

Supplemental Material to “Cyclical dependence and timing in market neutral hedge funds”

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The Supplemental Material describes the dating algorithm used in the paper, the bootstrap procedure used in the calculation of the test for tail dependence, and additional results both using index and individual data. The organisation of the Supplemental Material is as follows: Section 1 discusses the financial cycle dating algorithm as described in [Pagan and Sossounov \(2003\)](#). Section 2 briefly explains the bootstrap procedure used in the paper. Section 3 and 4 provide additional results using index and individual hedge fund data, respectively.

1 Dating algorithm of Pagan and Sossounov (2003)

The procedure proposed by Pagan and Sossounov (2003) is a pattern-recognition program that seeks to isolate the patterns using a sequence of rules, which can be classified into two main categories. The first deals with the location of peaks and troughs, which involves locating points that are higher or lower than a window of surrounding points. The second involves measuring the durations between the turning points, and censoring rules to restrict the minimal lengths of any phase as well as those of complete cycles.

The procedure for determination of turning points in the data are the following:

1. Determination of initial turning points in the raw data.
 - (a) Pagan and Sossounov (2003) determine initial turning points by choosing local peaks (troughs) as occurring when they are the highest (lowest) values in a window eight months on either side of the date.
 - (b) If there are multiple peaks/troughs, an enforcement of alternation of turns is done by selecting the highest of multiple peaks (or the lowest of multiple troughs).
2. Censoring operations (ensure alternation after each)
 - (a) Eliminate turns within 6 months of the beginning and the end of the time series.
 - (b) Eliminate peaks (troughs) at both ends of series which are lower or higher.
 - (c) Eliminate cycles whose duration is less than 16 months.
 - (d) Eliminate phases (i.e, increasing/decreasing trend) whose duration is less than 4 months (unless fall/rise exceeds 20 percent).
3. Statement of final turning points.

2 Bootstrap

As described in the main text, the challenges inherent in inference about the lack of tail dependence are: (i.) first, that the parameter of interest lies in the boundary of the parameter space, which renders the usual asymptotic inference as invalid (Andrews (1999)); and (ii.) second, that the MA filter and the nonparametric estimation of the quantiles also have influence. To this end, we consider the following bootstrap algorithm.

Consider the null hypothesis in which the bear state does not present tail dependence. The bootstrap algorithm is as follows:

1. Draw $\{F_F(x_{Mt}^{(b)}|s_t), F_F(x_{Ft}^{(b)}|s_t)\}_t^{T_{bear}}$ from a Gaussian copula with parameter δ_{bear} for those periods corresponding to a bear state.
2. Invert the empirical c.d.f. using linear interpolation to obtain $\{x_{Mt}^{(b)}, x_{Ft}^{(b)}\}_{t=1}^{T_{bear}}$.
3. Using the estimated coefficients of the MA, construct a sample of the original returns: $\{r_{Mt}^{(b)}, r_{Ft}^{(b)}\}_{t=1}^{T_{bear}}$.
4. Re-estimate the MA and filter the data to obtain the filtered bootstrap sample: $\{\tilde{x}_{Mt}^{(b)}, \tilde{x}_{Ft}^{(b)}\}_{t=1}^{T_{bear}}$.
5. Obtain the empirical c.d.f. and estimate the Student's-t copula. This step leads to the bootstrap parameter $\theta_{bear}^{(b)}$.
6. Estimate the Gaussian copula using the bootstrap data to obtain $\delta^{*(b)}$.
7. Compute the log-likelihood ratio:

$$LR^{(b)} = \sum_{t=1}^{T_{bear}} f^{Student's-t}(\tilde{x}_{Mt}^{(b)}, \tilde{x}_{Ft}^{(b)}; \theta_{bear}^{(b)}) - f^{Gaussian}(\tilde{x}_{Mt}^{(b)}, \tilde{x}_{Ft}^{(b)}; \delta^{*(b)})$$

where f^c is the log-p.d.f. of copula c .

8. Repeat 100 times steps 1 to 8.
9. Compare the LR obtained using the original sample with the distribution of $LR^{(b)}$.

We follow the same method for the remaining hypotheses but we use the corresponding data and parameters as inputs.

3 Robustness checks using index data

To obtain the baseline results, we filter the data using an MA(4) filter and drop the first two years of the sample (1997 and 1998) to avoid backfill bias. To verify whether the results are influenced by the filtering procedure, we re-estimate the model with unfiltered data, and with an MA(2) filter. We also re-estimate the model by starting at 1997, the first year of the sample. Table 1 to 5 show the results of the estimation of the copula model. As our tables indicate, the results remain the same.

Likewise, we define the states as proposed by Pagan and Sossounov (2003), instead of using the data from the NBER, because the states are linked to the financial markets. Nonetheless, to tackle the issue that the states are estimated using the same data we use for the dependence parameters, Tables 6 to 11 present the same results as Table 5 using NBER to define our states. We observe that the same conclusions arise; moreover, the correlation between market

neutral hedge funds and the asset market becomes more cyclical. To verify whether the state timing tests are robust to the definition of states, we repeat all the state timing regressions in the main text, but using the NBER recession indicator. Table 12 to 14 present the results for the baseline state timing regressions, and the regressions that control for other timing and illiquid holdings, respectively. As our results show, we obtain remarkably similar results as with the state timing indicator defined in the main text. These results indicate that market neutral hedge fund managers seem to exhibit superior information about not only financial states, but also business cycles.

Finally, we examine whether these funds exhibit the other forms of timing individually (and not jointly). As our results show in Table 15, most of these funds do not exhibit other forms of timing in aggregate except market neutral hedge funds, which exhibit return timing.

4 Robustness checks using individual data

Tables 16 to 21 present the estimation of the copula model with the MA(0) and MA(2) filter, but for individual hedge fund data. As the results indicate, there does not appear to be much differences between the results that are in the main text, and those that are provided here.

Moreover, to understand if the results are driven by dead or alive hedge funds, we re-estimate the copula model for each subsample. We report the results in Tables 27 to 32 for the case of dead funds, and in Tables 33 to 38 for the case of alive funds. Both groups present similar results. In particular, the correlation between the fund and the market is lower during bear periods than during bull periods, and we tend to reject tail dependence if we do not separate the states or if we consider only bull periods but we cannot reject Gaussianity during bear periods.

Table 39 presents the results of the state timing regressions when the equivalent state indicator is the NBER recession indicator. Our results confirm that market neutral hedge funds and equity hedge funds are superior state timers compared to the other hedge fund styles. Moreover, the proportion of funds that obtain abnormal returns and are superior state timers are quite similar to the those obtained with the Pagan and Sossounov (2003) indicator. Table 40 presents the results of estimating market, volatility and liquidity timing regressions separately for each of the individual hedge funds in the sample. As the results indicate, a larger proportion of market neutral hedge funds are return timers as opposed to volatility or liquidity timers. Meanwhile, there seems to be more volatility and liquidity timers from the other hedge fund styles than return timers. Finally, Tables 41 to 42 show that there are no substantial differences between alive and dead hedge funds.

Table 1: Copula Parameters. State: Pagan Filter: MA(0) Initial year: 1999

	Students-t Copula		Gaussian Copula	Tail dep.=0
	Correlation	Tail dependence	Correlation	p-value
<i>No States</i>				
Market neutral	0.122	0.161	0.084	0.000
Equity hedge	0.758	0.205	0.741	0.020
Equity non-hedge	0.856	0.404	0.840	0.010
Event driven	0.703	0.181	0.686	0.100
Fund of funds	0.616	0.136	0.590	0.050
<i>Bear</i>				
Market neutral	-0.281	0.003	-0.248	0.310
Equity hedge	0.760	0.000	0.730	0.830
Equity non-hedge	0.853	0.000	0.834	0.850
Event driven	0.631	0.000	0.590	0.740
Fund of funds	0.547	0.000	0.504	0.740
<i>Bull</i>				
Market neutral	0.226	0.152	0.217	0.000
Equity hedge	0.713	0.276	0.685	0.000
Equity non-hedge	0.830	0.386	0.808	0.000
Event driven	0.663	0.240	0.637	0.040
Fund of funds	0.578	0.219	0.530	0.000

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 2: Copula Parameters. State: Pagan Filter: MA(2) Initial year: 1999

	Students-t Copula		Gaussian Copula	Tail dep.=0
	Correlation	Tail dependence	Correlation	p-value
<i>No States</i>				
Market neutral	0.130	0.147	0.091	0.000
Equity hedge	0.769	0.294	0.746	0.000
Equity non-hedge	0.869	0.507	0.846	0.000
Event driven	0.745	0.255	0.726	0.010
Fund of funds	0.657	0.229	0.621	0.000
<i>Bear</i>				
Market neutral	-0.281	0.003	-0.248	0.290
Equity hedge	0.760	0.000	0.730	0.740
Equity non-hedge	0.853	0.000	0.834	0.730
Event driven	0.631	0.000	0.590	0.750
Fund of funds	0.547	0.000	0.504	0.740
<i>Bull</i>				
Market neutral	0.226	0.152	0.217	0.000
Equity hedge	0.713	0.276	0.685	0.020
Equity non-hedge	0.830	0.386	0.808	0.000
Event driven	0.663	0.240	0.637	0.050
Fund of funds	0.578	0.219	0.530	0.010

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 3: Copula Parameters. State: Pagan Filter: MA(0) Initial year: 1997

	Students-t Copula		Gaussian Copula	Tail dep.=0
	Correlation	Tail dependence	Correlation	p-value
<i>No States</i>				
Market neutral	0.217	0.181	0.187	0.000
Equity hedge	0.766	0.309	0.745	0.000
Equity non-hedge	0.855	0.453	0.837	0.000
Event driven	0.704	0.271	0.686	0.030
Fund of funds	0.624	0.226	0.593	0.010
<i>Bear</i>				
Market neutral	-0.281	0.003	-0.248	0.270
Equity hedge	0.760	0.000	0.730	0.810
Equity non-hedge	0.853	0.000	0.834	0.760
Event driven	0.631	0.000	0.590	0.830
Fund of funds	0.547	0.000	0.504	0.750
<i>Bull</i>				
Market neutral	0.325	0.169	0.305	0.000
Equity hedge	0.727	0.371	0.691	0.000
Equity non-hedge	0.829	0.454	0.803	0.000
Event driven	0.663	0.305	0.633	0.000
Fund of funds	0.586	0.277	0.536	0.000

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 4: Copula Parameters. State: Pagan Filter: MA(2) Initial year: 1997

	Students-t Copula		Gaussian Copula	Tail dep.=0
	Correlation	Tail dependence	Correlation	p-value
<i>No States</i>				
Market neutral	0.224	0.183	0.191	0.000
Equity hedge	0.783	0.376	0.754	0.000
Equity non-hedge	0.870	0.519	0.847	0.000
Event driven	0.756	0.280	0.739	0.010
Fund of funds	0.673	0.245	0.640	0.010
<i>Bear</i>				
Market neutral	-0.281	0.003	-0.248	0.250
Equity hedge	0.760	0.000	0.730	0.780
Equity non-hedge	0.853	0.000	0.834	0.840
Event driven	0.631	0.000	0.590	0.790
Fund of funds	0.547	0.000	0.504	0.750
<i>Bull</i>				
Market neutral	0.325	0.169	0.305	0.000
Equity hedge	0.727	0.371	0.691	0.000
Equity non-hedge	0.829	0.454	0.803	0.000
Event driven	0.663	0.305	0.633	0.000
Fund of funds	0.586	0.277	0.536	0.000

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 5: Copula Parameters. State: Pagan Filter: MA(4) Initial year: 1997

	Students-t Copula		Gaussian Copula	Tail dep.=0
	Correlation	Tail dependence	Correlation	p-value
<i>No States</i>				
Market neutral	0.226	0.188	0.195	0.000
Equity hedge	0.786	0.382	0.757	0.000
Equity non-hedge	0.872	0.515	0.852	0.000
Event driven	0.757	0.264	0.741	0.050
Fund of funds	0.681	0.305	0.640	0.000
<i>Bear</i>				
Market neutral	-0.281	0.003	-0.248	0.330
Equity hedge	0.760	0.000	0.730	0.790
Equity non-hedge	0.853	0.000	0.834	0.730
Event driven	0.631	0.000	0.590	0.740
Fund of funds	0.547	0.000	0.504	0.730
<i>Bull</i>				
Market neutral	0.325	0.169	0.305	0.000
Equity hedge	0.727	0.371	0.691	0.000
Equity non-hedge	0.829	0.454	0.803	0.000
Event driven	0.663	0.305	0.633	0.010
Fund of funds	0.586	0.277	0.536	0.000

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 6: Copula Parameters. State: NBER Filter: MA(0) Initial year: 1999

	Students-t Copula		Gaussian Copula	Tail dep.=0
	Correlation	Tail dependence	Correlation	p-value
<i>No States</i>				
Market neutral	0.122	0.161	0.084	0.000
Equity hedge	0.758	0.205	0.741	0.050
Equity non-hedge	0.856	0.404	0.840	0.000
Event driven	0.703	0.181	0.686	0.120
Fund of funds	0.616	0.136	0.590	0.060
<i>Bear</i>				
Market neutral	-0.423	0.009	-0.336	0.130
Equity hedge	0.836	0.000	0.799	0.820
Equity non-hedge	0.914	0.000	0.894	0.780
Event driven	0.737	0.000	0.683	0.720
Fund of funds	0.610	0.000	0.542	0.790
<i>Bull</i>				
Market neutral	0.238	0.144	0.212	0.000
Equity hedge	0.748	0.279	0.724	0.030
Equity non-hedge	0.844	0.401	0.826	0.000
Event driven	0.700	0.226	0.676	0.040
Fund of funds	0.634	0.180	0.602	0.000

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 7: Copula Parameters. State: NBER Filter: MA(2) Initial year: 1999

	Students-t Copula		Gaussian Copula	Tail dep.=0
	Correlation	Tail dependence	Correlation	p-value
<i>No States</i>				
Market neutral	0.130	0.147	0.091	0.000
Equity hedge	0.769	0.294	0.746	0.010
Equity non-hedge	0.869	0.507	0.846	0.000
Event driven	0.745	0.255	0.726	0.040
Fund of funds	0.657	0.229	0.621	0.000
<i>Bear</i>				
Market neutral	-0.423	0.009	-0.336	0.190
Equity hedge	0.836	0.000	0.799	0.840
Equity non-hedge	0.914	0.000	0.894	0.700
Event driven	0.737	0.000	0.683	0.720
Fund of funds	0.610	0.000	0.542	0.750
<i>Bull</i>				
Market neutral	0.238	0.144	0.212	0.000
Equity hedge	0.748	0.279	0.724	0.020
Equity non-hedge	0.844	0.401	0.826	0.000
Event driven	0.700	0.226	0.676	0.040
Fund of funds	0.634	0.180	0.602	0.040

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 8: Copula Parameters. State: NBER Filter: MA(4) Initial year: 1999

	Students-t Copula		Gaussian Copula	Tail dep.=0
	Correlation	Tail dependence	Correlation	p-value
<i>No States</i>				
Market neutral	0.130	0.173	0.095	0.000
Equity hedge	0.776	0.334	0.748	0.000
Equity non-hedge	0.873	0.524	0.852	0.000
Event driven	0.741	0.216	0.724	0.020
Fund of funds	0.669	0.293	0.625	0.000
<i>Bear</i>				
Market neutral	-0.423	0.009	-0.336	0.180
Equity hedge	0.836	0.000	0.799	0.660
Equity non-hedge	0.914	0.000	0.894	0.650
Event driven	0.737	0.000	0.683	0.750
Fund of funds	0.610	0.000	0.542	0.810
<i>Bull</i>				
Market neutral	0.238	0.144	0.212	0.000
Equity hedge	0.748	0.279	0.724	0.020
Equity non-hedge	0.844	0.401	0.826	0.000
Event driven	0.700	0.226	0.676	0.040
Fund of funds	0.634	0.180	0.602	0.060

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 9: Copula Parameters. State: NBER Filter: MA(0) Initial year: 1997

	Students-t Copula		Gaussian Copula	Tail dep.=0
	Correlation	Tail dependence	Correlation	p-value
<i>No States</i>				
Market neutral	0.217	0.181	0.187	0.000
Equity hedge	0.766	0.309	0.745	0.010
Equity non-hedge	0.855	0.453	0.837	0.000
Event driven	0.704	0.271	0.686	0.020
Fund of funds	0.624	0.226	0.593	0.000
<i>Bear</i>				
Market neutral	-0.423	0.009	-0.336	0.170
Equity hedge	0.836	0.000	0.799	0.770
Equity non-hedge	0.914	0.000	0.894	0.790
Event driven	0.737	0.000	0.683	0.800
Fund of funds	0.610	0.000	0.542	0.770
<i>Bull</i>				
Market neutral	0.332	0.148	0.313	0.000
Equity hedge	0.763	0.407	0.733	0.000
Equity non-hedge	0.845	0.474	0.824	0.000
Event driven	0.701	0.320	0.674	0.000
Fund of funds	0.641	0.279	0.603	0.000

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 10: Copula Parameters. State: NBER Filter: MA(2) Initial year: 1997

	Students-t Copula		Gaussian Copula	Tail dep.=0
	Correlation	Tail dependence	Correlation	p-value
<i>No States</i>				
Market neutral	0.224	0.183	0.191	0.000
Equity hedge	0.783	0.376	0.754	0.000
Equity non-hedge	0.870	0.519	0.847	0.000
Event driven	0.756	0.280	0.739	0.000
Fund of funds	0.673	0.245	0.640	0.000
<i>Bear</i>				
Market neutral	-0.423	0.009	-0.336	0.170
Equity hedge	0.836	0.000	0.799	0.830
Equity non-hedge	0.914	0.000	0.894	0.690
Event driven	0.737	0.000	0.683	0.760
Fund of funds	0.610	0.000	0.542	0.790
<i>Bull</i>				
Market neutral	0.332	0.148	0.313	0.000
Equity hedge	0.763	0.407	0.733	0.000
Equity non-hedge	0.845	0.474	0.824	0.000
Event driven	0.701	0.320	0.674	0.000
Fund of funds	0.641	0.279	0.603	0.000

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 11: Copula Parameters. State: NBER Filter: MA(4) Initial year: 1997

	Students-t Copula		Gaussian Copula	Tail dep.=0
	Correlation	Tail dependence	Correlation	p-value
<i>No States</i>				
Market neutral	0.226	0.188	0.195	0.000
Equity hedge	0.786	0.382	0.757	0.000
Equity non-hedge	0.872	0.515	0.852	0.000
Event driven	0.757	0.264	0.741	0.030
Fund of funds	0.681	0.305	0.640	0.000
<i>Bear</i>				
Market neutral	-0.423	0.009	-0.336	0.170
Equity hedge	0.836	0.000	0.799	0.720
Equity non-hedge	0.914	0.000	0.894	0.670
Event driven	0.737	0.000	0.683	0.740
Fund of funds	0.610	0.000	0.542	0.740
<i>Bull</i>				
Market neutral	0.332	0.148	0.313	0.030
Equity hedge	0.763	0.407	0.733	0.000
Equity non-hedge	0.845	0.474	0.824	0.000
Event driven	0.701	0.320	0.674	0.000
Fund of funds	0.641	0.279	0.603	0.000

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 12: State timing tests – NBER recession indicator

	α	γ	β_m	β_{smb}	β_{hml}	β_{umd}
<i>Market neutral hedge funds</i>						
Single factor model	0.002*** (0.001)	0.103*** (0.035)	0.065*** (0.019)			
FF 3 factor model	0.004*** (0.001)	0.102** (0.041)	0.062*** (0.018)	0.029** (0.014)	-0.008 (0.031)	
Carhart 4 factor model	0.002*** (0.000)	0.045* (0.027)	0.087*** (0.013)	0.020 (0.015)	0.017 (0.020)	0.002*** (0.000)
<i>Equity hedge</i>						
Single factor model	0.004*** (0.001)	0.091** (0.043)	0.345*** (0.028)			
FF 3 factor model	0.005*** (0.001)	0.081** (0.033)	0.321*** (0.024)	0.227*** (0.039)	-0.073 (0.049)	
Carhart 4 factor model	0.003*** (0.001)	0.045 (0.036)	0.336*** (0.022)	0.221*** (0.033)	-0.058 (0.038)	0.060** (0.025)
<i>Equity hedge</i>						
Single factor model	0.003* (0.001)	0.026 (0.077)	0.641*** (0.036)			
FF 3 factor model	0.004*** (0.001)	0.032 (0.066)	0.330*** (0.032)	0.615*** (0.029)	-0.035 (0.044)	
Carhart 4 factor model	0.002** (0.001)	0.019 (0.070)	0.621*** (0.029)	0.330*** (0.034)	-0.031 (0.042)	0.022 (0.022)
<i>Event driven</i>						
Single factor model	0.004*** (0.001)	-0.054 (0.058)	0.321*** (0.032)			
FF 3 factor model	0.005*** (0.001)	-0.080 (0.060)	0.317*** (0.026)	0.188*** (0.026)	0.059 (0.040)	
Carhart 4 factor model	0.003*** (0.001)	-0.090 (0.066)	0.312*** (0.027)	0.193*** (0.026)	0.051 (0.041)	-0.018 (0.021)
<i>Fund of funds</i>						
Single factor model	0.001 (0.001)	0.013 (0.090)	0.209*** (0.023)			
FF 3 factor model	0.003*** (0.001)	0.017 (0.092)	0.196*** (0.021)	0.132*** (0.028)	-0.038 (0.044)	
Carhart 4 factor model	0.001 (0.001)	0.062 (0.083)	0.215*** (0.016)	0.125*** (0.023)	-0.019 (0.035)	0.074*** (0.019)

Note: The table shows the abnormal return and timing abilities at the index level using the single factor, Fama French 3 factor, and the Carhart 4-factor model during the period January 1999 to December 2016. The state indicator used is the business cycle dating indicator published by the NBER. α is the abnormal return, γ is the state timing coefficient, β_m is the market return and $\beta_k, k = \{smb, hml, umd\}$ are the other market factors. *** - significance at 1% level, ** - significance at 5% level, * - significance at 10% level.

Table 13: Controlling for market, volatility and liquidity timing – NBER recession periods

	α	γ	β_M	δ	λ	ψ	β_{smb}	β_{hml}	β_{umd}
<i>Henriksson and Merton (1981) model</i>									
Market neutral hedge funds	0.003*** (0.001)	0.062** (0.031)	0.104*** (0.024)	-0.002 (0.002)	0.002 (0.002)	0.245 (0.218)	0.018 (0.016)	0.008 (0.026)	0.092*** (0.014)
Equity hedge	0.004** (0.002)	0.088* (0.046)	0.344*** (0.039)	-0.002 (0.003)	0.004* (0.002)	0.405 (0.246)	0.224*** (0.034)	-0.069* (0.040)	0.054** (0.026)
Equity non-hedge	0.001 (0.002)	0.088 (0.071)	0.574*** (0.037)	0.002 (0.003)	0.007*** (0.003)	0.499 (0.308)	0.321*** (0.032)	-0.055 (0.044)	0.013 (0.024)
Event driven	0.002 (0.001)	0.163** (0.079)	0.262*** (0.029)	0.003 (0.002)	0.008** (0.004)	0.558 (0.364)	0.185*** (0.026)	0.029 (0.046)	-0.027 (0.024)
Fund of funds	-0.000 (0.002)	0.010 (0.052)	0.156*** (0.032)	0.003 (0.002)	0.007** (0.003)	0.357 (0.246)	0.115*** (0.025)	-0.038 (0.037)	0.065*** (0.019)
<i>Treynor and Mazuy (1966) model</i>									
Market neutral hedge funds	0.001 (0.001)	0.067** (0.030)	0.071*** (0.015)	0.585*** (0.198)	0.005** (0.002)	0.211 (0.187)	0.019 (0.014)	0.006 (0.022)	0.095*** (0.014)
Equity hedge	0.003*** (0.001)	0.091* (0.049)	0.321*** (0.019)	0.440 (0.404)	0.006** (0.003)	0.380 (0.253)	0.225*** (0.034)	-0.070* (0.038)	0.056** (0.026)
Equity non-hedge	0.002** (0.001)	0.088 (0.072)	0.599*** (0.022)	0.109 (0.367)	0.007** (0.003)	0.497 (0.318)	0.325*** (0.032)	-0.053 (0.044)	0.014 (0.025)
Event driven	0.004*** (0.001)	0.159** (0.073)	0.296*** (0.022)	-0.501 (0.423)	0.005 (0.004)	0.588 (0.363)	0.185*** (0.024)	0.031 (0.049)	-0.029 (0.026)
Fund of funds	0.002*** (0.001)	0.006 (0.052)	0.197*** (0.020)	-0.319 (0.306)	0.005 (0.004)	0.380 (0.244)	0.117*** (0.024)	-0.035 (0.039)	0.064*** (0.020)

Note: The table shows the abnormal return and timing abilities at the index level using the Carhart 4-factor model controlling for other types of timing abilities during the period January 1999 to December 2016. The state indicator used is the business cycle dating indicator published by the NBER. α is the abnormal return, γ is the state timing coefficient, β_m is the coefficient corresponding to the market return, δ is the market timing coefficient, λ is the volatility timing coefficient, ψ is the liquidity timing coefficient, and $\beta_k, k = \{smb, hml, umd\}$ are the coefficients of the other pricing factors. *** - significance at 1% level, ** - significance at 5% level, * - significance at 10% level.

Table 14: Controlling for illiquid holdings – NBER recession indicator

	α	γ	β_m	$\beta_{m,t\text{ag}1}$	$\beta_{m,t\text{ag}2}$	$\gamma_{m,t\text{ag}1}$	$\gamma_{m,t\text{ag}2}$	β_{smb}	β_{hml}	β_{umd}
<i>Market neutral hedge funds</i>										
Fama French 3 factor model	0.002*** (0.001)	0.097*** (0.037)	0.061*** (0.018)	0.013 (0.013)	0.032** (0.013)	0.051 (0.044)	-0.055 (0.036)	0.031** (0.013)	-0.010 (0.030)	
Carhart 4 factor model	0.001** (0.001)	0.048* (0.027)	0.088*** (0.014)	0.027** (0.014)	0.010 (0.010)	-0.016 (0.031)	-0.008 (0.027)	0.017 (0.015)	0.016 (0.021)	0.094*** (0.013)
<i>Equity hedge</i>										
Fama French 3 factor model	0.003*** (0.001)	0.086*** (0.031)	0.323*** (0.023)	0.084*** (0.022)	0.041** (0.016)	0.055 (0.040)	-0.116*** (0.025)	0.224*** (0.036)	-0.086* (0.048)	
Carhart 4 factor model	0.002*** (0.001)	0.057 (0.035)	0.339*** (0.022)	0.092*** (0.023)	0.028* (0.015)	0.014 (0.056)	-0.088* (0.046)	0.216*** (0.032)	-0.070* (0.040)	0.057** (0.026)
<i>Equity non-hedge</i>										
Fama French 3 factor model	0.002* (0.001)	0.056 (0.059)	0.623*** (0.029)	0.113*** (0.022)	0.021 (0.016)	0.155*** (0.052)	-0.191*** (0.041)	0.319*** (0.029)	-0.056 (0.044)	
Carhart 4 factor model	0.001 (0.001)	0.048 (0.065)	0.627*** (0.029)	0.116*** (0.022)	0.017 (0.016)	0.143** (0.057)	-0.183*** (0.047)	0.316*** (0.030)	-0.051 (0.045)	0.017 (0.025)
<i>Event driven</i>										
Fama French 3 factor model	0.002* (0.001)	0.103* (0.058)	0.322*** (0.027)	0.118*** (0.025)	0.035** (0.016)	0.060 (0.061)	-0.114** (0.046)	0.178*** (0.024)	0.036 (0.041)	
Carhart 4 factor model	0.002* (0.001)	0.116* (0.063)	0.315*** (0.028)	0.115*** (0.024)	0.041*** (0.015)	0.079 (0.054)	-0.127*** (0.038)	0.182*** (0.024)	0.029 (0.045)	-0.026 (0.023)
<i>Fund of funds</i>										
Fama French 3 factor model	0.001 (0.001)	0.006 (0.080)	0.197*** (0.021)	0.079*** (0.019)	0.055*** (0.016)	0.093** (0.038)	-0.108*** (0.026)	0.126*** (0.026)	-0.057 (0.045)	
Carhart 4 factor model	0.000 (0.001)	0.040 (0.077)	0.216*** (0.018)	0.089*** (0.020)	0.039*** (0.014)	0.045 (0.046)	-0.075** (0.037)	0.116*** (0.022)	-0.038 (0.039)	0.067*** (0.019)

Note: The table shows the abnormal return and state timing abilities at the index level using the Fama-French 2 factor and the Carhart 4-factor models during the period January 1999 to December 2016, after controlling for illiquid holdings. The state indicator used is the business cycle dating indicator published by the NBER. α is the abnormal return, γ is the state timing coefficient, $\beta'_{m,t\text{ag}s}$ are the lagged market return coefficients, $\beta'_{m,t\text{ag}s}$ are the lagged state timing coefficients and $\beta_k, k = \{smb, hml, umd\}$ are the coefficients of the other pricing factors. *** - significance at 1% level, ** - significance at 5% level, * - significance at 10% level.

Table 15: Other timing models – index data

	α	δ	λ	ψ	β_M	β_{smb}	β_{hml}	β_{umd}
<i>Market neutral hedge funds</i>								
Return timing	0.001* (0.001)	0.370*** (0.122)			0.083*** (0.013)	0.022 (0.015)	0.017 (0.019)	0.101*** (0.012)
Volatility timing	0.002*** (0.000)		-0.000 (0.001)		0.077*** (0.014)	0.017 (0.016)	0.014 (0.021)	0.099*** (0.013)
Liquidity timing	0.002*** (0.001)			0.181 (0.132)	0.081*** (0.014)	0.014 (0.015)	0.007 (0.023)	0.097*** (0.014)
<i>Equity hedge</i>								
Return timing	0.003*** (0.001)	0.196 (0.271)			0.329*** (0.023)	0.221*** (0.034)	-0.060 (0.037)	0.065*** (0.024)
Volatility timing	0.003*** (0.001)		0.001 (0.002)		0.318*** (0.020)	0.218*** (0.032)	-0.064* (0.038)	0.064*** (0.024)
Liquidity timing	0.003*** (0.001)			0.261 (0.178)	0.336*** (0.023)	0.223*** (0.033)	-0.065 (0.041)	0.062** (0.024)
<i>Equity non-hedge</i>								
Return timing	0.002*** (0.001)	-0.189 (0.302)			0.613*** (0.028)	0.327*** (0.033)	-0.035 (0.045)	0.023 (0.019)
Volatility timing	0.003*** (0.001)		0.003 (0.002)		0.595*** (0.022)	-0.039 (0.045)	0.024 (0.019)	0.003*** (0.001)
Liquidity timing	0.002*** (0.001)			0.207 (0.283)	0.624*** (0.029)	0.331*** (0.034)	-0.038 (0.045)	0.023 (0.019)
<i>Event driven</i>								
Return timing	0.004*** (0.001)	-0.438 (0.460)			0.283*** (0.024)	0.182*** (0.022)	0.039 (0.047)	-0.012 (0.019)
Volatility timing	0.004*** (0.001)		0.001 (0.003)		0.280*** (0.018)	0.186*** (0.024)	0.040 (0.045)	-0.010 (0.018)
Liquidity timing	0.003*** (0.001)			0.341 (0.220)	0.300*** (0.030)	0.190*** (0.025)	0.039 (0.048)	-0.011 (0.019)
<i>Fund of funds</i>								
Return timing	0.002*** (0.001)	-0.622** (0.310)			0.219*** (0.023)	0.120*** (0.022)	-0.019 (0.034)	0.065*** (0.017)
Volatility timing	0.001** (0.001)		0.005 (0.003)		0.194*** (0.019)	0.122*** (0.022)	-0.024 (0.036)	0.069*** (0.016)
Liquidity timing	0.001 (0.001)			-0.019 (0.334)	0.230*** (0.023)	0.131*** (0.022)	-0.011 (0.031)	0.069*** (0.016)

Note: The table shows the abnormal return and return timing, volatility timing, and liquidity timing abilities at the index level using the Carhart 4-factor models during the period January 1999 to December 2016. α is the abnormal return, δ is the market timing coefficient, λ is the volatility timing coefficient, ψ is the liquidity timing coefficient, β_m is the coefficient corresponding to the market return, and $\beta_k, k = \{smb, hml, umd\}$ are the coefficients of the other pricing factors. *** - significance at 1% level, ** - significance at 5% level, * - significance at 10% level.

Table 16: Copula parameters for individual funds. State: NBER Filter: MA(0) Initial year: 1997

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	-0.006	0.192	0.069	0.059	0.081
Equity hedge	0.372	0.280	0.139	0.149	0.101
Equity non-hedge	0.545	0.341	0.258	0.180	0.146
Event driven	0.454	0.193	0.201	0.137	0.152
Fund of funds	0.442	0.188	0.150	0.126	0.123
Total	0.464	0.259	0.171	0.149	0.101
<i>Bear</i>					
Market neutral	-0.065	0.408	0.077	0.116	0.014
Equity hedge	0.429	0.374	0.157	0.208	0.015
Equity non-hedge	0.607	0.415	0.206	0.263	0.016
Event driven	0.500	0.311	0.251	0.239	0.023
Fund of funds	0.429	0.266	0.081	0.140	0.008
Total	0.505	0.344	0.127	0.197	0.015
<i>Bull</i>					
Market neutral	0.012	0.188	0.063	0.050	0.090
Equity hedge	0.360	0.274	0.141	0.145	0.096
Equity non-hedge	0.529	0.334	0.236	0.178	0.133
Event driven	0.440	0.191	0.178	0.135	0.121
Fund of funds	0.446	0.188	0.150	0.135	0.112
Total	0.467	0.255	0.165	0.150	0.096

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 17: Copula parameters for individual funds. State: NBER Filter: MA(2) Initial year: 1997

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	-0.004	0.186	0.047	0.049	0.057
Equity hedge	0.370	0.277	0.132	0.139	0.092
Equity non-hedge	0.542	0.336	0.241	0.175	0.150
Event driven	0.460	0.196	0.192	0.134	0.141
Fund of funds	0.454	0.193	0.162	0.130	0.132
Total	0.483	0.259	0.171	0.147	0.092
<i>Bear</i>					
Market neutral	-0.065	0.408	0.077	0.116	0.014
Equity hedge	0.429	0.374	0.157	0.208	0.018
Equity non-hedge	0.607	0.415	0.206	0.263	0.015
Event driven	0.500	0.311	0.251	0.239	0.023
Fund of funds	0.429	0.266	0.081	0.140	0.011
Total	0.505	0.344	0.127	0.197	0.018
<i>Bull</i>					
Market neutral	0.012	0.188	0.063	0.050	0.090
Equity hedge	0.360	0.274	0.141	0.145	0.095
Equity non-hedge	0.529	0.334	0.236	0.178	0.133
Event driven	0.440	0.191	0.178	0.135	0.125
Fund of funds	0.446	0.188	0.150	0.135	0.112
Total	0.467	0.255	0.165	0.150	0.095

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 18: Copula parameters for individual funds. State: NBER Filter: MA(4) Initial year: 1997

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	0.008	0.188	0.051	0.047	0.067
Equity hedge	0.371	0.277	0.128	0.142	0.090
Equity non-hedge	0.545	0.336	0.241	0.173	0.144
Event driven	0.459	0.193	0.194	0.137	0.148
Fund of funds	0.460	0.191	0.165	0.130	0.128
Total	0.486	0.258	0.173	0.147	0.090
<i>Bear</i>					
Market neutral	-0.065	0.408	0.077	0.116	0.014
Equity hedge	0.429	0.374	0.157	0.208	0.017
Equity non-hedge	0.607	0.415	0.206	0.263	0.016
Event driven	0.500	0.311	0.251	0.239	0.023
Fund of funds	0.429	0.266	0.081	0.140	0.009
Total	0.505	0.344	0.127	0.197	0.017
<i>Bull</i>					
Market neutral	0.012	0.188	0.063	0.050	0.090
Equity hedge	0.360	0.274	0.141	0.145	0.095
Equity non-hedge	0.529	0.334	0.236	0.178	0.134
Event driven	0.440	0.191	0.178	0.135	0.125
Fund of funds	0.446	0.188	0.150	0.135	0.108
Total	0.467	0.255	0.165	0.150	0.095

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 19: Copula parameters for individual funds. State: State Pagan Filter: MA(0) Initial year: 1997

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	0.086	0.202	0.081	0.099	0.219
Equity hedge	0.350	0.279	0.141	0.145	0.306
Equity non-hedge	0.575	0.297	0.253	0.193	0.354
Event driven	0.456	0.192	0.178	0.136	0.375
Fund of funds	0.477	0.199	0.165	0.144	0.314
Total	0.497	0.257	0.176	0.159	0.306
<i>Bear</i>					
Market neutral	0.026	0.306	0.099	0.120	0.067
Equity hedge	0.286	0.377	0.121	0.170	0.059
Equity non-hedge	0.533	0.360	0.202	0.231	0.072
Event driven	0.383	0.291	0.189	0.180	0.133
Fund of funds	0.336	0.273	0.162	0.167	0.067
Total	0.393	0.332	0.162	0.184	0.059
<i>Bull</i>					
Market neutral	0.089	0.195	0.071	0.084	0.162
Equity hedge	0.334	0.261	0.137	0.149	0.237
Equity non-hedge	0.541	0.289	0.217	0.187	0.289
Event driven	0.412	0.190	0.136	0.142	0.246
Fund of funds	0.431	0.192	0.151	0.140	0.260
Total	0.450	0.245	0.159	0.155	0.237

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 20: Copula parameters for individual funds. State: State Pagan Filter: MA(2) Initial year: 1997

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	0.070	0.206	0.065	0.100	0.162
Equity hedge	0.346	0.275	0.135	0.140	0.276
Equity non-hedge	0.566	0.294	0.235	0.188	0.328
Event driven	0.442	0.210	0.171	0.140	0.215
Fund of funds	0.476	0.193	0.165	0.145	0.185
Total	0.495	0.253	0.170	0.157	0.276
<i>Bear</i>					
Market neutral	0.016	0.356	0.094	0.141	0.086
Equity hedge	0.286	0.377	0.121	0.170	0.061
Equity non-hedge	0.533	0.360	0.202	0.231	0.072
Event driven	0.465	0.283	0.122	0.163	0.051
Fund of funds	0.418	0.285	0.075	0.136	0.028
Total	0.464	0.338	0.112	0.174	0.061
<i>Bull</i>					
Market neutral	0.123	0.211	0.041	0.083	0.043
Equity hedge	0.334	0.261	0.137	0.149	0.236
Equity non-hedge	0.541	0.289	0.217	0.187	0.302
Event driven	0.485	0.207	0.127	0.162	0.129
Fund of funds	0.543	0.170	0.108	0.142	0.092
Total	0.537	0.242	0.134	0.159	0.236

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 21: Copula parameters for individual funds. State: State Pagan Filter: MA(4) Initial year: 1997

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	0.089	0.196	0.064	0.092	0.190
Equity hedge	0.346	0.274	0.131	0.135	0.278
Equity non-hedge	0.564	0.292	0.232	0.182	0.323
Event driven	0.446	0.189	0.166	0.141	0.340
Fund of funds	0.482	0.198	0.171	0.146	0.321
Total	0.498	0.253	0.172	0.155	0.278
<i>Bear</i>					
Market neutral	0.026	0.306	0.099	0.120	0.062
Equity hedge	0.286	0.377	0.121	0.170	0.061
Equity non-hedge	0.533	0.360	0.202	0.231	0.069
Event driven	0.383	0.291	0.189	0.180	0.121
Fund of funds	0.336	0.273	0.162	0.167	0.064
Total	0.393	0.332	0.162	0.184	0.061
<i>Bull</i>					
Market neutral	0.089	0.195	0.071	0.084	0.148
Equity hedge	0.334	0.261	0.137	0.149	0.233
Equity non-hedge	0.541	0.289	0.217	0.187	0.292
Event driven	0.412	0.190	0.136	0.142	0.238
Fund of funds	0.431	0.192	0.151	0.140	0.253
Total	0.450	0.245	0.159	0.155	0.233

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 22: Copula parameters for individual funds. State: NBER Filter: MA(0) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	-0.027	0.209	0.061	0.060	0.081
Equity hedge	0.374	0.281	0.133	0.145	0.099
Equity non-hedge	0.547	0.348	0.250	0.184	0.143
Event driven	0.453	0.200	0.190	0.143	0.129
Fund of funds	0.445	0.190	0.131	0.124	0.099
Total	0.463	0.264	0.157	0.150	0.099
<i>Bear</i>					
Market neutral	-0.065	0.408	0.077	0.116	0.014
Equity hedge	0.429	0.374	0.157	0.208	0.015
Equity non-hedge	0.607	0.415	0.206	0.263	0.015
Event driven	0.500	0.311	0.251	0.239	0.020
Fund of funds	0.429	0.266	0.081	0.140	0.010
Total	0.505	0.344	0.127	0.197	0.015
<i>Bull</i>					
Market neutral	-0.012	0.211	0.054	0.050	0.081
Equity hedge	0.362	0.273	0.131	0.141	0.095
Equity non-hedge	0.532	0.342	0.222	0.182	0.116
Event driven	0.438	0.199	0.158	0.144	0.098
Fund of funds	0.450	0.189	0.122	0.128	0.082
Total	0.471	0.259	0.144	0.148	0.095

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 23: Copula parameters for individual funds. State: NBER Filter: MA(2) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	-0.027	0.204	0.041	0.048	0.062
Equity hedge	0.370	0.275	0.126	0.137	0.092
Equity non-hedge	0.545	0.342	0.235	0.178	0.143
Event driven	0.455	0.202	0.183	0.138	0.133
Fund of funds	0.455	0.194	0.152	0.130	0.125
Total	0.481	0.262	0.163	0.147	0.092
<i>Bear</i>					
Market neutral	-0.065	0.408	0.077	0.116	0.014
Equity hedge	0.429	0.374	0.157	0.208	0.018
Equity non-hedge	0.607	0.415	0.206	0.263	0.016
Event driven	0.500	0.311	0.251	0.239	0.031
Fund of funds	0.429	0.266	0.081	0.140	0.010
Total	0.505	0.344	0.127	0.197	0.018
<i>Bull</i>					
Market neutral	-0.012	0.211	0.054	0.050	0.071
Equity hedge	0.362	0.273	0.131	0.141	0.090
Equity non-hedge	0.532	0.342	0.222	0.182	0.124
Event driven	0.438	0.199	0.158	0.144	0.102
Fund of funds	0.450	0.189	0.122	0.128	0.082
Total	0.471	0.259	0.144	0.148	0.090

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 24: Copula parameters for individual funds. State: NBER Filter: MA(4) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	-0.011	0.205	0.044	0.048	0.062
Equity hedge	0.371	0.275	0.122	0.139	0.083
Equity non-hedge	0.546	0.342	0.234	0.176	0.137
Event driven	0.453	0.197	0.184	0.143	0.129
Fund of funds	0.460	0.191	0.155	0.131	0.121
Total	0.484	0.261	0.164	0.147	0.083
<i>Bear</i>					
Market neutral	-0.065	0.408	0.077	0.116	0.014
Equity hedge	0.429	0.374	0.157	0.208	0.018
Equity non-hedge	0.607	0.415	0.206	0.263	0.016
Event driven	0.500	0.311	0.251	0.239	0.020
Fund of funds	0.429	0.266	0.081	0.140	0.011
Total	0.505	0.344	0.127	0.197	0.018
<i>Bull</i>					
Market neutral	-0.012	0.211	0.054	0.050	0.076
Equity hedge	0.362	0.273	0.131	0.141	0.089
Equity non-hedge	0.532	0.342	0.222	0.182	0.121
Event driven	0.438	0.199	0.158	0.144	0.098
Fund of funds	0.450	0.189	0.122	0.128	0.082
Total	0.471	0.259	0.144	0.148	0.089

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 25: Copula parameters for individual funds. State: State Pagan Filter: MA(0) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	0.076	0.212	0.080	0.105	0.210
Equity hedge	0.349	0.281	0.137	0.146	0.283
Equity non-hedge	0.575	0.300	0.249	0.195	0.336
Event driven	0.452	0.200	0.173	0.134	0.336
Fund of funds	0.479	0.200	0.155	0.144	0.277
Total	0.497	0.259	0.169	0.161	0.283
<i>Bear</i>					
Market neutral	0.026	0.306	0.099	0.120	0.067
Equity hedge	0.286	0.377	0.121	0.170	0.059
Equity non-hedge	0.533	0.360	0.202	0.231	0.072
Event driven	0.383	0.291	0.189	0.180	0.105
Fund of funds	0.336	0.273	0.162	0.167	0.069
Total	0.393	0.332	0.162	0.184	0.059
<i>Bull</i>					
Market neutral	0.081	0.206	0.079	0.104	0.138
Equity hedge	0.334	0.260	0.134	0.149	0.218
Equity non-hedge	0.541	0.292	0.212	0.187	0.279
Event driven	0.402	0.206	0.129	0.145	0.223
Fund of funds	0.433	0.193	0.141	0.138	0.229
Total	0.450	0.247	0.152	0.154	0.218

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 26: Copula parameters for individual funds. State: State Pagan Filter: MA(2) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	0.076	0.207	0.067	0.102	0.181
Equity hedge	0.344	0.276	0.133	0.139	0.267
Equity non-hedge	0.566	0.296	0.232	0.190	0.311
Event driven	0.446	0.202	0.170	0.140	0.320
Fund of funds	0.478	0.202	0.167	0.147	0.314
Total	0.496	0.258	0.170	0.158	0.267
<i>Bear</i>					
Market neutral	0.026	0.306	0.099	0.120	0.052
Equity hedge	0.286	0.377	0.121	0.170	0.060
Equity non-hedge	0.533	0.360	0.202	0.231	0.074
Event driven	0.383	0.291	0.189	0.180	0.125
Fund of funds	0.336	0.273	0.162	0.167	0.070
Total	0.393	0.332	0.162	0.184	0.060
<i>Bull</i>					
Market neutral	0.081	0.206	0.079	0.104	0.138
Equity hedge	0.334	0.260	0.134	0.149	0.212
Equity non-hedge	0.541	0.292	0.212	0.187	0.267
Event driven	0.402	0.206	0.129	0.145	0.207
Fund of funds	0.433	0.193	0.141	0.138	0.229
Total	0.450	0.247	0.152	0.154	0.212

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 27: Copula parameters for **dead** funds. State: NBER Filter: MA(0) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	-0.054	0.230	0.049	0.053	0.061
Equity hedge	0.354	0.294	0.123	0.152	0.072
Equity non-hedge	0.501	0.414	0.238	0.187	0.132
Event driven	0.453	0.235	0.210	0.147	0.126
Fund of funds	0.425	0.190	0.121	0.122	0.096
Total	0.446	0.277	0.144	0.148	0.072
<i>Bear</i>					
Market neutral	-0.084	0.436	0.054	0.099	0.008
Equity hedge	0.422	0.372	0.155	0.207	0.016
Equity non-hedge	0.544	0.484	0.195	0.254	0.014
Event driven	0.496	0.314	0.269	0.220	0.006
Fund of funds	0.418	0.265	0.087	0.146	0.012
Total	0.466	0.351	0.124	0.190	0.016
<i>Bull</i>					
Market neutral	-0.044	0.229	0.044	0.050	0.076
Equity hedge	0.337	0.287	0.127	0.146	0.080
Equity non-hedge	0.486	0.406	0.213	0.184	0.120
Event driven	0.434	0.238	0.187	0.153	0.098
Fund of funds	0.427	0.191	0.112	0.127	0.073
Total	0.442	0.273	0.133	0.147	0.080

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 28: Copula parameters for **dead** funds. State: NBER Filter: MA(2) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	-0.052	0.228	0.027	0.036	0.045
Equity hedge	0.348	0.286	0.117	0.140	0.076
Equity non-hedge	0.497	0.407	0.223	0.179	0.140
Event driven	0.446	0.238	0.193	0.136	0.126
Fund of funds	0.432	0.194	0.143	0.129	0.117
Total	0.452	0.276	0.152	0.145	0.076
<i>Bear</i>					
Market neutral	-0.084	0.436	0.054	0.099	0.008
Equity hedge	0.422	0.372	0.155	0.207	0.016
Equity non-hedge	0.544	0.484	0.195	0.254	0.015
Event driven	0.496	0.314	0.269	0.220	0.011
Fund of funds	0.418	0.265	0.087	0.146	0.011
Total	0.466	0.351	0.124	0.190	0.016
<i>Bull</i>					
Market neutral	-0.044	0.229	0.044	0.050	0.061
Equity hedge	0.337	0.287	0.127	0.146	0.080
Equity non-hedge	0.486	0.406	0.213	0.184	0.122
Event driven	0.434	0.238	0.187	0.153	0.098
Fund of funds	0.427	0.191	0.112	0.127	0.069
Total	0.442	0.273	0.133	0.147	0.080

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 29: Copula parameters for **dead** funds. State: NBER Filter: MA(4) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	0.061	0.142	0.042	0.053	0.141
Equity hedge	0.370	0.258	0.133	0.130	0.281
Equity non-hedge	0.628	0.180	0.247	0.177	0.305
Event driven	0.462	0.160	0.181	0.145	0.305
Fund of funds	0.552	0.170	0.195	0.141	0.399
Total	0.560	0.225	0.190	0.154	0.281
<i>Bear</i>					
Market neutral	0.014	0.221	0.115	0.100	0.077
Equity hedge	0.251	0.370	0.151	0.168	0.082
Equity non-hedge	0.595	0.257	0.215	0.231	0.053
Event driven	0.404	0.204	0.228	0.189	0.134
Fund of funds	0.361	0.225	0.211	0.165	0.088
Total	0.420	0.298	0.198	0.185	0.082
<i>Bull</i>					
Market neutral	0.057	0.140	0.047	0.060	0.090
Equity hedge	0.367	0.238	0.101	0.130	0.161
Equity non-hedge	0.601	0.190	0.216	0.184	0.250
Event driven	0.421	0.173	0.120	0.133	0.195
Fund of funds	0.507	0.160	0.146	0.123	0.263
Total	0.515	0.214	0.150	0.147	0.161

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 30: Copula parameters for **dead** funds. State: State Pagan Filter: MA(0) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	0.083	0.234	0.088	0.115	0.242
Equity hedge	0.340	0.287	0.139	0.150	0.276
Equity non-hedge	0.542	0.343	0.239	0.196	0.339
Event driven	0.440	0.215	0.166	0.135	0.310
Fund of funds	0.455	0.206	0.142	0.145	0.237
Total	0.466	0.269	0.159	0.161	0.276
<i>Bear</i>					
Market neutral	0.030	0.335	0.092	0.127	0.068
Equity hedge	0.301	0.379	0.108	0.169	0.045
Equity non-hedge	0.501	0.400	0.196	0.231	0.082
Event driven	0.374	0.323	0.171	0.174	0.092
Fund of funds	0.327	0.288	0.144	0.164	0.057
Total	0.384	0.345	0.147	0.181	0.045
<i>Bull</i>					
Market neutral	0.090	0.226	0.091	0.114	0.167
Equity hedge	0.320	0.267	0.148	0.155	0.242
Equity non-hedge	0.509	0.329	0.210	0.188	0.299
Event driven	0.394	0.219	0.133	0.150	0.218
Fund of funds	0.405	0.197	0.139	0.143	0.219
Total	0.418	0.255	0.152	0.157	0.242

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 31: Copula parameters for **dead** funds. State: State Pagan Filter: MA(2) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	0.087	0.228	0.076	0.113	0.205
Equity hedge	0.335	0.280	0.135	0.142	0.262
Equity non-hedge	0.532	0.337	0.225	0.191	0.343
Event driven	0.434	0.216	0.159	0.136	0.310
Fund of funds	0.453	0.206	0.160	0.150	0.281
Total	0.465	0.265	0.165	0.159	0.262
<i>Bear</i>					
Market neutral	0.030	0.335	0.092	0.127	0.061
Equity hedge	0.301	0.379	0.108	0.169	0.052
Equity non-hedge	0.501	0.400	0.196	0.231	0.073
Event driven	0.374	0.323	0.171	0.174	0.109
Fund of funds	0.327	0.288	0.144	0.164	0.066
Total	0.384	0.345	0.147	0.181	0.052
<i>Bull</i>					
Market neutral	0.090	0.226	0.091	0.114	0.159
Equity hedge	0.320	0.267	0.148	0.155	0.236
Equity non-hedge	0.509	0.329	0.210	0.188	0.284
Event driven	0.394	0.219	0.133	0.150	0.224
Fund of funds	0.405	0.197	0.139	0.143	0.212
Total	0.418	0.255	0.152	0.157	0.236

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 32: Copula parameters for **dead** funds. State: State Pagan Filter: MA(4) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	0.083	0.222	0.073	0.107	0.197
Equity hedge	0.331	0.280	0.128	0.141	0.255
Equity non-hedge	0.529	0.334	0.217	0.186	0.318
Event driven	0.430	0.207	0.146	0.139	0.310
Fund of funds	0.456	0.204	0.154	0.147	0.261
Total	0.469	0.264	0.158	0.156	0.255
<i>Bear</i>					
Market neutral	0.030	0.335	0.092	0.127	0.091
Equity hedge	0.301	0.379	0.108	0.169	0.049
Equity non-hedge	0.501	0.400	0.196	0.231	0.091
Event driven	0.374	0.323	0.171	0.174	0.132
Fund of funds	0.327	0.288	0.144	0.164	0.063
Total	0.384	0.345	0.147	0.181	0.049
<i>Bull</i>					
Market neutral	0.090	0.226	0.091	0.114	0.174
Equity hedge	0.320	0.267	0.148	0.155	0.239
Equity non-hedge	0.509	0.329	0.210	0.188	0.277
Event driven	0.394	0.219	0.133	0.150	0.218
Fund of funds	0.405	0.197	0.139	0.143	0.207
Total	0.418	0.255	0.152	0.157	0.239

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 33: Copula parameters for **alive** funds. State: NBER Filter: MA(0) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	0.042	0.127	0.091	0.068	0.077
Equity hedge	0.414	0.250	0.153	0.130	0.125
Equity non-hedge	0.620	0.181	0.270	0.178	0.149
Event driven	0.453	0.137	0.161	0.135	0.146
Fund of funds	0.508	0.173	0.164	0.124	0.129
Total	0.529	0.215	0.189	0.150	0.125
<i>Bear</i>					
Market neutral	-0.012	0.347	0.136	0.142	0.026
Equity hedge	0.443	0.381	0.160	0.211	0.019
Equity non-hedge	0.706	0.241	0.223	0.277	0.016
Event driven	0.506	0.313	0.222	0.269	0.024
Fund of funds	0.462	0.267	0.059	0.118	0.001
Total	0.554	0.321	0.135	0.213	0.019
<i>Bull</i>					
Market neutral	0.071	0.128	0.079	0.046	0.077
Equity hedge	0.412	0.237	0.140	0.133	0.112
Equity non-hedge	0.604	0.182	0.236	0.178	0.122
Event driven	0.445	0.123	0.116	0.122	0.085
Fund of funds	0.526	0.165	0.157	0.126	0.112
Total	0.531	0.206	0.170	0.148	0.112

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 34: Copula parameters for **alive** funds. State: NBER Filter: MA(2) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	0.038	0.109	0.076	0.058	0.090
Equity hedge	0.415	0.246	0.144	0.130	0.128
Equity non-hedge	0.620	0.176	0.253	0.175	0.138
Event driven	0.467	0.135	0.167	0.142	0.159
Fund of funds	0.528	0.174	0.180	0.132	0.139
Total	0.552	0.214	0.189	0.150	0.128
<i>Bear</i>					
Market neutral	-0.012	0.347	0.136	0.142	0.026
Equity hedge	0.443	0.381	0.160	0.211	0.030
Equity non-hedge	0.706	0.241	0.223	0.277	0.016
Event driven	0.506	0.313	0.222	0.269	0.049
Fund of funds	0.462	0.267	0.059	0.118	0.005
Total	0.554	0.321	0.135	0.213	0.030
<i>Bull</i>					
Market neutral	0.071	0.128	0.079	0.046	0.077
Equity hedge	0.412	0.237	0.140	0.133	0.117
Equity non-hedge	0.604	0.182	0.236	0.178	0.124
Event driven	0.445	0.123	0.116	0.122	0.110
Fund of funds	0.526	0.165	0.157	0.126	0.119
Total	0.531	0.206	0.170	0.148	0.117

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 35: Copula parameters for **alive** funds. State: NBER Filter: MA(4) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	0.056	0.119	0.071	0.051	0.090
Equity hedge	0.420	0.243	0.149	0.136	0.120
Equity non-hedge	0.622	0.175	0.255	0.169	0.147
Event driven	0.466	0.127	0.161	0.154	0.122
Fund of funds	0.534	0.172	0.191	0.133	0.144
Total	0.551	0.211	0.195	0.149	0.120
<i>Bear</i>					
Market neutral	-0.012	0.347	0.136	0.142	0.026
Equity hedge	0.443	0.381	0.160	0.211	0.019
Equity non-hedge	0.706	0.241	0.223	0.277	0.018
Event driven	0.506	0.313	0.222	0.269	0.049
Fund of funds	0.462	0.267	0.059	0.118	0.005
Total	0.554	0.321	0.135	0.213	0.019
<i>Bull</i>					
Market neutral	0.071	0.128	0.079	0.046	0.077
Equity hedge	0.412	0.237	0.140	0.133	0.104
Equity non-hedge	0.604	0.182	0.236	0.178	0.124
Event driven	0.445	0.123	0.116	0.122	0.098
Fund of funds	0.526	0.165	0.157	0.126	0.112
Total	0.531	0.206	0.170	0.148	0.104

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 36: Copula parameters for **alive** funds. State: State Pagan Filter: MA(0) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	0.060	0.141	0.060	0.068	0.154
Equity hedge	0.369	0.266	0.133	0.136	0.297
Equity non-hedge	0.637	0.181	0.266	0.194	0.317
Event driven	0.478	0.160	0.188	0.133	0.390
Fund of funds	0.544	0.164	0.192	0.134	0.404
Total	0.560	0.225	0.194	0.158	0.297
<i>Bear</i>					
Market neutral	0.014	0.221	0.115	0.100	0.064
Equity hedge	0.251	0.370	0.151	0.168	0.079
Equity non-hedge	0.595	0.257	0.215	0.231	0.060
Event driven	0.404	0.204	0.228	0.189	0.122
Fund of funds	0.361	0.225	0.211	0.165	0.089
Total	0.420	0.298	0.198	0.185	0.079
<i>Bull</i>					
Market neutral	0.057	0.140	0.047	0.060	0.115
Equity hedge	0.367	0.238	0.101	0.130	0.177
Equity non-hedge	0.601	0.190	0.216	0.184	0.257
Event driven	0.421	0.173	0.120	0.133	0.171
Fund of funds	0.507	0.160	0.146	0.123	0.276
Total	0.515	0.214	0.150	0.147	0.177

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 37: Copula parameters for **alive** funds. State: State Pagan Filter: MA(2) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	0.049	0.137	0.045	0.057	0.154
Equity hedge	0.365	0.264	0.127	0.132	0.281
Equity non-hedge	0.631	0.181	0.245	0.188	0.307
Event driven	0.473	0.167	0.194	0.147	0.402
Fund of funds	0.545	0.173	0.185	0.137	0.388
Total	0.559	0.228	0.185	0.155	0.281
<i>Bear</i>					
Market neutral	0.014	0.221	0.115	0.100	0.051
Equity hedge	0.251	0.370	0.151	0.168	0.090
Equity non-hedge	0.595	0.257	0.215	0.231	0.062
Event driven	0.404	0.204	0.228	0.189	0.110
Fund of funds	0.361	0.225	0.211	0.165	0.085
Total	0.420	0.298	0.198	0.185	0.090
<i>Bull</i>					
Market neutral	0.057	0.140	0.047	0.060	0.115
Equity hedge	0.367	0.238	0.101	0.130	0.174
Equity non-hedge	0.601	0.190	0.216	0.184	0.243
Event driven	0.421	0.173	0.120	0.133	0.171
Fund of funds	0.507	0.160	0.146	0.123	0.275
Total	0.515	0.214	0.150	0.147	0.174

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 38: Copula parameters for **alive** funds. State: State Pagan Filter: MA(4) Initial year: 1999

	Correlation		Tail dependence		Tail dep.=0
	Mean	St. Dev.	Mean	St. Dev.	# rejections
<i>No States</i>					
Market neutral	0.061	0.142	0.042	0.053	0.141
Equity hedge	0.370	0.258	0.133	0.130	0.281
Equity non-hedge	0.628	0.180	0.247	0.177	0.305
Event driven	0.462	0.160	0.181	0.145	0.305
Fund of funds	0.552	0.170	0.195	0.141	0.399
Total	0.560	0.225	0.190	0.154	0.281
<i>Bear</i>					
Market neutral	0.014	0.221	0.115	0.100	0.077
Equity hedge	0.251	0.370	0.151	0.168	0.082
Equity non-hedge	0.595	0.257	0.215	0.231	0.053
Event driven	0.404	0.204	0.228	0.189	0.134
Fund of funds	0.361	0.225	0.211	0.165	0.088
Total	0.420	0.298	0.198	0.185	0.082
<i>Bull</i>					
Market neutral	0.057	0.140	0.047	0.060	0.090
Equity hedge	0.367	0.238	0.101	0.130	0.161
Equity non-hedge	0.601	0.190	0.216	0.184	0.250
Event driven	0.421	0.173	0.120	0.133	0.195
Fund of funds	0.507	0.160	0.146	0.123	0.263
Total	0.515	0.214	0.150	0.147	0.161

Note: This table presents the estimated dependence statistics for the different hedge fund styles without conditioning on the state, conditioning on the bear state and conditioning on the bull state. The first two columns correspond to the model with a Student's- t copula. The first one refers to the correlation parameter while the second one presents the tail dependence coefficient $\lambda = 2t_{\eta+1}(-\sqrt{\eta+1}\sqrt{1-\delta}/\sqrt{1+\delta})$. The third column corresponds to the correlation coefficient if we consider a Gaussian copula. The fourth column tests the Gaussian vs the Student's- t copula.

Table 39: State timing for individual funds - NBER recession periods

	%of (+) and significant α	% of (+) and significant γ	% of (-) and significant γ
<i>Market neutral hedge funds</i>			
Single factor	0.500	0.100	0.048
FF 3 factor	0.500	0.100	0.048
Carhart 4 factor	0.481	0.081	0.038
<i>Equity hedge</i>			
Single factor	0.461	0.150	0.088
FF 3 factor	0.414	0.148	0.092
Carhart 4 factor	0.410	0.119	0.090
<i>Equity non-hedge</i>			
Single factor	0.421	0.150	0.196
FF 3 factor	0.384	0.150	0.211
Carhart 4 factor	0.388	0.110	0.186
<i>Event driven</i>			
Single factor	0.629	0.102	0.188
FF 3 factor	0.578	0.141	0.188
Carhart 4 factor	0.574	0.137	0.156
<i>Fund of funds</i>			
Single factor	0.393	0.102	0.139
FF 3 factor	0.379	0.086	0.167
Carhart 4 factor	0.376	0.053	0.209

Note: The following table shows abnormal return and return timing abilities at the fund level using the single-factor, Fama French (FF) three-factor, and the Carhart four-factor models during the period of January 1999 to December 2016. The state indicator used is the business cycle dating indicator published by the NBER.

Table 40: Return, volatility and liquidity timing for individual funds

	Proportion of return timers	Proportion of volatility timers	Proportion of liquidity timers
<i>Market neutral hedge funds</i>			
Single factor	0.124	0.071	0.086
FF 3 factor	0.119	0.062	0.081
Carhart 4 factor	0.119	0.081	0.081
<i>Equity hedge</i>			
Single factor	0.070	0.112	0.114
FF 3 factor	0.082	0.112	0.113
Carhart 4 factor	0.092	0.121	0.113
<i>Equity non-hedge</i>			
Single factor	0.061	0.094	0.101
FF 3 factor	0.069	0.098	0.101
Carhart 4 factor	0.076	0.095	0.106
<i>Event driven</i>			
Single factor	0.063	0.113	0.145
FF 3 factor	0.063	0.113	0.129
Carhart 4 factor	0.063	0.109	0.133
<i>Fund of funds</i>			
Single factor	0.003	0.026	0.028
FF 3 factor	0.001	0.021	0.019
Carhart 4 factor	0.003	0.016	0.021

Note: The following table shows return, volatility and liquidity timing abilities at the fund level using the single-factor, Fama French (FF) three-factor, and the Carhart four-factor models during the period of January 1999 to December 2016.

Table 41: State timing for individual funds – alive hedge funds

	% of (+) and significant α	% of (+) and significant γ	% of (-) and significant γ
<i>Market neutral hedge funds</i>			
Single factor	0.590	0.167	0.026
FF 3 factor	0.564	0.154	0.026
Carhart 4 factor	0.538	0.154	0.026
<i>Equity hedge</i>			
Single factor	0.466	0.134	0.044
FF 3 factor	0.471	0.123	0.052
Carhart 4 factor	0.455	0.125	0.060
<i>Equity non-hedge</i>			
Single factor	0.349	0.103	0.142
FF 3 factor	0.342	0.106	0.151
Carhart 4 factor	0.367	0.101	0.172
<i>Event driven</i>			
Single factor	0.695	0.061	0.305
FF 3 factor	0.695	0.061	0.317
Carhart 4 factor	0.683	0.037	0.341
<i>Fund of funds</i>			
Single factor	0.426	0.018	0.235
FF 3 factor	0.445	0.032	0.265
Carhart 4 factor	0.416	0.020	0.267

Note: The following table shows abnormal return and state timing abilities at the fund level of alive funds using the single-factor, Fama French (FF) three-factor, Carhart four-factor, and the conditional return timing models during the period of January 1999 to December 2016. The state indicator used is the [Pagan and Sossounov \(2003\)](#) state indicator.

Table 42: State timing for individual funds – dead hedge funds

	%of (+) and significant α	% of (+) and significant γ	% of (-) and significant γ
<i>Market neutral hedge funds</i>			
Single factor	0.386	0.106	0.053
FF 3 factor	0.386	0.121	0.076
Carhart 4 factor	0.371	0.068	0.061
<i>Equity hedge</i>			
Single factor	0.383	0.120	0.090
FF 3 factor	0.336	0.129	0.088
Carhart 4 factor	0.332	0.120	0.088
<i>Equity non-hedge</i>			
Single factor	0.280	0.111	0.123
FF 3 factor	0.248	0.125	0.147
Carhart 4 factor	0.243	0.120	0.155
<i>Event driven</i>			
Single factor	0.569	0.075	0.138
FF 3 factor	0.506	0.063	0.138
Carhart 4 factor	0.511	0.063	0.144
<i>Fund of funds</i>			
Single factor	0.414	0.041	0.199
FF 3 factor	0.403	0.057	0.243
Carhart 4 factor	0.374	0.039	0.225

Note: The following table shows abnormal return and state timing abilities at the fund level of dead funds using the single-factor, Fama French (FF) three-factor, Carhart four-factor, and the conditional return timing models during the period of January 1999 to December 2016. The state indicator used is the [Pagan and Sossounov \(2003\)](#) state indicator.

References

- Andrews, D. W. K. (1999). Estimation when a parameter is on a boundary. *Econometrica* 67(6), pp. 1341–1383.
- Henriksson, R. D. and R. C. Merton (1981). On market timing and investment performance. ii. statistical procedures for evaluating forecasting skills. *Journal of business*, 513–533.
- Pagan, A. R. and K. A. Sossounov (2003). A simple framework for analysing bull and bear markets. *Journal of Applied Econometrics* 18(1), 23–46.
- Treynor, J. and K. Mazuy (1966). Can mutual funds outguess the market? *Harvard Business Review* 44(4), 131–136.