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Statistical Screens for "Return Smoothing" by Hedge Funds:
SEC & Investor Interest

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Very recently, an econometrics article, Conditional Return Smoothing in the Hedge Fund Industry, authored by Nicholas P.B. Bollen and Veronika Krepely Pool,[1] has been receiving attention in the press.[2] The thesis of this article is that a statistical method can be developed to screen for artificial return smoothing – the alteration of the value of a hedge fund's assets by a fund manager to make gains and losses appear more regular and less variable than they really are. The statistical test is to see if a hedge fund's reported returns exhibit a time-series pattern that is consistent with artificial smoothing. If a good test is developed to screen for potential return smoothing, it could be used by the Securities and Exchange Commission to select candidates for risk-based examinations. SEC Commissioner Paul S. Atkins and former Commissioner Cynthia A. Glassman noted three years ago that such a screen had not been developed, but Bollen and Pool believe they have developed one. Their conclusion is somewhat different than that suggested in the press: "In our analysis, the sub-sample of funds featuring conditional serial correlation comprises a small portion of the overall sample, as expected, since fraud is presumably a rare phenomenon."[3] They also are thoughtful and state that their test is not a true test for fraud but a screen to indicate when further investigation is warranted. Finally of note, they state that their results indicate that "the power of our test is reasonable for funds with history lengths at or above the median [60 months of reporting history]."[4]

My goal here is to give you enough information to understand the Bollen and Pool article, and to suggest that the SEC and some sophisticated investors (and undoubtedly shortly fund-of-fund managers and firms that sell due diligence) will be using the authors' formulae and methods to test funds they have or will invest in. Funds employ more than enough quantitatively sophisticated people to employ the tests suggested to their own reported returns. Those responsible for risk evaluation and prevention at a hedge fund

CONTINUED ON PAGE 3

Table of CONTENTS

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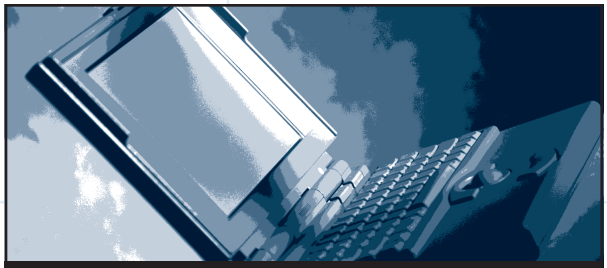

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should be looking to the same tools to perform their own analysis first.

The SEC's Office of Compliance Inspections and Examinations (OCIE) unit has developed a series of tools, entitled "Absolute Compliance," that examiners can use to analyze trade data. It has 12 to 15 forensic compliance tests that can be used to analyze trade data for problems. I suspect that they will be developing a tool to test for potential return smoothing along the lines of those suggested in the Bollen and Pool article.

Like all analyses based upon statistical models, the authors have a number of stated and unstated assumptions that may or may not be universally applicable or applicable in any particular case (e.g., change of fund strategy or in the mix of strategies followed is not accounted for in their analysis), but again the point is that this is an initial screen that may be used. It is particularly applicable for funds that have a significant percentage of assets that are "fair valued."

The statistical method that is used is "conditional serial correlation." Serial correlation is the statistician's way of testing for whether a variable (in our situation, the returns of a hedge fund), that is observable at regular time intervals (say in monthly or quarterly reports to investors) exhibits correlation with itself. Although we in legal and compliance are used to saying past performance is not a predictor of future results, statisticians test for this by looking for the correlation of the variable with itself. If one can successfully identify returns that are correlated with themselves when they should not be, then there may be reason for an investor or a regulator to follow up and determine why.

The statistician's definition of serial correlation is "The correlation of a variable with itself over successive time intervals." This is sometimes called autocorrelation. "Correlation" itself has a technical meaning, which is the departure of two variables from independence. There are a number of mathematical formulae that are used. Because economists love regression models, which imply the relation between variables is linear[5] (mathematically like a straight line), the usual formulae measure the extent to which the data varies from one that is perfectly linear. Adding the word "conditional" to the test means that an indicator is added that essentially means the reported/observable variable is altered from its true value depending on whether it is above or below a specified benchmark (which may itself change with time).

The authors of the article assume that asset returns are in fact independently distributed (in the technical statistical sense), which many econometric articles have demonstrated to be the case.[6] Further, as they note, the algorithm that fund managers use to value assets and report returns is not directly observable, so they use what they characterize as a "well motivated" specification of the algorithm that they believe produces results that should match what is actually reported. They describe it this way:

> **Managers have an incentive to affect the shape of the reported return distribution in order to make it more attractive to investors. During periods of large positive returns, managers likely fully report fund returns for fear of lagging competitors. During periods of large negative returns, managers may only partially report fund returns to mitigate capital flight. Though we focus exclusively on this behavioral pattern, other algorithms could be accommodated in our framework.**

When they say "partially report fund returns", what they mean is that the reported returns will understate losses (or overstate small gains), and the under-reporting will either use "reserved" gain from prior periods or future reports will understate actual gains to reabsorb the understating. This is not different in concept from the "income smoothing" that was the subject of public company accounting cases a few years ago.

The authors go on to develop formulae and empirically derive conditional serial correlation coefficients. They use the Center for International Securities and Derivatives Markets (CISDM) hedge fund database, maintained by the University of Massachusetts in cooperation with Managed Account Reports LLC, with data through December 2003. This database consists of two sets of files, one for live funds and one for dead funds. They included the dead funds in their data set for analysis. Each set of files contains a performance file with monthly observations of returns, total net assets, and net asset values, and a fund informa-

tion file with fund name, strategy type, management fees, and other supplementary details.

They also analyzed information on managed futures accounts and mutual funds so that they would have asset classes to compare that have managers, but whose valuations are largely if not wholly derived from public markets. Hence, they do test for the accuracy and power of their model.

The formulae are daunting to the non-quantitatively trained person, but the underlying thinking is accessible. Oh yes, their formula and the results they ultimately develop follow. The formula and the data are the authors' of the article of course, and not mine.

The Formula

If asset returns are generated by $R_t^o = \mu + \beta\Lambda_t + \varepsilon$ and observed returns are constructed as $R_t^o = (\theta_o(1-|_t) + \Psi_o)R_t + (\theta_t(1-|_{t-1}) + \Psi_t|_{t-1})R_{t-1}$ where $|_{t-j} = 1$ if $R_{t-j} \geq C$ for $j=0,1$ and zero otherwise, then observed returns will display conditional serial correlation if $\theta_1 \neq \Psi_1$. Conditional serial correlation can be detected by estimating parameters of $R_t^o = a + (b_1 - (1-|_{t-1}) + b_1^+|_{t-1} + \eta$, and will result in $b_1^- \neq b_1^+$.

Live Funds – Serial correlation and other data

Listed are summary statistics of the returns of hedge funds, CTAs, and managed futures in the December 2003 CISDM database. Live funds are in existence as of December 2003. Dead funds ceased reporting sometime prior to December 2003. Listed are the number of funds (#), equally-weighted average monthly return (μ), standard deviation of returns (σ), Sharpe ratio (*S*), skewness (*W*), excess kurtosis (*K*), first-order serial correlation (ρ), and the number of funds with significant positive (# Pos) and significant negative (# Neg) serial correlation. 'E-D' denotes Event-Driven, 'G' denotes Global, and 'M-N' denotes Market Neutral.

Conditional Serial Correlation Data

Listed for each type of hedge fund, CTA, and managed futures are the number of funds and the number of funds with significant positive and significant negative coefficients evaluated at the two-sided 5% level. Data are from the December 2003 CISDM database. Listed are results when

	#	μ	σ	*S*	*W*	*K*	ρ	# Pos serial correlation	# Neg serial correlation
Hedge Funds									
E-D	139	0.98	2.77	0.33	-0.24	3.98	0.2	62	0
G Emerging	96	1.63	6.7	0.35	-0.07	4.79	0.19	29	0
G Established	288	1.33	5.08	0.24	0.41	2.72	0.13	61	0
G International	37	1.13	5.08	0.17	0.16	2.71	0.15	16	0
G Macro	46	1.11	4.39	0.25	0.23	2.08	0.05	6	0
Long Only	12	1.31	9.21	0.14	0.13	1.38	0.06	2	0
M-N	344	1.06	2.82	0.41	-0.07	4.08	0.19	129	0
Sector	108	1.46	6.18	0.25	0.55	3.83	0.11	22	0
Short-Sellers	20	0.6	7.14	0.05	-0.04	1.92	0.07	1	0
Fund of Funds of	425	0.76	2.01	0.33	-0.16	3.78	0.22	185	0
CTAs									
Agriculture	14	1.43	5.78	0.19	0.67	2.41	0	1	0
Currency	34	1.15	5.02	0.19	0.92	4.47	0.08	8	0
Diversified	143	1.46	6.94	0.16	0.57	2.29	-0.05	0	8
Energy	2	1.23	4.34	0.25	1.01	1.35	-0.01	0	0
Financial	46	1.37	6.05	0.18	0.64	2.59	0.01	5	0
Stock Index	22	1.25	6.1	0.13	0.42	5.58	0.04	3	1
Managed Futures									
Public Pools	161	1.15	5.58	0.17	0.45	2.2	0.03	11	6
Private Pools	103	1.2	6.57	0.15	0.48	3.57	0.01	5	6

CISDM indices, as well as the asset-based style (ABS) factors developed by Fung and Hsieh,[7] are used as available factors in determining the indicator variable for smoothing in their model. b_1^+ and b_1^- are the coefficients of the regression analysis used to estimate the conditional serial correlation coefficients. Note that a "rejection," i.e., something counted in the eight columns to the right of the # are indicative of conditional smoothing of returns. Again, the author's note this is not demonstrative of fraud but merely an indication of a need for more analysis, as factors they have not taken into account could produce the same pattern of returns.

NOTES

1. Bollen, Nicolas P.B. and Pool, Veronika Krepely, "Conditional Return Smoothing in the Hedge Fund Industry." Journal of Financial and Quantitative Analysis (JFQA), Forthcoming Available at SSRN: http://ssrn.com/abstract=937990.
2. *See, e.g.*, Alistair Barr, Managers May Misreport Returns, Study Says, Marketwatch, October 9, 2007 http://www.marketwatch.com/news/story/story.aspx?guid=%7BD1251185%2D6A37%2D42F0%2D82BE%2D5E6411C73EE2%7D&siteid=rss.
3. Bollen and Pool, *Ibid*.
4. Id.
5. If you care, the standard formula is

$$\rho_{X,Y} = \frac{\operatorname{cov}(X,Y)}{\sigma_X \sigma_Y} = \frac{E((X-\mu_X)(Y-\mu_Y))}{\sigma_X \sigma_Y},$$

Where ρ (rho) is the correlation coefficient, cov is the covariance operator, E is the expected value operator and σ (sigma) is the standard deviation of the variable. In a serial correlation test, X would be the time series of returns and Y would be the same with the time offset by one period.

6. And which many asset managers routinely demonstrate is not by beating their benchmark most of the time.
7. Fung, William and Hsieh, David A., "Hedge Fund Benchmarks: A Risk Based Approah." Financial Analysts Journal 60 (2004) 65-80.

	CISDM					ABS			
		b_1^+		b_1^-		b_1^+		b_1^-	
	#	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg
Hedge Funds									
E-D	210	56	4	14	10	60	4	10	7
G Emerging	137	22	2	7	4	24	0	1	5
G Established	534	65	9	30	16	64	7	14	24
G International	58	17	0	1	4	19	0	3	4
G Macro	92	11	3	3	3	11	4	4	5
Long Only	24	3	1	3	1	2	1	3	1
M-N	511	147	7	20	38	144	15	25	35
Sector	160	20	2	16	5	26	1	10	6
Short-Sellers	25	1	0	0	1	1	0	0	1
Fund of Funds	567	168	6	27	17	191	4	16	24
CTAs									
Agriculture	32	1	3	7	1	1	1	5	0
Currency	90	13	7	5	2	10	5	2	3
Diversified	319	11	18	11	17	17	16	14	21
Energy	8	0	0	0	0	0	0	0	1
Financial	116	7	5	2	8	8	5	3	8
Stock Index	49	2	3	2	2	5	2	2	6
Managed Futures									
Public Pools	489	39	18	21	25	36	17	15	29
Private Pools	268	12	14	9	9	10	10	13	7
Totals	3,689	595	102	178	163	629	92	140	187
% Rejections		16.13%	2.76%	4.83%	4.42%	17.05%	2.49%	3.80%	5.07%