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Modeling the Risk Dynamics of Hedge Funds

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Abstract

This paper investigates the risk dynamics of hedge fund index returns and the market timing abilities of hedge fund managers. The empirical evidence shows that the systematic risk of all hedge fund index returns are highly variable over time, implying that reported alpha returns as well as standard risk management metrics are unreliable. In almost all cases volatility is asymmetric and the range of estimated betas is rather large. The degree of persistence is also very high. The results show that both systematic and unsystematic risk of all hedge fund styles is time varying. Furthermore, there is no evidence of successful market timing.

JEL classification numbers: G1, G11, G12, C5
Keywords: Hedge Funs, Volatility Dynamics, Conditional Heteroscedasticity

1 Introduction and Literature Review

The growth in money under management by hedge funds has been spectacular during the last fifteen years. As of the second quarter of 2012, the amount stood at 1.7 trillion US dollars according to Barclays' Alternative Investment Databases. There are many reasons for this growth. Hedge funds have a great deal of flexibility given that they are largely unregulated pools of money managed by professional managers. Such flexibility allows managers to exploit perceived market inefficiencies more easily than traditional buy-and-hold mutual fund managers. More specifically, hedge funds can use leverage, take short positions and use derivative securities in their hedging, speculative and arbitrage activities. Another measure of the importance of hedge funds is their

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trading activity which according to Stulz (2007) accounts for approximately half the trading in the New York and London stock exchanges.

The performance of hedge fund managers and the compensation structure has been a subject of considerable research in the academic world as well as a subject of intense debate in the investment world. As discussed in Stulz (2007), typically the total fee consists of the standard management fee plus an incentive fee. The first, ranges between 1%-2% and the latter is calculated as a percentage of the profits that can range between 15%-25%. There are many variations and many stipulations about the particular incentive fee structure but in all instances the higher fees charged by hedge fund managers are based on the perceived ability of these managers to earn "alpha returns", i.e., returns that cannot be explained (replicated) by common risk factors. Ibbotson, Chen and Zhou (2011) find that during the period 1995-2009, hedge finds were able to add a significant amount of alpha to a typical portfolio consisting of stocks bonds and cash. On average, the alpha return was 3% whereas, beta exposure contributed 4.7% during the same period.

There is no general agreement as to what constitutes "alpha returns" or, equivalently what is the appropriate set of risk factors to use when estimating alpha. In most cases the statistical framework used is based on the Capital Asset Pricing Model whereby excess returns on the hedge fund are regressed against excess returns on a suitable proxy for the market portfolio. The intercept of the regression is the alpha return component. The underlying assumption is that the model parameters, i.e., the market exposure parameter, the so-called beta, and the intercept are constant. A growing body of literature finds that returns on speculative assets are non-stationary, in their second moments and co-moments. If the betas are time varying it is possible that returns due to market co-movements are mistakenly interpreted as alpha returns. This is a very important issue since management fees can only be justified on the basis of alpha returns.

There is also a small but growing body of literature dealing with the market timing abilities of hedge fund managers and the degree to which these managers can earn alpha returns, i.e., returns unrelated to general market movements. The assumption however almost always is that the relationship of hedge fund returns to markets movements, the so-called beta parameter, is constant through over time. There has been plenty of evidence however that the returns of speculative assets in general do not follow stationary distributions. For hedge fund returns in particular Brooks and Kat (2002) report that hedge fund index returns exhibit high kurtosis which has been linked to non-stationarity of higher moments. Similar findings are reported by Fuss, Kaiser and Adams (2006) and Kat and Lu (2002). Such findings cast doubt on the validity of traditional measures of investment performance such as the well known and extensively used Sharpe Ratio (see Sharpe 1994).

Regarding the market timing ability of hedge fund managers, the evidence reported up to now is mixed. For example, Chen and Liang (2007), based on a sample of 221 funds self-identified as market timers for the 1994–2005 period, find that the evidence supports timing ability, especially in bear and volatile markets. Similar findings are reported by Xin Li and Shawky (2013) for Long/Short type hedge funds. On the other had Cave, Hubner and Sougne (2012) report that depending on the particular style, there have been positive, negative and mixed market timers during the financial crisis of 2008. Fung, Xu and Yau (2002) find that global hedge fund managers do not show positive market timing ability but instead demonstrate superior security selection ability.

The mixed evidence is, to some extend due to different time horizons and sample sizes employed in different studies. Almost all of these studies however employ statistical methods that assume stationary distributions. Thus, exposures to risk factors are assumed constant over the sample period. Given the evidence against stationarity however, such an assumption is not warranted and it may lead to erroneous conclusions.

The purpose of this paper is to test the market timing abilities of hedge fund managers and the possibility that beta coefficients are time-varying. More specifically, this study attempts to provide answers to the following questions:

a) Is the systematic risk (beta) of hedge funds with a variety of investment styles time varying?
b) Is the systematic risk higher during market downturns (i.e., asymmetric)?
c) Is time variation and/or asymmetry related to the particular investment style?
d) What is the degree of persistence and predictability in systematic risk?

2 Data and Methodology

That data used in this study are weekly returns on hedge funds with the following investment styles:

Convertible Arbitrage	(CONV)
Dedicated Short Bias	(DEDS)
Event Driven	(DRIV)
Emerging Markets	(EMGM)
Equity Market Neutral	(NEUT)
Fixed Income Arbitrage	(FIAR)
Global Macro (GLMA)	
Long-Short Equity	(LSEQ)
Managed Futures	(FUTR)
Multiple Strategy	(MSTR)

The data cover the period 9/12/2005 till 3/12/2012 for total of 340 weekly observations. The return series data are obtained from the TASS Hedge Funds Data Base which produces indexes of investment performance of several hedge fund classes.

The model that is used is a bivariate EGARCH model described by the following set of equations:

$$R_{i,t} = \alpha_i + \beta_{i,t} R_{m,t} + \theta R_{i,t-1} + \varepsilon_{i,t} \quad (1)$$
$$R_{m,t} = \alpha_m + \varepsilon_{m,t} \quad (2)$$

where $R_{i,t}$ and $R_{m,t}$ are the daily excess returns on the individual security and the market portfolio respectively; $\beta_{i,t}$ is the time-varying security beta; $\alpha_{i,t}$ and $\alpha_{m,t}$ are constants and; $\varepsilon_{i,t}$ and $\varepsilon_{m,t}$ are innovations or, error terms for the individual security and the market respectively.

The elements of the variance/covariance matrix of the two error terms follow a bivariate EGARCH model described by the following set of equations (see Koutmos and Booth 1995):

$$\sigma^2[\varepsilon_{i,t}] = exp\{a_{i,0} + a_{i,1}(|z_{i,t-1}| - E|z_{i,t-1}| + c_i z_{i,t-1}) + b_i ln(\sigma^2[\varepsilon_{i,t-1}])\} \quad (3)$$
$$\sigma^2[\varepsilon_{m,t}]=exp\{a_{m,0} + a_{m,1}(|z_{m,t-1}| - E|z_{m,t-1}| + c_m z_{m,t-1})+ b_m ln(\sigma^2[\varepsilon_{m,t-1}]\} \quad (4)$$
$$\sigma_{i,m,t} =(\rho_{i,m} + \gamma_i R^-_{t-1}) \; (\sigma^2[\varepsilon_{i,t}] \, \sigma^2[\varepsilon_{m,t}])^{1/2} \quad (5)$$

where, $ln(.)$ are natural logarithms, $z_{i,t} = \varepsilon_{i,t}/ \sigma[\varepsilon_{i,t}]$ and $z_{m,t} = \varepsilon_{m,t}/ \sigma[\varepsilon_{m,t}]$ are normalized innovations; $\sigma_{i,m,t}$ and $\rho_{i,m}$ are the conditional covariance and the conditional correlation coefficient; and $a_{i,0}$, $a_{i,1}$, c_i, b_i, $a_{m,0}$, $a_{m,1}$, c_m, b_m, are fixed parameters to be estimated. This version of the model assumes that the conditional correlation is constant but the conditional covariance is time-varying. The beta of the individual hedge fund is given by

$$\beta_{i,t} = (\sigma_{i,m,t}/ \sigma^2[\varepsilon_{m,t}]) \quad (6)$$

Assuming that the returns of each hedge fund and the market index are jointly conditionally normally distributed, we can estimate the fixed parameters of the model described by (1)-(5) by maximizing the sample log-likelihood function. The latter can be written as

$$L(\Theta)= - T\, log(2\pi) - (1/2)\, \Sigma\, (log\, /H_t/ + E_t H_t^{-1} E_t'), \quad (7)$$

where T is the number of observations, Θ is the parameter vector to be estimated, $E_t=[\varepsilon_{i,t}\ \varepsilon_{m,t}]$ is the 1x2 vector of innovations at time t, $H_t = Cov_{t-1}(E_t)$, where the diagonal elements of H_t are given by (3) and (4) and the cross diagonal elements are given by (5). Because of nonlinearities in the log-likelihood function numerical maximization techniques are used to obtain parameter estimates. The particular algorithm used is based on Berndt et al. (1974).

3 Main Empirical Findings

The descriptive statistics reported on Table 1 suggest that all returns are negatively skewed and highly leptokyrtic. The later is mostly due to time variation in the variance of the returns. Unconditional normality is rejected in all instances on the basis of the Jarque-Bera statistic. Using the Sharpe ratio, it can be seen that the majority of hedge fund styles have underperformed the market index, the only exceptions being the Event Driven (DRIV) and the Managed Futures (FUTR).

Table 2 reports pairwise correlations among hedge fund styles and the market index. The estimated values do not follow a particular pattern. Dedicated Short Bias (DEDS) has a significant negative correlation with the market (-0.5436) and Managed Futures (FUTR) also has a negative correlation with the market (-0.1327). The rest of the hedge fund indices have positive correlations ranging from a high of 0.6524, for Long-Short Equity (LSEQ) to low of 0.0976 for the Equity Market Neutral (NEUT). Overall, the correlations with the market are rather low, suggesting that hedge funds focus on alpha strategies with low correlations with the market.

Table 3 reports the results of a market model where we allow for an asymmetric exposure to the market and for autocorrelation in the returns. The form of the regression equation is as follows:

$$\boldsymbol{R_{i,t} = a_i + \beta_i R_{m,t} + \delta_i R^{+}_{m,t} + \theta R_{i,t-1} + \varepsilon_{i,t}} \quad (8)$$

where, $R^{+}_{m,t} = R_{m,t}$ when the market return is positive and zero otherwise. The objective is to capture any asymmetric exposure to the market which would be an indication of market timing. If for example δ_i is positive and significant then we have evidence of successful market timing. The results show that most hedge funds have positive market exposure with the exception of Dedicated Short Bias (DEDS) and Managed Futures (FUTR). Surprisingly, the asymmetry parameter is negative and statistically significant in across all hedge fuind indices with the exception of Dedicated Short Bias and Managed Futures. This implies that that exposure to the market is low when the market return is positive and high when the market return is negative. If there was any effort at timing the market the results are exactly opposite of what we might have expected. This is contrary to the findings of Li and Shawky (2013) and Chen and Liang (2007). This may be due to the fact that this study is using more recent data that include the financial crisis of 2008 or, to the different methodologies. Though, the evidence on market timing is negative, there is support for the notion that hedge fund managers are doing a good job on the security selection front. Most alpha parameters (a_i) are positive and statistically significant. This is in agreement to the findings of Fung, Xu and Yau (2002).

Table 4 reports the results from the Vector EGARCH model. The alphas cease to be significant indicating that the earlier finding may have been spurious. The parameters describing the variance covariance matrix are highly significant confirming time variation in second moments and cross-moments. Parameter *c* is negative and significant suggesting that volatility is asymmetric in the sense that it is higher following negative returns than it is following positive returns. The estimated beta coefficients are time varying and the range of values is typically very large. This shows that models assuming constant market exposure are misspecified. The time-series behavior of the estimated betas is explored using the following regression:

$$\beta_{i,t} = g_{i,0} + g_{i,1}\beta_{i,t-1} + g_{i,2}R_{m,t} + g_{i,3}R^{+}_{m,t} + v_{i,t} \ , \qquad (9)$$

where, g_1 captures persistence, g_2, market timing and g_3 asymmetric timing. The results show that in all instances there is a high degree of persistence over time in the estimated betas. There is some evidence of successful market timing but in most cases that is more than offset by the asymmetric parameter on market timing which implies timing of the wrong type.

Overall, the evidence suggests that hedge funds do not show exhibit superior skill in timing the market. There is however, evidence of security selection skill.

5 Conclusion

The evidence in this paper shows that the betas of several hedge fund style indexes are highly variable over time. This in turn renters the estimated alpha returns unreliable. In almost all cases volatility is asymmetric and the range of estimated betas is rather large. The degree of persistence is also very high. Both, the simple regression and the vector EGARCH model show no evidence of successful market timing, though there is positive evidence of superior security selection.

References

[1] Brooks, C., and Kat H.M. 2002. "The Statistical Properties of Hedge Fund Returns and their Implications for Investors", *The Journal of Alternative Investments*, Fall 2002, pp. 26-44.

[2] Cave A., Hubner G., and Sougne D. (2012) "The market timing skills of hedge funds during the financial crisis", Managerial Finance, Vol. 38 Iss: 1, pp.4 - 26

[3] Chen Y. and Liang Bing. 2007. "Do Market Timing Hedge Funds Time the Market?", Journal of Financial and Quantitative Analysis, Vol. 42, No. 4, pp. 827-856.

[4] Fung H.G., Xu X.E. and Yau J. 2002. "Global Hedge Funds: Risk, Return and Market Timing", Financial Analysts Journal, Vol. 58(6) pp. 19-31.

[5] Fuss, R., Kaiser D.G. and Adams Z. 2007. "Value at Risk, GARCH Modeling and the Forecasting of Hedge Fund Return Volatility" Journal of Derivatives & Hedge Funds, Vol. 13, No. 1, pp. 2-25.
[6] Ibbotson, Roger G., Peng Chen, and Kevin X. Zhu. 2011. “The ABCs of Hedge Funds: Alphas, Betas, and Costs.” Financial Analysts Journal, vol. 67, no. 1 (January/February):15–25.
[7] Kat, H.M. and Lu, S. 2002. "An Excursion Into the Statistical Properties of Hedge Fund Returns", Working Paper, the University of Reading.
[8] Koutmos G. and G. G. Booth 1995. "Asymmetric Volatility Transmission in International Stock Markets" Journal of International Money and Finance, 1995, Vol. 14, No. 6, pp. 747-762.
[9] Sharp, W. 1994. "The Sharpe Ratio", The Journal of Portfolio Management" Fall 1994, pp. 49-59.
[10] Stulz, René. 2007. “Hedge Funds: Past, Present, and Future.” Journal of Economic Perspectives, vol. 21, no. 2 (Spring):175–194.
[11] Xin Li and Shawky A. 2013. "The Market Timing Skills of Long/Short Equity Hedge Fund Managers" Working Paper, Department of Economics at Albany.

Table 1: Summary Statistics

	MKT	CONV	DEDS	DRIV	EMGM	FIAR	FUTR	GLMA	LSEQ	MSTR	NEUT	PWA
Mean	0.129540	0.037536	-0.130862	0.066929	0.065623	-0.081432	0.111435	0.032287	0.026423	0.030529	-0.061447	0.020678
Median	0.272000	0.128541	-0.182880	0.169205	0.269440	0.066291	0.208249	0.072470	0.189773	0.130988	0.045656	0.112948
Maximum	13.03700	6.029340	15.63580	4.096383	4.587563	9.462362	3.744122	6.955768	2.907927	5.563733	8.602502	3.099085
Minimum	-18.39000	-7.262559	-10.59765	-4.099896	-6.332163	-9.180135	-8.230506	-8.509443	-7.002433	-7.106266	-12.63314	-3.740877
Std. Dev.	3.043640	1.119194	2.162652	0.913102	1.481622	1.153622	1.358062	1.118984	1.067188	0.795833	1.202939	0.620264
Sharpe Ratio	0.029750	-0.001310	-0.078570	0.030590	0.017970	-0.104720	0.053340	-0.006000	-0.011790	-0.008470	-0.083500	-0.295520
Skewness	-0.555257	-2.031758	1.097491	-0.642861	-1.024830	-2.260453	-1.130175	-1.343084	-1.877006	-1.506371	-4.394248	-1.515061
Kurtosis	8.574959	20.73492	12.40328	5.995271	5.707445	41.08983	8.078915	19.43950	11.35325	30.44137	60.53551	11.72535
Jarque-Bera	456.4269	4675.933	1317.009	150.0743	162.8805	20781.74	436.5269	3919.302	1184.656	10764.74	47849.46	1205.051
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	43.91400	12.72472	-44.36213	22.68897	22.24635	-27.60557	37.77636	10.94530	8.957434	10.34946	-20.83052	7.009795
Sum Sq. Dev.	3131.147	423.3774	1580.847	281.8092	741.9787	449.8254	623.3840	423.2183	384.9445	214.0725	489.1068	130.0379
Observations	339	339	339	339	339	339	339	339	339	339	339	339

Notes: MKT=Market Index; CONV=Convertible Arbitrage; DEDS=Dedicated Short Bias; DRIV=Event Driven; EMGM=Emerging Markets; FIAR=Fixed Income Arbitrage GLMA=Global Macro; LSEQ=Long-Short Equity; FUTR=Managed Futures; MSTR=Multiple Strategy; NEUT=Market Neutral; PWA=Price Weighted Index.

Table 2: Cross-Correlations

	MKT	CONV	DEDS	DRIV	EMGM	FIAR	FUTR	GLMA	LSEQ	MSTR	NEUT	PWA
MKT	1.000000	0.277741	-0.543640	0.234926	0.500921	0.265140	-0.132727	0.314816	0.652471	0.295926	0.097670	0.309063
CONV	0.277741	1.000000	0.038981	0.470848	0.464990	0.528897	-0.076788	0.383841	0.421660	0.640735	0.191053	0.672869
DEDS	-0.543640	0.038981	1.000000	-0.059975	-0.299977	-0.023986	-0.104402	-0.099429	-0.338340	-0.019313	0.071568	0.061303
DRIV	0.234926	0.470848	-0.059975	1.000000	0.409839	0.297932	0.155915	0.256580	0.475163	0.493784	0.248319	0.677450
EMGM	0.500921	0.464990	-0.299977	0.409839	1.000000	0.363610	0.133425	0.438335	0.658465	0.466031	0.230578	0.734660
FIAR	0.265140	0.528897	-0.023986	0.297932	0.363610	1.000000	-0.141734	0.339950	0.370895	0.416063	0.148214	0.528404
FUTR	-0.132727	-0.076788	-0.104402	0.155915	0.133425	-0.141734	1.000000	0.193638	0.046058	0.001330	0.050247	0.325107
GLMA	0.314816	0.383841	-0.099429	0.256580	0.438335	0.339950	0.193638	1.000000	0.373759	0.427272	0.099060	0.617290
LSEQ	0.652471	0.421660	-0.338340	0.475163	0.658465	0.370895	0.046058	0.373759	1.000000	0.355886	0.173214	0.637195
MSTR	0.295926	0.640735	-0.019313	0.493784	0.466031	0.416063	0.001330	0.427272	0.355886	1.000000	0.349123	0.688969
NEUT	0.097670	0.191053	0.071568	0.248319	0.230578	0.148214	0.050247	0.099060	0.173214	0.349123	1.000000	0.457390
PWA	0.309063	0.672869	0.061303	0.677450	0.734660	0.528404	0.325107	0.617290	0.637195	0.688969	0.457390	1.000000

Notes: MKT=Market Index; CONV=Convertible Arbitrage; DEDS=Dedicated Short Bias; DRIV=Event Driven; EMGM=Emerging Markets; FIAR=Fixed Income Arbitrage GLMA=Global Macro; LSEQ=Long-Short Equity; FUTR=Managed Futures; MSTR=Multiple Strategy; NEUT=Market Neutral; PWA=Price Weighted Index.

Table 3: OLS

$$R_{i,t} = a_i + \beta_i R_{m,t} + \delta_i R^{+}_{m,t} + \theta R_{i,t-1} + \varepsilon_{i,t}$$

	α	β	δ	θ	$Q^2(5)$	$Q_{i,M}(5)$
Convertible Arbitrage	0.1763 (2.515)**	0.1696 (6.186)**	-1.756 (-3.737)**	0.4546 (9.894)**	41.893**	66.633**
Dedicated Short Bias	-0.0625 (-0.451)	-0.3529 (-6.658)**	-0.0737 (-0.812)	0.0161 (0.347)	10.300**	14.780*
Emerging Markets	0.1198 (1.278)	0.2940 (8.029)**	-0.1244 (-1.970)**	0.2631 (5.601)**	12.055**	9.856**
Equity Market Neutral	0.1214 (1.358)	0.1351 (3.912)**	-0.2109 (-3.575)**	0.0327 (0.608)	31.268**	12.112**
Event Driven	0.2444 (3.826)**	0.1650 (6.684)**	-0.2148 (-5.095)**	0.1838 (3.625)**	15.689**	17.728**
Fixed Income Arbitrage	0.1913 (2.453)**	0.2184 (6.940)**	-0.2769 (-5.128)**	0.2376 (4.613)**	21.594**	72.688**
Global Macro	0.1202 (1.511)	0.1762 (5.768)**	-0.1301 (-2.483)**	0.1310 (2.561)**	20.142**	19.133**
Long-Short Equity	0.0988 (1.735)*	0.2768 (12.312)**	-0.1231 (-3.189)**	0.2622 (6.590)**	17.548**	23.306**
Managed Futures	0.1369 (1.338)	-0.0272 (-0.685)	-0.0633 (-0.935)	0.0921 (1.688)*	20.635*	23.500**
Multiple Strategy	0.1151 (2.125)**	0.1329 (6.338)**	-0.1220 (-3.345)**	0.2955 (5.883)**	17.105*	16.620**
Price-Weighted Average	0.1336 (3.338)**	0.1231 (7.756)**	-0.1456 (-5.380)**	0.3067 (6.364)**	16.954*	15.515**
Equally-Weighted Average	0.1332 (3.263)**	0.1156 (7.109)**	-0.1518 (-5.481)**	0.2949 (5.973)**	11.751*	13.719**

Notes: (**) and (*) indicate statistical significance at the 5% and the 10% levels respectively. Numbers in parentheses are t-statistics. $Q^2(5)$ and $Q_{i,M}(5)$ are the Ljung-Box statistics for the squared residuals and the cross product of the residuals testing for serial correlation up to 5 lags.

Table 4: Vector EGARCH

$$R_{i,t} = \alpha_i + \beta_{i,t} R_{m,t} + \theta R_{i,t-1} + \varepsilon_{i,t}$$
$$R_{m,t} = \alpha_m + \varepsilon_{m,t}$$
$$\sigma^2[\varepsilon_{i,t}] = exp\{a_{i,0} + a_{i,1}(|z_{i,t-1}| - E|z_{i,t-1}| + c_i z_{i,t-1}) + b_i \ln(\sigma^2[\varepsilon_{i,t-1}])\}$$
$$\sigma^2[\varepsilon_{m,t}] = exp\{a_{m,0} + a_{m,1}(|z_{m,t-1}| - E|z_{m,t-1}| + c_m z_{m,t-1}) + b_m \ln(\sigma^2[\varepsilon_{m,t-1}])\}$$
$$\sigma_{i,m,t} = (\rho_{i,m} + \gamma_i R^-_{t-1})\ (\sigma^2[\varepsilon_{i,t}]\ \sigma^2[\varepsilon_{m,t}])^{1/2}$$
$$\beta_{i,t} = (\sigma_{i,m,t} / \sigma^2[\varepsilon_{m,t}])$$

	α	$\beta_{t\|t-1}$ (average, minimum maximum)	θ	a_0	a_1	c	b	ρ	γ	$Q^2(5)$ $Q_{i,M}(5)$
Convertible Arbitrage	0.0303 (0.957)	0.0297 0.0081 0.1772	0.4046 (8.894)**	-0.0522 (-3.853)**	0.3167 (9.232)**	-0.1531 (-0.285)	0.9979 (57.09)**	0.0965 (2.265)**	0.0248 (0.454)	5.930 6.574
Dedicated Short Bias	-0.2940 (-0.031)	-0.3387 -2.3940 -0.0865	0.0160 (0.355)	1.3079 (10.288)**	0.5544 (11.80)**	-0.4996 (-5.665)**	0.3604 (6.333)**	-0.4850 (11.35)**	0.1112 (2.533)**	8.962 1.609
Emerging Markets	0.0243 (0.348)	0.1602 0.0498 0.3497	0.2861 (5.831)**	0.4156 (3.886)**	0.1962 (1.875)*	-0.9617 (-1.596)	0.9617 (15.96)**	0.3638 (7.801**	-0.1061 (-1.823)*	8.104 5.119
Equity Market Neutral	-0.0654 (-1.805)*	0.0304 0.0073 0.1423	0.0321 (0.608)	-0.1005 (-1.352)	0.2143 (17.83)**	-0.3558 (-6.107)**	0.9062 (34.42)**	0.0604 (1.265)	0.0419 (0.062)	2.557 0.119
Event Driven	0.0559 (1.433)	0.0535 0.0142 0.1729	0.1739 (3.025)**	-0.0150 (-1.555)	0.1958 (4.489)**	0.0672 (0.720)	0.9058 (59.51)**	0.1201 (2.096)**	0.1163 (1.670)*	0.334 5.830
Fixed Income Arbitrage	-0.0849 (-5.916)**	0.0278 0.0002 0.1713	0.2563 (4.103)**	-0.0033 (-1.275)	0.0151 (5.591)**	-0.0961 (-4.411)**	0.9661 (26.20)**	0.0189 (0.327)	0.1419 (2.206)*	4.944 3.306
Global Macro	0.0323 (0.657)	0.0526 0.0203 0.1451	0.1317 (2.562)**	0.0067 (0.623)	0.2502 (4.392)**	-0.0123 (-0.984)	0.9978 (37.50)**	0.1302 (2.464)**	0.0018 (0.030)	8.317 7.106
Long-Short Equity	0.0021 (0.052)	0.1196 0.0599 0.2048	0.2601 (6.530)**	-0.0481 (-3.220)**	0.0397 (1.978)**	-0.2753 (-1.658)	0.9469 (44.41)**	0.3553 (7.656)**	0.1271 (2.486)**	5.815 4.084

Managed Futures	0.2082 (2.937)**	0.0129 -0.0003 0.0511	0.0621 (1.483)	0.0269 (1.228)	0.0697 (2.228)**	-0.4133 (-1.268)	0.9348 (34.71)**	0.0396 (0.878)	-0.0399 (-0.773)	7.264 3.379
Multiple Strategy	0.0548 (3.315)**	0.0410 0.0109 0.1557	0.3455 (5.843)**	-0.0204 (-3.214)	0.1273 (7.197)**	-0.3187 (-4.143)**	0.9618 (38.92)**	0.1427 (2.957)**	0.0869 (1.435)	4.728 5.070
Price-Weighted Average	0.0052 (0.183)	0.0348 0.0164 0.1073	0.2850 (5.061)**	-0.2283 (-2.832)**	0.1884 (5.382)**	-0.0767 (-0.761)	0.9239 (15.44)**	0.1640 (3.334)**	0.0084 (0.1369)	1.688 6.954
Equally-Weighted Average	0.0014 (0.050)	0.0223 0.0113 0.1084	0.2950 (5.972)**	-0.2498 (-3.239)**	0.2152 (5.441)**	-0.0605 (-0.625)	0.9130 (15.05)**	0.1072 (1.972)**	-0.0023 (-0.036)	0.281 2.807

Notes: (**) and (*) indicate statistical significance at the 5% and the 10% levels respectively. Numbers in parentheses are t-statistics. $Q^2(5)$ and $Q_{i,M}(5)$ are the Ljung-Box statistics for the squared residuals and the cross product of the residuals testing for serial correlation up to 5 lags.

Table 5: Beta Dynamics

$$\beta_{i,t} = g_{i,0} + g_{i,1}\beta_{i,t-1} + g_{i,2}R_{m,t} + g_{i,3}R^{+}_{m,t} + v_{i,t}$$

	g_0	g_1	$g_2 \times 10^2$	$g_3 \times 10^4$
Convertible Arbitrage	0.0061 (4.909)**	0.7898 (23.36)**	-0.0611 (-0.145)	0.0970 (0.182)
Dedicated Short Bias	-0.3081 (-11.43)**	0.1232 (2.277)**	0.8751 (1.256)	0.9112 (0.761
Emerging Markets	0.0944 (10.91)**	0.5024 (11.17)**	0.5638 (4.007)**	-1.3542 (-5.518)**
Equity Market Neutral	0.0034 (2.791)**	0.8648 (31.30)**	-0.0329 (-0.874)	0.0607 (0.932)
Event Driven	0.0224 (7.427)**	0.5662 (12.50)**	-0.0411 (-0.062)	0.0691 (0.609)
Fixed Income Arbitrage	0.0183 (7.324)**	0.1491 (2.795)**	-0.2024 (-2.553)**	0.4384 (3.323)**
Global Macro	0.0071 (4.933)**	0.8932 (37.36)**	0.8971 (37.36)**	-0.1437 (3.315)**
Long-Short Equity	0.0459 (8.134)**	0.6199 (14.32)**	0.0384 (0.551)	-0.0688 (-0.572)
Managed Futures	0.0146 (11.38)**	0.1392 (2.633)**	0.1234 (3.152)**	-0.3198 (-4.746)**
Multiple Strategy	0.0051 (3.298)**	0.8460 (29.08)**	-0.0365 (-0.820)	0.0995 (1.295)
Price-Weighted Average	0.0106 (7.368)**	0.7245 (19.68)**	0.0229 (1.193)	-0.0886 (-2.664)**
Equally-Weighted Average	0.0097 (8.748)**	0.5955 (13.71)**	0.0778 (0.435)	-0.0628 (-2.040)**

Notes: (**) and (*) indicate statistical significance at the 5% and the 10% levels respectively. Numbers in parentheses are t-statistics.