proposed by Im and Schmidt (1999) that can be simply computed from OLS applied to equation (7) augmented with the terms (9) and (10).

$$y_t = \alpha + \beta_{CBRF} CBRF_t + \beta_{DEF} DEF_t + \beta_{TERM} TERM_t + \beta_w w_t + \beta_v v_t + \varepsilon_t \qquad (8)$$

$$w_t = (\hat{u}_t^3 - 3\hat{\sigma}^2 \hat{u}_t) \qquad (9)$$

$$v_t = (\hat{u}_t^2 - \hat{\sigma}^2) \qquad (10)$$

Where w_t is the kurtosis function and v_t is the skewness function of the residuals from (7) $\hat{u}_t$ denotes the residual and $\hat{\sigma}^2$ denotes the standard residual variance estimate obtained from OLS applied to equation (7). There are two moment conditions necessary for RALS estimation. The first is the least squares moment condition which asserts that the explanatory variables in (7)

[8] See for example Simkowitz and Beedles (1978) and Badrinath and Chatterjee (1988).

and the error term from (7) are uncorrelated and the second refers to the additional moment conditions that a function of the error term (7) is uncorrelated with the explanatory variables in (7).

The efficiency gain for the three models, as characterised by ρ^2, ranges from 0.62 to 0.69. The adjusted R^2 indicates an improvement in the goodness of fit with the inclusion of the RALS terms. The skewness coefficient, β_V, is significantly negative for the HFRI index irrespective of sample period consistent with arbitrageurs receiving a risk premium for holding skewness. This is consistent with the theoretical expectation that arbitrageurs must receive a risk premium for holding a portfolio with negative skewness in the distribution of its returns. However, the skewness coefficient, β_V, is insignificant for the CSFB Tremont index and the kurtosis coefficient is insignificant from zero for all of the samples. The coefficients on *CBRF* have increased in both magnitude and significance while the coefficients on *DEF* and *TERM* have reduced in magnitude and significance. The alphas (performance measures) generated by the RALS estimation of the linear model are higher than those from the OLS estimation of the linear model indicating that OLS estimation may in fact understate performance. However, the Q-Stats indicate that the error terms remain autocorrelated, though the statistics have decreased in magnitude.[9]

The RALS estimate of the linear factor model provides useful information on the skewness and kurtosis risks of convertible arbitrage hedge funds indices. The evidence presented support the theoretical expectation that arbitrageurs receive a risk premium for holding a portfolio with negative skewness in its return distribution.

4. Empirical analysis of individual funds

In addition to hedge fund indices, it is well documented that the returns of many individual convertible arbitrage hedge funds are also characterised by negative skewness and excess kurtosis (See Kat and Lu (2001)). In this section of the paper we provide estimates of the risk premium individual hedge funds receive for bearing skewness and kurtosis risk. We also provide estimates of hedge fund abnormal performance after controlling for these risks.

The individual fund data was sourced from the HFR database. The original database consisted of 113 funds. However, many funds have more than one series in the database. Often this appears to be due to a dual domicile. (E.g. Fund X *Ltd* and Fund X *LLC* with almost identical returns.)

[9] In Hutchinson and Gallagher (2006) the lag of the hedge fund index excess return was specified as an illiquidity risk factor. The hedge fund index exhibits high first order autocorrelation and specifying this factor corrects both the serial correlation and the skewness and kurtosis characteristics of the series. As the aim of this paper is to identify the skewness and kurtosis risks of the strategy, the one period lag of the hedge fund index is therefore not specified as an explanatory variable.

To ensure that no fund was included twice, the cross correlations between the individual funds returns is estimated. If two funds correlation coefficients are greater than 0.90, then the details of the funds are examined in detail. In two cases high correlation coefficients are estimated due to a fund reporting twice, in USD and in EUR. In this situation the EUR series was deleted. Finally, in order to have adequate data to run the factor model tests, any fund which did not have 24 consecutive monthly returns between 1990 and 2002 is excluded. The final sample consists of fifty five hedge funds. Of these fifty five funds, twenty five were still alive at the end of December 2002 and thirty were dead. Table 4 reports descriptive statistics on each hedge fund. The mean number of observations is fifty seven months up to a maximum of eighty two. The mean monthly return is 0.90% and the minimum monthly return by a fund over the sample period was -34%. The maximum monthly return was +23%. The mean skewness is -0.47 and the mean kurtosis is 3.48. The Ljung and Box (1978) Q-Statistic tests the joint hypothesis that the first ten lagged autocorrelations are all equal to zero. The results reject this hypothesis for twenty four of the hedge funds.

Table 5 provides descriptive characteristics of the default (*DEF*), term structure (*TERM*), convertible bond arbitrage (*CBRF*), skewness (*SKEW*) and kurtosis (*KURT*) risk factors. *KURT* is the kurtosis function (9) of the residuals from (7), estimated for the HFRI convertible arbitrage index, and *SKEW* is the skewness function (10) of the residuals from (7), estimated for the HFRI convertible arbitrage index. The correlation coefficient for *SKEW* and *KURT* is significantly negative at -0.86. *SKEW*, the skewness risk factor is also significantly negatively correlated with *DEF*, the default risk factor at the 5% level.

In Hutchinson and Gallagher (2006) evidence was presented, consistent with the findings of Asness, Krail and Liew (2001) that, due to the illiquidity in the securities held by convertible arbitrage hedge funds, the specification of lagged and contemporaneous risk factors more fully captures the risk characteristics of individual convertible arbitrage hedge funds. The results of this model (11) are reported in Table 6 to aid comparison with the results incorporating the skewness and kurtosis risk factors.

$$y_t = \alpha + \beta_0' DEF + \beta_1' TERM + \beta_2' CBRF + \varepsilon \qquad (11)$$

Where y_t is the excess return on the portfolio at time *t-1*, $DEF = (DEF_t, DEF_{t-1}, DEF_{t-2})$, $TERM = (TERM_t, TERM_{t-1}, TERM_{t-2})$ and $CBRF = (CBRF_t, CBRF_{t-1}$ and $CBRF_{t-2})$. The β coefficient is the sum of the contemporaneous β and lagged β s. Figures in parenthesis are *P*-Values from the joint test of $\beta_{jt} + \beta_{jt-1} + \beta_{jt-2} = 0$ for *DEF*, *TERM* and *CBRF* and $\alpha = 0$.

Table 7 presents results from estimating the following model of individual fund performance measurement (derived from the non-synchronous trading literature).

$$y_t = \alpha + \beta_0' DEF + \beta_1' TERM + \beta_2' CBRF + \beta_{KURT} KURT_t + \beta_{SKEW} SKEW_t + u_t \qquad (12)$$

This is the factor model specification from Hutchinson and Gallagher (2006) augmented with the skewness and kurtosis common risk factors $KURT_t$ and $SKEW_t$. $DEF = (DEF_t, DEF_{t-1}, DEF_{t-2})$, $TERM = (TERM_t, TERM_{t-1}, TERM_{t-2})$, $CBRF = (CBRF_t, CBRF_{t-1}$ and $CBRF_{t-2})$, and $KURT_t$ is equal to $(\hat{u}_t^3 - 3\hat{\sigma}^2\hat{u}_t)$ and $SKEW_t$ is equal to $(\hat{u}_t^2 - \hat{\sigma}^2)$ and $\hat{u}_t$ denotes the residual and $\hat{\sigma}^2$ denotes the standard residual variance estimate obtained from OLS applied to equation (7) on the HFRI convertible arbitrage hedge fund index.

The coefficient of the kurtosis risk factor is significantly different from zero for twenty two hedge funds with a mean coefficient of -0.21. The skewness risk factor is significantly different from zero for twenty of the hedge funds with a mean coefficient of -0.30. Both of these results are consistent with the expectation that arbitrageurs are rewarded for holding portfolios exhibiting skewness and kurtosis in their return distribution. The default risk, term structure risk and convertible bond arbitrage risk coefficients are significantly different from zero for between thirty three and thirty five hedge funds with mean coefficients of 0.26, 0.08 and 0.41 respectively. These coefficients are similar to those reported in Table 6 for the model omitting skewness and kurtosis risk factors (0.17, 0.40 and 0.42 for *DEF*, *TERM* and *CBRF* respectively). The mean adjusted R^2 is 23.3% compared to a mean adjusted R^2 of 21% in Table 6. The alphas for the fifty five funds are significantly different from zero (minimum of -2.3% and maximum of +0.9% per month) with a mean alpha coefficient of 29 basis points per month or 3.5% per annum.[10] This compares to the mean alpha of 34 basis points per month for the non-synchronous model which omitted skewness and kurtosis risk factors. This is equivalent to 15% of the abnormal performance estimate from the model omitting skewness and kurtosis risk. This evidence suggests that convertible arbitrageurs are being rewarded with a risk premium of approximately five basis points per month, or sixty basis points per annum, for bearing skewness and kurtosis risk. This is a finding consistent with Kat and Miffre (2005) who estimate that failure to specify kurtosis and skewness risk factors will lead to an upward bias in hedge fund performance estimates of 1%.

[10] All of the mean coefficients are statistically significant from zero at the 1% level, with the exception of *DEF*, which is significant at the 15% level.

5. Conclusion

In this article we demonstrate that skewness and kurtosis are important risk factors in the returns of convertible arbitrage hedge funds. We estimate convertible arbitrage risk factors using RALS, an estimation technique explicitly incorporating non-normality in a time series' return distribution, a feature of convertible arbitrage hedge fund returns. An additional contribution is the specification and estimation of skewness and kurtosis risk factors which are highly significant explanatory variables in the returns of individual hedge funds.

Evidence is presented demonstrating RALS estimation of the hedge fund index risk factor models improves efficiency relative to OLS. This is expected, considering the non-normality documented in the return distribution of these hedge fund indices. Evidence also presented in this paper indicates that skewness is a significant risk factor in the returns of both convertible arbitrage hedge funds and hedge fund indices. Consistent with theoretical expectations arbitrageurs are rewarded with a risk premium for holding portfolios with negative skewness in the return distribution. Kurtosis is also a significant factor in the returns of convertible arbitrage hedge funds but is not significant for the indices. This risk premium associated with skewness and kurtosis risk is estimated to be sixty basis points per annum, approximately 15% of the abnormal return reported in Hutchinson and Gallagher (2006). Individual convertible arbitrage hedge funds are rewarded for holding portfolios with significant excess kurtosis in the distribution of returns.

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Table 1
Descriptive statistics for the convertible bond arbitrage indices and risk factors

CSFBRF is the excess return on the CSFB Tremont Convertible Arbitrage index, HFRIRF is the excess return on the HFRI Convertible Arbitrage index. *TERM* and *DEF* are Fama and French's proxies for the deviation of long-term bond returns from expected returns due to shifts in interest rates and shifts in economic conditions that change the likelihood of default. *CBRF* is the excess return on the simulated convertible arbitrage portfolio.

	Mean	T-Stat	Variance	Std Error	Skewness	Kurtosis	Jarque-Bera
Panel A: Dependent Variables							
CSFBRF	0.440	3.291	1.930	1.744	-1.76***	4.61***	151.16***
HFRIRF	0.538	6.818	0.972	0.986	-1.42***	3.28***	122.46***
Panel B: Explanatory Returns							
DEF	0.603	3.026	6.186	2.487	-0.91***	5.70***	232.56***
TERM	0.112	0.577	5.825	2.413	-0.36*	0.22	3.65
CBRF	0.325	2.307	3.104	1.762	-1.36***	9.00***	573.96***

***, ** and * indicate significance at the 1%, 5% and 10% level respectively.
Statistics are generated using RATS 5.0

Panel C: Correlations

	TERM	*DEF*	*CSFBRF*	*HFRIRF*	*CBRF*
TERM	1.00				
DEF	-0.40	1.00			
CSFBRF	0.04	0.23	1.00		
HFRIRF	0.09	0.28	0.80	1.00	
CBRF	0.01	0.39	0.32	0.48	1.00

With the exception of the *CSFBRF* correlations, coefficients greater than absolute 0.25, 0.19 and 0.17 are significant at the 1%, 5% and 10% levels respectively.
CSFBRF correlation coefficients greater than absolute 0.22, 0.17 and 0.14 are significant at the 1%, 5% and 10% levels respectively.

Table 2
Linear model estimated by OLS

This table presents the results from estimating the following linear model of convertible arbitrage returns.

$$y_t = \alpha + \beta_{CBRF} CBRF_t + \beta_{DEF} DEF_t + \beta_{TERM} TERM_t + \varepsilon_t$$

Where y_t is the excess return on the HFRI Convertible Arbitrage index. *TERM* and *DEF* are Fama and French's proxies for the deviation of long-term bond returns from expected returns due to shifts in interest rates and shifts in economic conditions that change the likelihood of default. *CBRF* is the excess return on the simulated convertible arbitrage portfolio. JB Stat is the Jacque and Bera (1987) statistical test of normality of the residuals. Skewness and Kurt are estimates of the skewness and kurtosis of the factor model residuals.

α	β_{CBRF}	β_{DEF}	β_{TERM}	Q Stat	JB Stat	Skewness	Kurt	Adj. R^2
Panel A: HFRI 1990 to 2002								
0.3838	0.1709	0.1502	0.1578	69.14***	71.04***	-1.14***	2.39***	32.41%
(3.65)***	(4.44)***	(2.70)***	(3.00)***					
Panel B: HFRI 1993 to 2002								
0.3947	0.2119	0.1496	0.1679	47.73***	64.69***	-1.16***	2.75***	27.54%
(3.23)***	(2.60)***	(2.20)**	(2.95)***					
Panel C: CSFB 1994 to 2002								
0.3014	0.1715	0.1694	0.1791	106.60***	91.15***	-1.36***	3.59***	12.99%
(1.30)	(1.91)*	(2.27)**	(3.49)***					

t-statistics in parenthesis are heteroskedasticity and autocorrelation-consistent, due to Newey and West (1987).

*, **, *** indicate coefficient is significantly different from zero at the .10, .05 and .01 levels respectively.

Table 3
Linear model estimated by RALS

This table presents the results from estimation of the following linear model of convertible arbitrage returns using RALS

$$y_t = \alpha + \beta_{CBRF} CBRF_t + \beta_{DEF} DEF_t + \beta_{TERM} TERM_t + \beta_w w_t + \beta_v v_t + \varepsilon_t$$

Where y_t is the excess return on the HFRI Convertible Arbitrage index and the lag of y act as a proxy for illiquidity. *TERM* and *DEF* are Fama and French's proxies for the deviation of long-term bond returns from expected returns due to shifts in interest rates and shifts in economic conditions that change the likelihood of default. *CBRF* is the excess return on the simulated convertible arbitrage portfolio. w_t is the RALS kurtosis function of the OLS residuals and v_t is the RALS skewness function of the OLS residuals. ρ^2 is the efficiency test proposed by Im and Schmidt (1999).

α	β_{CBRF}	β_{DEF}	β_{TERM}	β_W	β_V	Q Stat	Adj. R^2	ρ^2
Panel A: HFRI 1990 to 2002								
0.3682	0.2019	0.1037	0.0843	-0.0779	-0.4992	33.30**	54.71%	0.66
(4.07)***	(6.04)***	(2.17)**	(1.66)*	(-1.16)	(-3.11)***			
Panel B: HFRI 1993 to 2002								
0.3873	0.2220	0.1123	0.0830	-0.0513	-0.4300	32.51***	49.47%	0.69
(3.62)***	(3.98)***	(1.96)*	(1.31)	(-0.71)	(-2.44)**			
Panel C: CSFB 1994 to 2002								
0.4216	0.1167	0.1291	0.1010	0.0266	-0.1385	108.64***	44.96%	0.62
(1.37)	(1.45)	(3.28)***	(2.28)**	(0.51)	(-0.76)			

t-statistics in parenthesis are heteroskedasticity and autocorrelation-consistent, due to Newey and West (1987).

*, **, *** indicate coefficient is significantly different from zero at the .10, .05 and .01 levels respectively.

Table 4
Statistics on individual hedge fund returns

This table presents descriptive statistics on the fifty five hedge funds included in the sample. For each fund *N* is the number of monthly return observations, *Min* and *Max* are the minimum and maximum monthly return, *Skewness* and *Kurtosis* are the skewness and kurtosis of the hedge funds return distribution and *Q-Stat* is the Ljung and Box (1978) Q-Statistic jointly testing the series' ten lags of autocorrelation are significantly different from zero.

	N	*Mean*	*Min*	*Max*	*Skewness*	*Kurtosis*	*Q-Stat*
HF1	69	1.01	-4.41	4.95	-0.65	3.05	6.94
HF2	69	1.04	-8.07	9.77	0.32	2.80	13.11
HF3	38	1.74	-1.57	11.21	1.92	6.66	7.68
HF4	60	1.55	-1.62	11.74	2.08	8.85	9.46
HF5	69	1.31	-10.27	12.08	-0.64	4.44	12.36
HF6	69	1.33	-8.99	9.31	-1.19	4.37	16.39*
HF7	58	0.98	-2.49	3.43	-0.61	1.78	8.82
HF8	82	1.28	0.00	4.54	1.12	1.96	83.37***
HF9	57	0.80	-5.70	9.03	0.01	0.02	6.66
HF10	27	1.23	-1.69	5.48	0.25	-0.02	14.13
HF11	52	0.59	-0.74	3.00	1.73	7.62	10.65
HF12	58	0.82	-2.38	3.95	0.40	1.55	25.39***
HF13	30	0.33	-0.77	0.95	-1.11	3.49	4.24
HF14	55	1.02	-0.81	2.88	0.27	0.13	26.07***
HF15	42	1.05	-0.81	3.38	0.54	0.02	28.55***
HF16	38	1.18	0.00	2.87	0.46	-0.55	16.40*
HF17	25	0.45	-0.59	1.65	0.20	-0.49	9.33
HF18	36	1.27	-2.51	7.08	0.90	2.65	11.88
HF19	69	0.92	-5.20	3.17	-2.34	5.87	37.27***
HF20	69	1.02	-4.31	3.64	-1.71	3.99	10.88
HF21	37	0.24	-34.16	3.84	-5.72	34.05	0.76
HF22	69	1.37	-2.77	5.08	0.32	0.18	21.23**
HF23	69	0.68	-1.88	2.75	-0.58	1.09	18.23*
HF24	69	0.85	-2.17	6.53	1.27	6.12	7.50
HF25	69	1.02	-4.31	3.64	-1.71	3.99	10.88
HF26	69	0.96	-4.41	4.95	-0.53	2.56	7.94
HF27	69	1.05	-2.13	3.11	-0.55	1.20	18.14*
HF28	25	0.92	-0.88	2.60	-0.10	-0.73	14.13
HF29	24	-0.40	-5.52	4.00	-0.21	-0.66	18.33**
HF30	38	1.21	-2.68	6.88	0.56	1.14	9.43
HF31	69	1.06	-8.96	5.54	-2.04	6.49	23.27***
HF32	69	0.82	-1.70	3.86	0.36	-0.07	12.58
HF33	69	0.41	-24.68	23.25	-0.17	2.22	6.66
HF34	69	1.24	-3.98	6.77	-0.14	0.50	23.27***
HF35	69	1.00	-11.88	7.14	-1.29	4.62	17.20*
HF36	69	0.69	-1.61	1.78	-1.21	3.22	57.12***
HF37	36	0.83	-1.78	2.92	-0.19	1.49	13.55

HF38	69	0.87	-4.82	4.07	-1.22	5.80	11.67
HF39	51	0.94	-2.30	3.95	0.03	1.07	14.97
HF40	51	0.92	-1.60	2.41	-0.85	1.78	17.50*
HF41	69	1.25	-9.19	4.10	-3.01	12.59	24.62***
HF42	24	1.02	-2.09	2.94	-0.82	1.63	13.19
HF43	69	0.75	-2.16	2.80	-0.86	1.54	7.28
HF44	69	1.66	-9.56	5.20	-2.86	11.47	30.42***
HF45	41	1.45	-8.13	8.30	-0.20	1.78	39.69***
HF46	69	1.03	-2.02	3.45	-0.84	1.87	8.89
HF47	69	0.95	-2.30	4.16	0.43	3.25	24.78***
HF48	69	0.98	-1.32	4.83	0.45	1.73	10.20
HF49	69	0.82	-1.08	2.22	-0.49	0.97	13.15
HF50	67	0.80	-3.29	3.37	-0.77	1.51	17.65*
HF51	57	0.93	-8.34	4.21	-2.34	10.54	14.35
HF52	52	0.94	-2.40	3.40	-0.39	-0.02	8.26
HF53	69	1.02	-3.70	6.05	-0.51	4.32	23.33***
HF54	57	0.72	-2.00	2.28	-0.84	2.89	19.30**
HF55	69	0.82	-0.98	2.01	-0.53	1.09	18.54**
Mean	57	0.96	-4.47	5.06	-0.47	3.48	
Min	24	-0.40	-34.16	0.95	-5.72	-0.73	
Max	82	1.74	0.00	23.25	2.08	34.05	

***, ** and * indicate significance at the 1%, 5% and 10% level respectively.
Statistics are generated using RATS 5.0

Table 5
Descriptive statistics of the individual fund risk factors

This table presents descriptive statistics and cross correlations for the common risk factors in convertible arbitrage. Where *DEF* is the default risk factor, *TERM* is the term structure risk factor, *CBRF* is the convertible bond arbitrage risk factor, *KURT* is the factor mimicking for kurtosis risk and *SKEW* is the factor mimicking for skewness risk.

	Mean %	Variance	Min	Max	
DEF	0.60	6.19	-10.59	9.48	
TERM	0.11	5.82	-6.56	6.81	
CBRF	0.33	3.10	-10.36	4.99	
KURT	-0.57	8.19	-26.70	1.19	
SKEW	-0.00	1.76	-0.64	9.62	
	DEF	*TERM*	*CBRF*	*KURT*	*SKEW*
DEF	1.00				
TERM	-0.40	1.00			
CBRF	0.39	0.01	1.00		
KURT	0.14	-0.02	0.07	1.00	
SKEW	-0.19	0.03	-0.06	-0.86	1.00

With the exception of the *CSFBRF* correlations, coefficients greater than 0.25, 0.19 and 0.17 are significant at the 1%, 5% and 10% levels respectively.
CSFBRF correlations, coefficients greater than 0.22, 0.17 and 0.14 are significant at the 1%, 5% and 10% levels respectively.
Statistics are generated using RATS 5.0

Table 6
Results of estimating non-synchronous regressions of individual fund risk factors

This table presents the results of estimating the excess returns of individual hedge funds on the following model of hedge fund returns.

$$y_t = \text{a} + \beta_0\text{'}\, DEF + \beta_1\text{'}TERM + \beta_2\text{'}CBRF + \varepsilon$$

Where y_t is the excess return on the portfolio at time $t\text{-}1$, $DEF = (DEF_t, DEF_{t\text{-}1}, DEF_{t\text{-}2})$, $TERM = (TERM_t, TERM_{t\text{-}1}, TERM_{t\text{-}2})$ and $CBRF = (CBRF_t, CBRF_{t\text{-}1}$ and $CBRF_{t\text{-}2})$. The β coefficient is the sum of the contemporaneous β and lagged β s. Figures in parenthesis are *P*-Values from the joint test of $\beta_{jt} + \beta_{jt\text{-}1} + \beta_{jt\text{-}2} = 0$ for *DEF*, *TERM* and *CBRF*.

Fund	$r_i - r_f$	α	$\beta_{DEF(t\ to\ t\text{-}2)}$	$\beta_{TERM(t\ to\ t\text{-}2)}$	$\beta_{CBRF(t\ to\ t\text{-}2)}$	Adj R^2	Q stat	N
1	0.65	0.51	0.08	0.00	0.42	10.3%	7.90	69
		(0.00)	(0.60)	(0.98)	(0.11)		(0.25)	
2	0.69	-0.01	0.04	-0.41	1.18	17.0%	21.01	69
		(0.98)	(0.91)	(0.42)	(0.07)		(0.00)	
3	1.38	1.28	-0.47	-0.70	1.34	21.8%	24.80	38
		(0.00)	(0.09)	(0.15)	(0.04)		(0.00)	
4	1.19	1.09	-0.46	-0.73	1.40	30.0%	24.20	60
		(0.00)	(0.01)	(0.01)	(0.00)		(0.00)	
5	0.95	0.15	1.01	0.76	0.97	52.4%	33.92	69
		(0.71)	(0.01)	(0.01)	(0.15)		(0.00)	
6	0.97	0.43	0.56	0.38	1.13	30.2%	18.00	69
		(0.19)	(0.15)	(0.19)	(0.11)		(0.01)	
7	0.62	0.58	0.18	0.25	0.50	32.0%	23.47	58
		(0.00)	(0.02)	(0.01)	(0.02)		(0.00)	
8	0.92	0.80	0.05	0.18	0.04	-1.1%	26.58	82
		(0.00)	(0.69)	(0.13)	(0.85)		(0.00)	
9	0.44	-0.01	0.28	0.62	0.54	46.7%	21.71	57
		(0.97)	(0.19)	(0.02)	(0.06)		(0.00)	
10	0.87	1.04	0.40	0.43	0.05	17.6%	15.84	27
		(0.00)	(0.05)	(0.15)	(0.89)		(0.01)	
11	0.23	0.28	0.03	0.01	-0.03	-9.0%	22.31	52
		(0.00)	(0.57)	(0.88)	(0.85)		(0.00)	
12	0.46	0.40	-0.06	0.23	0.49	-1.4%	20.22	58
		(0.01)	(0.65)	(0.18)	(0.07)		(0.00)	
13	-0.03	-0.10	-0.09	0.01	0.46	48.6%	21.00	30
		(0.04)	(0.01)	(0.78)	(0.00)		(0.00)	
14	0.66	0.63	-0.01	0.07	0.44	2.9%	19.87	55
		(0.00)	(0.89)	(0.35)	(0.01)		(0.00)	
15	0.69	0.65	-0.05	0.05	0.32	-11.1%	20.68	42
		(0.00)	(0.62)	(0.72)	(0.24)		(0.00)	
16	0.82	0.66	-0.10	0.12	0.76	12.5%	18.54	38

		(0.00)	(0.33)	(0.39)	(0.00)		(0.01)	
17	0.09	0.08	-0.20	-0.20	0.33	4.6%	19.95	25
		(0.51)	(0.00)	(0.00)	(0.07)		(0.00)	
18	0.91	1.10	0.28	0.20	-0.21	25.0%	14.42	36
		(0.00)	(0.22)	(0.52)	(0.64)		(0.03)	
19	0.56	-0.22	0.89	0.88	0.13	42.6%	7.61	69
		(0.22)	(0.00)	(0.00)	(0.59)		(0.27)	
20	0.66	0.33	0.31	0.27	0.12	7.4%	7.76	69
		(0.31)	(0.30)	(0.20)	(0.45)		(0.26)	
21	-0.12	-0.47	0.61	1.91	0.25	29.4%	17.67	37
		(0.62)	(0.26)	(0.05)	(0.76)		(0.01)	
22	1.11	0.86	0.21	0.49	-0.12	7.5%	20.69	69
		(0.02)	(0.57)	(0.10)	(0.73)		(0.00)	
23	0.38	-0.20	0.51	0.53	0.03	25.7%	22.65	69
		(0.25)	(0.00)	(0.00)	(0.85)		(0.00)	
24	0.38	-0.05	0.60	0.71	-0.20	26.3%	22.83	69
		(0.79)	(0.00)	(0.00)	(0.35)		(0.00)	
25	0.66	0.33	0.31	0.27	0.12	7.4%	23.10	69
		(0.31)	(0.30)	(0.20)	(0.45)		(0.00)	
26	0.60	0.47	0.08	0.06	0.36	7.5%	7.05	69
		(0.01)	(0.62)	(0.74)	(0.18)		(0.32)	
27	0.69	0.20	0.66	0.51	0.02	40.3%	12.81	69
		(0.09)	(0.00)	(0.00)	(0.88)		(0.05)	
28	0.56	0.47	0.09	0.23	0.50	39.5%	17.22	25
		(0.00)	(0.39)	(0.06)	(0.03)		(0.01)	
29	-0.76	0.09	0.49	-0.98	-1.69	73.9%	18.18	24
		(0.78)	(0.00)	(0.00)	(0.00)		(0.01)	
30	0.85	0.70	0.09	0.08	0.97	47.4%	18.85	38
		(0.04)	(0.53)	(0.51)	(0.03)		(0.00)	
31	0.70	0.45	-0.31	-0.80	1.02	11.6%	24.15	69
		(0.23)	(0.37)	(0.06)	(0.03)		(0.00)	
32	0.33	-0.05	0.26	0.19	0.37	5.0%	28.35	69
		(0.85)	(0.28)	(0.28)	(0.10)		(0.00)	
33	0.05	-1.58	-0.96	-1.12	4.52	10.1%	17.50	69
		(0.20)	(0.30)	(0.34)	(0.00)		(0.01)	
34	0.67	-0.37	0.51	0.33	0.78	29.0%	38.28	69
		(0.32)	(0.05)	(0.31)	(0.05)		(0.00)	
35	0.64	-0.61	1.03	0.51	1.03	41.1%	7.22	69
		(0.12)	(0.06)	(0.27)	(0.05)		(0.30)	
36	0.13	0.18	0.13	0.32	-0.14	21.0%	12.74	69
		(0.08)	(0.03)	(0.00)	(0.10)		(0.05)	

37	0.47	0.40	-0.16	0.05	0.09	16.2%	34.31	36
		(0.01)	(0.21)	(0.72)	(0.78)		(0.00)	
38	0.52	0.10	0.38	0.26	0.52	38.3%	23.62	69
		(0.62)	(0.03)	(0.09)	(0.04)		(0.00)	
39	0.58	0.43	0.05	0.08	0.82	49.9%	6.73	51
		(0.01)	(0.59)	(0.45)	(0.00)		(0.35)	
40	0.52	0.25	0.19	0.16	0.14	53.4%	5.24	51
		(0.00)	(0.01)	(0.04)	(0.18)		(0.51)	
41	0.89	0.55	-0.01	-0.22	0.77	17.0%	47.83	69
		(0.25)	(0.98)	(0.33)	(0.07)		(0.00)	
42	0.66	0.58	-0.24	0.07	0.40	-1.8%	50.38	24
		(0.04)	(0.08)	(0.71)	(0.13)		(0.00)	
43	0.39	0.38	0.12	0.10	0.10	-1.7%	11.20	69
		(0.00)	(0.20)	(0.44)	(0.47)		(0.08)	
44	1.30	0.67	0.22	0.03	0.89	22.0%	26.23	69
		(0.25)	(0.65)	(0.92)	(0.00)		(0.00)	
45	1.09	1.15	-0.06	-0.10	0.08	-18.8%	91.61	41
		(0.14)	(0.88)	(0.86)	(0.94)		(0.00)	
46	0.67	0.56	0.14	0.10	0.00	-2.0%	29.48	69
		(0.00)	(0.33)	(0.43)	(0.99)		(0.00)	
47	0.36	0.44	0.14	0.39	-0.09	19.3%	29.79	69
		(0.03)	(0.39)	(0.04)	(0.62)		(0.00)	
48	0.62	0.29	0.21	0.21	0.59	30.4%	37.23	69
		(0.00)	(0.10)	(0.18)	(0.00)		(0.00)	
49	0.46	0.19	0.18	0.14	0.16	43.3%	53.46	69
		(0.03)	(0.02)	(0.04)	(0.09)		(0.00)	
50	0.44	0.33	0.00	-0.07	0.61	35.8%	18.30	67
		(0.01)	(1.00)	(0.53)	(0.00)		(0.01)	
51	0.57	0.66	0.07	-0.15	-0.47	-5.2%	11.81	57
		(0.03)	(0.79)	(0.66)	(0.30)		(0.07)	
52	0.58	0.64	0.15	0.13	0.11	7.1%	20.65	52
		(0.00)	(0.44)	(0.63)	(0.73)		(0.00)	
53	0.66	0.22	0.72	0.66	-0.25	13.4%	26.31	69
		(0.17)	(0.00)	(0.01)	(0.58)		(0.00)	
54	0.36	0.32	0.01	0.12	0.46	16.2%	40.07	57
		(0.00)	(0.89)	(0.26)	(0.01)		(0.00)	
55	0.46	0.17	0.38	0.29	0.01	38.0%	22.84	69
		(0.02)	(0.00)	(0.00)	(0.91)		(0.00)	
Mean		0.34	0.17	0.14	0.42	21%		
P-Value		(0.00)	(0.00)	(0.03)	(0.00)			

Table 7

Results of estimating non-synchronous regressions of individual fund risk factors

This table presents the results of estimating the excess returns of individual hedge funds on the following model of hedge fund returns.

$$y_t = \alpha + \beta_0' DEF + \beta_1'TERM + \beta_2'CBRF + \beta_{KURT}KURT_t + \beta_{SKEW}SKEW_t + u_t$$

Where $DEF = (DEF_t, DEF_{t-1}, DEF_{t-2})$, $TERM = (TERM_t, TERM_{t-1}, TERM_{t-2})$, $CBRF = (CBRF_t, CBRF_{t-1}$ and $CBRF_{t-2})$, *KURT* is the kurtosis risk factor and *SKEW* is the skewness risk factor and the β coefficient is the sum of the contemporaneous β and lagged β s. Numbers in parenthesis are *P*-Values from the joint test of $\beta_{jt} = \beta_{jt-1} = \beta_{jt-2} = 0$ for *DEF*, *TERM* and *CBRF* and $\beta = 0$ for *KURT* and *SKEW*.

Fund	$r_i - r_f$	α	$\beta_{DEF(t\ to\ t-2)}$	$\beta_{TERM(t\ to\ t-2)}$	$\beta_{CBRF(t\ to\ t-2)}$	β_{KURT}	β_{SKEW}	Adj R^2	Q Stat (10)
1	0.65	0.57	0.09	0.01	0.42	0.15	0.17	9.1%	0.57
		(0.00)	(0.83)	(0.97)	(0.00)	(0.30)	(0.56)		(0.00)
2	0.69	-0.17	-0.18	-0.57	1.10	-0.55	-1.21	20.9%	-0.17
		(0.64)	(0.27)	(0.05)	(0.02)	(0.06)	(0.06)		(0.64)
3	1.38	1.00	-0.77	-0.89	1.59	-0.70	-1.12	27.2%	15.23
		(0.02)	(0.05)	(0.05)	(0.00)	(0.03)	(0.05)		(0.02)
4	1.19	1.05	-0.54	-0.69	1.45	-0.13	-0.54	31.4%	21.16
		(0.00)	(0.01)	(0.02)	(0.00)	(0.27)	(0.02)		(0.00)
5	0.95	0.21	0.95	0.74	0.96	0.09	-0.05	51.2%	33.25
		(0.61)	(0.00)	(0.00)	(0.02)	(0.64)	(0.87)		(0.00)
6	0.97	0.45	0.53	0.38	1.11	0.06	-0.06	28.0%	19.19
		(0.19)	(0.33)	(0.35)	(0.17)	(0.80)	(0.90)		(0.00)
7	0.62	0.54	0.15	0.27	0.51	-0.14	-0.30	32.9%	26.42
		(0.00)	(0.00)	(0.00)	(0.05)	(0.01)	(0.02)		(0.00)
8	0.92	0.77	-0.02	0.15	0.00	-0.15	-0.41	5.6%	18.78
		(0.00)	(0.82)	(0.57)	(0.82)	(0.02)	(0.01)		(0.00)
9	0.44	0.02	0.27	0.59	0.56	0.03	0.01	44.3%	20.61
		(0.95)	(0.08)	(0.01)	(0.00)	(0.87)	(0.98)		(0.00)
10	0.87	1.08	0.40	0.39	0.00	-0.09	0.12	6.9%	15.01
		(0.00)	(0.22)	(0.36)	(0.70)	(0.80)	(0.83)		(0.02)
11	0.23	0.26	0.02	0.01	-0.03	-0.07	-0.07	-12.7%	21.69
		(0.00)	(0.44)	(0.96)	(0.86)	(0.56)	(0.42)		(0.00)
12	0.46	0.40	-0.05	0.22	0.48	-0.01	0.07	-5.1%	19.05
		(0.02)	(0.98)	(0.06)	(0.18)	(0.95)	(0.65)		(0.00)
13	-0.03	-0.12	-0.10	0.00	0.47	-0.03	-0.09	46.2%	19.87
		(0.01)	(0.00)	(0.00)	(0.00)	(0.56)	(0.10)		(0.00)
14	0.66	0.64	-0.02	0.10	0.45	0.00	-0.15	4.6%	18.91
		(0.00)	(0.91)	(0.56)	(0.02)	(0.92)	(0.15)		(0.00)
15	0.69	0.67	-0.11	-0.14	0.20	-0.56	0.33	0.1%	17.76
		(0.00)	(0.20)	(0.13)	(0.00)	(0.05)	(0.20)		(0.01)
16	0.82	0.66	-0.14	0.02	0.71	-0.29	0.13	13.5%	17.10

		(0.00)	(0.06)	(0.12)	(0.00)	(0.04)	(0.53)		(0.01)
17	0.09	0.07	-0.21	-0.21	0.33	-0.07	-0.08	-8.7%	18.59
		(0.53)	(0.00)	(0.00)	(0.00)	(0.54)	(0.67)		(0.00)
18	0.91	0.95	0.15	0.15	-0.07	-0.21	-0.69	24.0%	13.39
		(0.00)	(0.01)	(0.00)	(0.55)	(0.49)	(0.06)		(0.04)
19	0.56	-0.07	0.40	0.48	0.09	-0.39	-1.10	57.4%	8.95
		(0.71)	(0.00)	(0.00)	(0.17)	(0.00)	(0.00)		(0.18)
20	0.66	0.22	0.15	0.16	0.10	-0.37	-0.78	14.7%	10.40
		(0.50)	(0.22)	(0.05)	(0.07)	(0.00)	(0.02)		(0.11)
21	-0.12	-0.83	0.05	1.17	0.33	-2.32	-0.53	32.5%	16.61
		(0.40)	(0.01)	(0.06)	(0.57)	(0.05)	(0.48)		(0.01)
22	1.11	0.98	-0.03	0.28	-0.15	-0.13	-0.48	7.7%	16.49
		(0.00)	(0.05)	(0.05)	(0.29)	(0.16)	(0.06)		(0.01)
23	0.38	-0.18	0.51	0.54	0.03	0.02	0.04	23.3%	22.14
		(0.32)	(0.00)	(0.00)	(0.26)	(0.66)	(0.73)		(0.00)
24	0.38	-0.15	0.69	0.78	-0.17	0.00	0.09	24.7%	19.38
		(0.50)	(0.01)	(0.01)	(0.33)	(1.00)	(0.63)		(0.00)
25	0.66	0.22	0.15	0.16	0.10	-0.37	-0.78	14.7%	18.29
		(0.50)	(0.22)	(0.05)	(0.07)	(0.00)	(0.02)		(0.01)
26	0.60	0.53	0.09	0.07	0.36	0.17	0.20	6.6%	8.89
		(0.00)	(0.55)	(0.74)	(0.01)	(0.28)	(0.51)		(0.18)
27	0.69	0.17	0.69	0.54	0.02	-0.02	-0.02	38.7%	12.74
		(0.22)	(0.00)	(0.00)	(0.41)	(0.69)	(0.92)		(0.05)
28	0.56	0.48	0.06	0.19	0.47	-0.18	-0.10	32.3%	21.10
		(0.00)	(0.22)	(0.02)	(0.00)	(0.26)	(0.73)		(0.00)
29	-0.76	0.06	0.53	-0.88	-1.57	0.41	0.13	70.9%	22.12
		(0.85)	(0.00)	(0.00)	(0.00)	(0.11)	(0.67)		(0.00)
30	0.85	0.64	-0.06	-0.15	0.93	-0.72	0.03	50.5%	17.84
		(0.03)	(0.04)	(0.09)	(0.00)	(0.04)	(0.95)		(0.01)
31	0.70	0.29	-0.53	-0.82	0.86	-0.47	-1.36	22.2%	13.97
		(0.42)	(0.09)	(0.18)	(0.12)	(0.08)	(0.03)		(0.03)
32	0.33	-0.21	0.15	0.11	0.35	-0.30	-0.65	11.1%	17.67
		(0.44)	(0.39)	(0.30)	(0.03)	(0.00)	(0.01)		(0.01)
33	0.05	-2.10	-0.66	-0.80	4.43	-0.46	-0.59	8.8%	16.57
		(0.10)	(0.56)	(0.28)	(0.02)	(0.46)	(0.70)		(0.01)
34	0.67	-0.56	0.45	0.18	0.79	-0.31	-0.96	34.5%	39.05
		(0.07)	(0.00)	(0.12)	(0.01)	(0.00)	(0.00)		(0.00)
35	0.64	-0.39	0.92	0.44	1.04	0.27	0.20	40.0%	9.16
		(0.47)	(0.00)	(0.00)	(0.07)	(0.48)	(0.70)		(0.16)
36	0.13	0.26	0.11	0.27	-0.13	0.07	0.04	32.9%	13.53
		(0.01)	(0.02)	(0.01)	(0.13)	(0.12)	(0.70)		(0.04)

37	0.47	0.36	-0.16	0.13	0.18	0.20	-0.30	15.1%	28.32
		(0.03)	(0.13)	(0.31)	(0.00)	(0.16)	(0.28)		(0.00)
38	0.52	0.11	0.35	0.24	0.49	-0.02	-0.14	37.0%	17.63
		(0.65)	(0.00)	(0.01)	(0.03)	(0.90)	(0.55)		(0.01)
39	0.58	0.39	0.02	0.07	0.82	-0.20	-0.17	49.9%	5.14
		(0.01)	(0.01)	(0.00)	(0.00)	(0.25)	(0.09)		(0.53)
40	0.52	0.15	0.17	0.11	0.15	-0.24	-0.29	57.3%	3.81
		(0.16)	(0.00)	(0.06)	(0.40)	(0.02)	(0.00)		(0.70)
41	0.89	0.34	-0.26	-0.31	0.57	-0.59	-1.65	40.2%	37.97
		(0.43)	(0.00)	(0.01)	(0.20)	(0.03)	(0.01)		(0.00)
42	0.66	0.63	-0.17	0.12	0.47	0.40	0.61	-1.4%	36.40
		(0.00)	(0.08)	(0.39)	(0.00)	(0.08)	(0.14)		(0.00)
43	0.39	0.38	0.13	0.09	0.10	0.00	0.10	-4.0%	8.79
		(0.00)	(0.48)	(0.50)	(0.04)	(0.96)	(0.54)		(0.19)
44	1.30	0.62	-0.29	-0.31	0.89	-0.59	-1.61	40.4%	21.15
		(0.23)	(0.02)	(0.01)	(0.00)	(0.02)	(0.01)		(0.00)
45	1.09	1.20	-0.19	-0.50	-0.15	-1.06	0.60	-19.7%	60.18
		(0.16)	(0.68)	(0.40)	(0.85)	(0.17)	(0.64)		(0.00)
46	0.67	0.56	0.16	0.10	0.01	0.01	0.08	-5.2%	20.35
		(0.00)	(0.70)	(0.60)	(0.20)	(0.90)	(0.67)		(0.00)
47	0.36	0.31	0.11	0.31	-0.08	-0.19	-0.52	25.4%	21.03
		(0.07)	(0.32)	(0.05)	(0.50)	(0.00)	(0.00)		(0.00)
48	0.62	0.27	0.18	0.21	0.57	-0.05	-0.17	29.1%	28.44
		(0.01)	(0.00)	(0.01)	(0.05)	(0.52)	(0.27)		(0.00)
49	0.46	0.23	0.08	0.07	0.16	-0.04	-0.19	47.9%	38.53
		(0.00)	(0.00)	(0.00)	(0.07)	(0.40)	(0.04)		(0.00)
50	0.44	0.26	-0.06	-0.07	0.60	-0.19	-0.50	41.1%	12.32
		(0.03)	(0.00)	(0.00)	(0.00)	(0.02)	(0.01)		(0.06)
51	0.57	0.46	-0.02	-0.13	-0.42	-0.61	-1.05	11.9%	13.73
		(0.11)	(0.17)	(0.32)	(0.07)	(0.05)	(0.12)		(0.03)
52	0.58	0.55	0.09	0.05	0.11	-0.41	-0.14	9.3%	12.31
		(0.01)	(0.21)	(0.10)	(0.27)	(0.05)	(0.52)		(0.06)
53	0.66	0.25	0.60	0.57	-0.27	-0.10	-0.29	12.0%	23.29
		(0.21)	(0.02)	(0.08)	(0.02)	(0.21)	(0.22)		(0.00)
54	0.36	0.34	0.01	0.14	0.47	0.04	-0.03	15.1%	42.09
		(0.00)	(0.03)	(0.03)	(0.00)	(0.51)	(0.80)		(0.00)
55	0.46	0.15	0.39	0.30	0.01	-0.02	-0.02	36.4%	16.79
		(0.07)	(0.00)	(0.00)	(0.43)	(0.60)	(0.82)		(0.01)
Mean		0.29	0.26	0.08	0.41	-0.21	-0.30	23.3%	
P-Value		(0.00)	(0.00)	(0.15)	(0.00)	(0.00)	(0.00)		