Internet Appendix to “Strategic Delays and Clustering in Hedge Fund Reported Returns”

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Internet Appendix

A. Construction of Suspicious Return Flags

In this section we describe the procedure used to calculate the suspicious return flags. We start with the returns that are found in the TASS database at the end of our collection period (March 2014). We estimate the return flags each year in our sample period (2009-2013) using the fund's entire return history through the end of the prior year. For example, a fund's return flag in 2010 is based upon all available returns prior to 2010. A fund must have at least 24 return observations to be included in the estimation. The first flag is based on a two-sided test for whether the monthly return autocorrelation equals zero. AUTOCORRELATION is triggered if the autocorrelation is positive and we reject the null hypothesis at the 10% level. The second flag is based on Bollen and Pool's (2009, 2012) test for whether the return distribution is discontinuous at zero. Specifically, we calculate a histogram for the return distribution and count the number of observations that appear in the first bin to the left of zero. We follow Bollen and Pool (2012) in selecting the optimal bin width. Next we calculate the number of observations that appear in the adjacent bin to the left, and again count the number of observations that appear in the adjacent bin to the right. We then run a two-sided test of the null hypothesis that the difference between the first number and the average of the second and third numbers equals zero (i.e., a "smooth" return distribution about zero). DISCONTINUITY is triggered if the difference is negative and we reject the null hypothesis at the 10% level.

The next seven flags are based on the December return spread of Agarwal et al. (2011) and the six data quality measures of Straumann (2008) and Bollen and Pool (2012). We first round the reported returns to the second digit, and then compute several sample statistics from the rounded returns. To determine whether the sample statistics are sufficiently unusual (and therefore indicative of poor data quality), we run a simulation that draws rounded returns from a

Normal distribution with a mean and variance equal to the fund's actual sample mean and sample variance of rounded returns. The simulation involves 10,000 trials. For each trial, we draw the same number of returns as the actual number of fund returns, and calculate the December return spread - i.e., the mean difference between December and nonDecember returns- and the six data quality measures from the simulated returns. DEC is triggered if the actual December return spread is larger than the top 10th percentile of simulated December return spreads. ZERO flag is triggered if the actual number of zero returns is more than the top 10th percentile of simulated number of zero returns. NEGATIVE is triggered if the actual number of negative returns is less than the bottom 10th percentile of simulated number of negative returns. UNIQUE is triggered if the actual number of unique returns is less than the bottom 10th percentile of simulated number of unique returns. MAX_RUNS flag is triggered if the actual maximum length of a string of identical returns is larger than the top 10th percentile of simulated maximum length of a string of identical returns. RETURN_BLOCKS flag is triggered if the actual number of recurring return blocks of length two is larger than the top 10th percentile of simulated numbers of recurring return blocks of length two. The UNIFORMITY flag is based on a measure of whether the second digit is uniformly distributed between 0 and 9 (see Straumann, 2008). The flag is triggered if this measure computed from the actual returns is larger than the top 10th percentile of simulated measures.

The next two flags are based on the fund's conditional return correlation and maximum R-squared. Both variables are derived from the same regression model. We first start with the seven factors from the Fung and Hsieh (2004) model, as well as one-month lagged observations of the seven factors. For each fund, we select the combination of three factors (from the set of 14) that maximizes the adjusted R-squared in a regression where the dependent variable is the fund's monthly return. MAXRSQ is an indicator variable that equals one if the adjusted R-squared is not statistically different from zero at the 10% significance level. We obtain the distribution of the maximum R-squared from a simulation exercise in which, for each fund, we draw a number of observations from the standard normal distribution that is equal in length the fund's actual return history. By construction, these simulated returns are independent from the 14 factors. Next, we regress the simulated returns on all possible combinations of three factors (from the possible set of 14), identify the set that maximizes the adjusted R-squared, and then record this maximum adjusted R-squared. We repeat this procedure 100 times, so that we obtain a distribution of 100 observations of the maximum adjusted R-squared, for each fund, under the null hypothesis of independence between factors and returns. MAXRSQ equals one if the actual maximal adjusted R-squared is less than the 90% percentile of this distribution.

Next we follow Bollen and Pool (2008) and estimate the following regression model of monthly fund returns (R):

$$\mathrm{R_t} = \mathrm{a} + \mathrm{b}^{+}\mathrm{R_{t\text{-}1}} + \mathrm{b}^{-}(1 - \mathrm{I_{t\text{-}1}})\mathrm{R_{t\text{-}1}} + \epsilon_\mathrm{t} \tag{A-1}$$

where $\mathrm{I_{t\text{-}1}} = 1$ if the month t-1 fitted value from the fund's maximum adjusted R-squared regression model (identified above) is larger than its mean and zero otherwise. A positive b^{-} coefficient from Eq. (A-1) would indicate that the fund's autocorrelation is greater when the fund is performing poorly (as proxied by it's factor-based return), and therefore indicative of the smoothing behavior considered by Bollen and Pool (2008). We define CONDCORR as a dummy variable that equals one if the b^{-} coefficient is positive and significant at the 10% level. As for the other variables discussed above, MAXRSQ and CONDCORR are re-estimated each year of our sample period (2009-2013) using only the available return data that are generated at the end of the prior year.

The above analysis delivers eleven variables that capture suspicious patterns of reported returns. For parsimony in our analysis, we reduce the number of flags to one by aggregating the eleven flags - AUTOCORRELATION, DISCONTINUITY, ZERO, NEGATIVE, UNIQUE, MAX_RUNS, RETURN_BLOCKS, UNIFORMITY, DEC, MAXRSQ, and CONDCORR. We do this two ways. First, we use the sum of the all of the eleven return flags (FLAGSSUM). Second, we use the first principal component (FLAGSPC) calculated from the cross section of the eleven flags in a given year.

Lastly, our analysis features a variable (RESTATE) that identifies whether a fund's return history has been restated over our sample period. This variable is based on all 1,257 snapshots of the TASS returns history that we collected over 01/2009-03/2014. We use the multiple snapshots to identify restatements - that is changes in returns reported for the same fund and month. Following Patton et al. (2013), we define a restatement as a change to an earlier reported return of at least 1 basis point, and that the change is made at least 90 days after the corresponding performance period.[1] RESTATE equals one if the fund restated at least one return using all available snapshots as of the prior month. Therefore, once the flag is triggered for a particular month and fund, it takes the value of unity for all subsequent months.

B. Bias Estimates From a Simple Clustering Strategy

In this section we discuss the bias in estimates of average monthly excess returns that would result from hedge fund managers following a simple clustering strategy. The clustering strategy we consider allows for both nonstrategic and strategic clusters. A fraction θ of all clusters are nonstrategic. A nonstrategic cluster is when a manager decides to report two returns together for reasons that are unrelated to fund returns - for example, this may depend on the fund's exposure

[1]For example, to identify which funds restated their returns for the May 2009 performance period, we only consider changes to May 2009 returns made August 29, 2009 or later relative to the May 2009 returns as reported in the August 28, 2009 snapshot. For very late reporting funds that have not yet reported any information on May 2009 returns as of August 28, 2009, we consider all changes to May 2009 returns relative to their RDATE (defined above).

to illiquid assets that require more time to value. On the other hand, a strategic cluster occurs when the manager is concerned that the fund return is below c_1. This captures the idea that managers behaving strategically will choose to delay the reporting of poor performance (i.e., when $R<c_1$). We assume that, while the returns in nonstrategic clusters are always reported to TASS, a strategic cluster will be reported to TASS only if either the first half of the cluster ($R(1)$) is above c_1, or, in case $R(1)<c_1$, the sum of the first ($R(1)$) and second ($R(2)$) halves of the cluster are above c_2. This captures the idea that managers behaving strategically will not report poor performance unless, after realizing subsequent performance, the cumulative performance is sufficiently good. The bias can be expressed as follows:

$$\mathrm{BIAS} \quad = \quad -\mathrm{E}\left[\mathrm{R}|\text{not reported}\right] * \mathrm{P}[\text{not reported}]$$

where R is the monthly excess return and E[.] and P[.] denote expectation and probability, respectively. Using the notation of our setup, a return is not reported if and only if it is part of a cluster and both $R(1)<c_1$ and $R(1)+R(2)<c_2$.

Given the frequency of nonstrategic clusters (θ), we solve for c_1, c_2, and BIAS after making a few assumptions about the return distribution. In particular, we assume the following:

- The mean monthly excess return in the first half of a cluster is normally distributed with a mean of zero and a standard deviation of 4.324%. The second half of a cluster is conditionally normally distributed with conditional mean .076*R(1) and standard deviation $\sqrt{4.324\%^2 * (1 - .076^2)}$.
- The number of *reported* cluster returns is 20,625 and the number of nonclustered returns is 187,550.

The two assumptions listed above match our sample moments. Given the above assumptions and the structure of the clustering strategy, we solve numerically for the two thresholds (c_1 and c_2) such that the mean monthly return in the first and second halves of *reported* clusters match those reported in of Table 5 (i.e., -0.24% and 0.21%, respectively).

Our numerical procedure is as follows. We first draw 250,000 pairs of monthly excess returns according to the distributional assumptions above. We then fix θ and classify the first 250,000* θ observations as nonstrategic clusters, while the remaining observations are strategic clusters. We then search over different combinations of (c_1, c_2) over the intervals $\mathrm{c}_1 \in$ [-6%,0] and $\mathrm{c}_2 \in$ [-6%,0] in increments of 0.12%. For each pair of thresholds, we determine the proportion of the strategic clusters that are not reported and, hence, the proportion of nonreported returns within all clusters (denoted by P[not reported| cluster]). Our search ends when we find a pair (c_1, c_2) such that the mean monthly return in the first and second halves of *reported* clusters - that is, all nonstrategic clusters and strategic clusters for which either 1) $\mathrm{R}(1)>\mathrm{c}_1$ or 2) $\mathrm{R}(1)<\mathrm{c}_1$ and $\mathrm{R}(1)+\mathrm{R}(2)>\mathrm{c}_2$ - are each less than 0.01% away in absolute value from -0.24% and 0.21%, respectively. To calculate the expected value of a non reported return we take the sample mean return contained in all strategic disclosures that are not reported. Finally, we calculate the probability of a nonreported returns as:

$$\mathrm{P[not\ reported]} = \frac{\#\ \text{nonreported returns}}{\#\ \text{nonreported returns+20,625+187,550}},$$

where

$$\#\ \text{nonreported returns} = \frac{20,625 * \mathrm{P[not\ reported|cluster]}}{1 - \mathrm{P[not\ reported|cluster]}}$$

Table A1 reports the estimated bias, cluster thresholds, and components of the bias for different values of θ. Panel A shows that the bias is on the order of 2-4 basis points per month, depending on the frequency of nonstrategic clusters. For example, if 60% of all clusters are strategic (i.e.,

θ =0.40), then the following program of strategic clustering matches the sample means of the observed return clusters: initiate a return cluster if the fund's excess return (R(1)) is less than -4.56% and, after the subsequent return is realized, then report both returns if their sum exceeds -3.24%; otherwise, if the sum of the two returns is less than -3.24%, then do not report either return. Under this program, the expected value of nonreported returns is a substantial -4.46% per month. The frequency of nonreporting is 0.74%, which implies a bias in the sample mean of observed returns of 3.3 basis points per month.

Panels B and C of Table A1 show the results from repeating the same analysis except changing the degree of monthly return autocorrelation. For example, Panel B shows that, under the assumption of zero autocorrelation in monthly returns, the bias in observed returns is somewhat smaller, about 2-3 basis points per month, depending on the percentage of nonstrategic disclosures. On the other hand, the bias is greater (3-4 basis points) when we allow for an AR(1) coefficient of 0.15, and therefore stronger autocorrelation than that observed for the full sample of returns data. Overall, a 2-4 basis points per month bias in average returns is consistent with a simple clustering strategy and the observed return clusters in our sample.

Table A1: Estimates of Bias From a Simple Clustering Strategy

The table presents estimates of the bias from a simple clustering strategy that allows for nonstrategic and strategic clusters. A nonstrategic cluster is when a manager decides to report two returns together for reasons that are unrelated to fund returns; a strategic cluster occurs when the manager realizes that the fund return is below a threshold level, denoted by c_1. Returns in nonstrategic clusters are always reported, but the returns in a strategic cluster are reported if and only if the sum of the first and second halves of the cluster are above a threshold level, denoted by c_2. The thresholds (c_1 and c_2) are chosen such that the expected returns on the first and second halves of the observed clusters are equal to the sample means in Table **??**. Pnr|clus is the conditional probability that a return is not reported given that it is part of a return cluster, while Pnr is the unconditional probability that a return is not reported. ER|nr is the conditional expected return given that it is not reported, and BIAS is the mean observed monthly return minus the mean of both the observed and unobserved monthly return (i.e., -1*ER|nr*Pnr). Results are reported for different autocorrelation coefficients in monthly returns, including 0.076 (matched sample estimate, Panel A), zero (Panel B), and 0.15 (double the matched sample estimate, Panel C). Further details are provided in the Internet Appendix.

θ	c_1	c_2	Pnr|clus	Pnr	ER|nr	BIAS
Panel A. Matched return autocorrelation						
0.20	-5.88	-2.52	0.0628	0.0066	-4.68	0.0309
0.30	-5.04	-2.52	0.0735	0.0078	-4.44	0.0346
0.40	-4.56	-3.24	0.0700	0.0074	-4.46	0.0330
0.50	-3.84	-3.60	0.0695	0.0073	-4.39	0.0322
0.60	-2.76	-3.60	0.0703	0.0074	-4.20	0.0313
0.70	-1.20	-4.32	0.0604	0.0063	-4.23	0.0268
Panel B. Zero return autocorrelation						
0.20	-6.00	-2.04	0.0597	0.0063	-4.43	0.0277
0.30	-5.40	-2.52	0.0631	0.0066	-4.35	0.0288
0.40	-4.80	-3.12	0.0635	0.0067	-4.33	0.0289
0.50	-4.20	-3.72	0.0598	0.0063	-4.33	0.0271
0.60	-3.24	-3.84	0.0595	0.0062	-4.21	0.0263
0.70	-1.68	-4.20	0.0551	0.0057	-4.14	0.0238
Panel C. High return autocorrelation						
0.20	-5.52	-2.52	0.0735	0.0078	-4.77	0.0372
0.30	-4.68	-2.52	0.0848	0.0091	-4.51	0.0411
0.40	-4.08	-3.00	0.0848	0.0091	-4.45	0.0405
0.50	-3.48	-3.48	0.0796	0.0085	-4.42	0.0375
0.60	-2.40	-3.60	0.0780	0.0083	-4.25	0.0354
0.70	-0.60	-4.32	0.0666	0.0070	-4.27	0.0299