

**Long-Run Performance Evaluation:
Correlation and Heteroskedasticity-Consistent Tests**

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Abstract

Although much work has been done on evaluating long-run equity abnormal returns, the statistical tests used in the literature are misspecified when event firms come from nonrandom samples. Specifically, industry clustering or overlapping returns in the sample contribute to test misspecification. We propose a new test of long-run performance that uses the average long-run abnormal return for each monthly cohort of event firms, but weights these average abnormal returns in a way that allows for heteroskedasticity and autocorrelation. Our tests work well in random samples and in samples with industry clustering and with overlapping returns, without a reduction in power compared to the methodologies of Lyon, Barber and Tsai (1999).

I. Introduction

One of the most significant challenges to the efficient market hypothesis comes from studies of long-run performance following important corporate events. Several studies document that stocks underperform their benchmarks in the long-run following new equity issues, stock mergers, and dividend omissions. Other studies have found that stocks outperform their benchmarks following repurchases, stock splits and dividend initiations.¹ Although the magnitudes of underperformance or outperformance that these papers document are non-trivial, Barber and Lyons (1997), Kothari and Warner (1997) and others question the reliability of the methods that these papers use for statistical inference. Specifically, they show that in simulations, empirical rejection levels significantly exceed the theoretical levels of significance.

Lyon, Barber and Tsai (1999) (henceforth LBT) evaluate various tests of long-run abnormal returns. In a traditional event study framework, they recommend that researchers use either a bootstrapped skewness-adjusted t -statistic, or the distribution of mean abnormal returns of pseudoportfolios generated by simulation for statistical inference. Many recent papers on long-run stock performance follow their recommendations. Their methods perform well in random samples of firms. However, as LBT caution, for these methods the “misspecification in nonrandom samples is pervasive.”

An important reason for the misspecification is that the LBT approach assumes that the observations are cross-sectionally uncorrelated. This assumption holds in random samples of event firms, but is violated in nonrandom samples. In nonrandom samples where the returns

¹ See Ritter (1991), Loughran and Ritter (1995) and Spiess and Affleck-Graves (1995) for evidence on new issues, Loughran and Vijh (1997), Michaely, Thaler and Womack (1995) for dividend initiations and omissions, and Ikenberry, Lakonishok and Varmaelen (1996) for repurchases.

for event firms are positively correlated, the variability of the test statistics is larger than in a random sample. Therefore, if the empiricist calibrates the distribution of the test statistics in random samples and uses the empirical cutoff points for nonrandom samples, the tests reject the null hypothesis of no abnormal performance too often.

Such excess rejection is of major concern for event studies because the events tend to occur within firms that share similar characteristics. For example, new equity issues were concentrated among technology firms in certain years, and in oil and gas or other industries in certain other years. Therefore, the applications of the tests that are currently used could result in mistaken inferences in practical applications.

In this paper, we propose a methodology that is robust in nonrandom samples. We recommend a t -statistic that is computed using a generalized version of the Hansen and Hodrick (1980) standard error. Our generalization allows for heteroskedasticity, autocorrelation, and for weights to differ across observations. These generalizations accommodate samples that may contain different number of firms in different months and where the variability of portfolio returns could depend on the number of stocks in the portfolios and other factors.

We consider nonrandom samples that are concentrated in particular industries and also nonrandom samples where event firms enter the sample on multiple occasions within the holding period. These are the situations when LBT note pervasive misspecifications when their test statistics are used. We examine the performance of our test statistics using bootstrap experiments. We find that the distributions of the test statistics that we propose are similar in both random and nonrandom samples. Therefore, we can reliably use the distribution of the test

statistic in randomly generated samples to determine the critical values for samples that are not selected at random.

Our approach is robust because we allow for correlation across observations. Therefore, the standard error reflects the properties of the sample and will be larger if a sample is concentrated in any particular industry, or if it is tilted towards any unobservable common factors. As a result, the distributions of the test statistics we propose are the same in random and nonrandom samples.

We also examine the power of our tests using size and book-to-market matched firms, and also size and book-to-market matched portfolios as benchmarks. For both of these cases, the power of using our tests is about the same as that of the LBT tests. Therefore, the empiricist does not have to sacrifice power to gain the robustness with our tests.

The rest of the paper is organized as follows. Section I presents the methodology that we propose and Section II describes our simulation procedure. Section III presents the simulation results in random samples and examines the robustness in nonrandom samples. Section IV evaluates the power of the tests and Section V concludes the paper.

II. Data and test statistics

Many of the papers in the long horizon literature use the methodology advocated by LBT.² To facilitate direct comparison with the LBT methodology, we conduct our experiments using the same data and sample period as LBT. We obtain monthly return data from CRSP dataset. Our sample comprises NYSE, Amex, and Nasdaq stocks, and our sample period is July 1973 through December 1994. We exclude ADRs, closed-end funds, and REITs, and we keep

² For example, see Mitchell and Stafford (2000), Eberhart and Siddique (2002), Boehme and Sorescu (2002), Gompers and Lerner (2003), and Byun and Rozeff (2003).

only stocks with a CRSP share class of 10 or 11. We also use book value of common equity from Compustat (data item 60).

We follow LBT to construct 70 size and book-to-market reference portfolios. Specifically, we first assign stocks to size deciles, based on the market value of equity at the end of June each year. We compute firm size at the end of June each year using CRSP end-of-month prices and total shares outstanding. For each year, we use NYSE size decile breakpoints to assign firms to each of the size categories. We place Amex and Nasdaq stocks in the appropriate NYSE size decile based on their end-of-June market capitalization. Because many small firms listed on Nasdaq fall in the small firm decile, we further partition it into five portfolios using size breakpoints based on all NYSE, Amex, and Nasdaq companies in this decile. This procedure yields a total of 14 size categories. We further subdivide each size category into book-to-market quintiles based on the book to market ratios of the stocks at the end of the previous calendar year. We calculate the book-to-market (BM) ratio using the most recent book value of equity at the end of December divided by the market value of equity at the end of December. We evenly divide each of the 14 size-based portfolios into five portfolio based on the previous December's BM ratio. This procedure gives us a total of 70 size/book-to-market reference portfolios.

Our sample comprises N “event” firms, which we randomly choose for each simulation. We wish to test whether the event firms exhibit abnormal return performance from the event date through a H -month holding period. We define the H -month abnormal return for stock i that starts at the beginning of the event month t as:

$$AR_i(t, H) = \prod_{j=t}^{t+H-1} (1 + R_{i,j}) - \prod_{j=t}^{t+H-1} (1 + R_{b,j}),$$

where $R_{i,t}$ is the return for stock i in month t , and $R_{b,t}$ is the return in month t for the firm's benchmark b . We consider three long-run performance horizons: one year, three years, and five years. Therefore, in our simulation experiments, H equals 12, 36, or 60.

We use two types of benchmarks for each test statistic. The first benchmark is a buy-and-hold size/BM-matched portfolio. Specifically, the size/BM portfolio that includes the event firm on the event date serves as the benchmark. The second benchmark is a size/BM matched individual control firm. We identify all firms with an equity market capitalization between 70 percent and 130 percent of the event firm at the most recent end of June. From this set of firms, we select the one with BM closest to the event firm in the previous December. If a matching firm is delisted sometime during the H -month period, the next closest firm by BM on the event date replaces the delisted firm. If the event firm is delisted prior to the conclusion of the H -month period, we compute the abnormal return only during the time period when the event firm has valid stock returns.

A. Conventional t -statistic

To test the null hypothesis that the average abnormal return for these N event firms equals zero, the conventional t -statistic is

$$t = \frac{\overline{AR}_{\text{sample}}(H)}{\text{standard error}},$$

where $\overline{AR}_{\text{sample}}(H) = \frac{1}{N} \sum_{i=1}^N AR_i(t, H)$ and

$$\text{standard error} = \frac{\sqrt{\frac{1}{N-1} \sum_{i=1}^N [AR_i(t, H) - \overline{AR}_{\text{sample}}(H)]^2}}{N}. \quad (1)$$

B. Test statistics based on monthly cohort average abnormal returns

Let N_t equal the number of stocks in the sample in month t , and let N be the total number of stocks in the sample. Therefore,

$$N = \sum_{t=1}^T N_t,$$

where T is the number of months in the sample.

Define the average abnormal return for each event month t across all stocks in the sample that month (we refer to this group of firms as a monthly cohort) as

$$\overline{AR}(t, H) = \begin{cases} \frac{1}{N_t} \sum_{i=1}^{N_t} AR_i(t, H) & \text{if } N_t > 0 \\ 0 & \text{otherwise,} \end{cases}$$

Let $\overline{AR}(H)$ be a $T \times 1$ column vector where the t^{th} element equals $\overline{AR}(t, H)$. $\overline{AR}(H)$ is the average long-run abnormal return of each monthly cohort. For example, if there were three stocks in the sample month $t=10$, then $\overline{AR}(t=10, H=36)$ would be the average 36-month abnormal return starting in month $t=10$ for these three event firms. If a month does not contain any event, the abnormal return for that month is set equal to zero.

Define w as a $T \times 1$ column vector of weights where the t^{th} element is the ratio of the number of events that occur in month t divided by N . Specifically,

$$w(t) = \frac{N_t}{N}.$$

Note that the sample average abnormal return is equal to the monthly weight vector w times the average abnormal return of each monthly cohort

$$\overline{AR}_{\text{sample}}(H) = w' \overline{AR}(H).$$

The variance of $\overline{AR}_{\text{sample}}(H)$ is given by

$$\text{variance}\left[\overline{AR}_{\text{sample}}(H)\right] = w'Vw,$$

where V is the $T \times T$ variance-covariance matrix of $\overline{AR}(H)$. Because holding periods overlap for monthly cohorts that are closer than H months apart, we allow the first through $H-1^{\text{th}}$ serial covariance of cohort returns to be non-zero, and we set all higher order serial covariances equal to zero.

We consider two estimators for the variance-covariance matrix V . The first estimator is the Hansen and Hodrick (1980) estimator. This estimator allows for serial correlation of monthly returns, but assumes homoskedasticity. This estimator is denoted as SC_V, and the ij^{th} element of SC_V is

$$\text{sc_v}_{i,j} = \begin{cases} \sigma^2 = \frac{1}{T_N} \sum_{\substack{t=1 \\ N_t > 0}}^T \left[\overline{AR}(t, H) - \overline{AR}_{\text{by month}}(H) \right]^2, & \text{if } i = j \\ \rho_j = \frac{1}{T_{N,j}} \sum_{\substack{t=1 \\ N_t > 0 \\ N_{t+j} > 0}}^T \left[\overline{AR}(t, H) * \overline{AR}(t+j, H) \right], & \text{if } 1 \leq |i-j| \leq H-1 \text{ and } T_{N,j} \geq 5 \\ 0, & \text{otherwise,} \end{cases} \quad (2)$$

where $T_{N,j}$ is the number of times where month t and month $t+j$ both have at least one event (i.e., $N_t > 0$ and $N_{t+j} > 0$). σ^2 is the variance of monthly cohort H-period abnormal returns including only months with at least one event. ρ_j is the estimator of j^{th} -order serial covariance. To reduce estimation error for this autocovariance, we require at least five cases

where month t and month $t+j$ both have at least one event.³ If $T_{N,j} < 5$, the covariance is set to zero.

The autocorrelation consistent t -statistic that we propose is

$$SC_{-t} = \frac{\overline{AR}_{\text{sample}}(H)}{\sqrt{w' SC_{-V} w}}.$$

The second estimator for V that we consider allows for heteroskedasticity as well as serial correlation and is denoted as HSC_{-V} . Allowing for heteroskedasticity is important for at least two reasons. First, stock return volatility varies over time. In addition, the number of event firms each month and the types of stocks, particularly the industry composition of these firms, typically varies substantially across sample months. For example, the hot-issue phenomenon in the IPO market results in some time periods having a large number of new issues while other periods experience very few firms going public. These factors may cause the volatility of monthly cohort abnormal returns to change over time.

The ij^{th} element of HSC_{-V} is

$$hsc_{-v_{i,j}} = \begin{cases} \overline{AR}(i, H)^2, & \text{if } i = j, \\ AR(i, H) * AR(j, H), & \text{if } 1 \leq |i - j| \leq H - 1 \\ 0, & \text{otherwise.} \end{cases} \quad (3)$$

This estimator generalizes White's heteroskedasticity-consistent estimator and allows for serial covariances to be non-zero whenever the holding periods of monthly cohorts overlap. The heteroskedasticity and autocorrelation consistent t -statistic that we propose is

$$HSC_{-t} = \frac{\overline{AR}_{\text{sample}}(H)}{\sqrt{w' HSC_{-V} w}}.$$

³ The covariance estimators we use do not subtract the sample mean. We impose the null hypothesis that the sample mean equals zero. In unreported tests, we examined the performance of serial covariance estimators where we subtracted the sample means and the distribution of the test statistics were quite similar to those we report here.

Our proposed test statistics follow a t-distribution in large samples. However, we do not know the distribution of the test statistic in small samples. Therefore, in later sections, we use bootstrap experiments to examine the small sample properties of our test statistics.

The appendix in LBT also considers a test statistic that attempts to explicitly account for cross-sectional correlations, using a different approach. They report that their generalization does not eliminate the misspecification in the test statistics that they recommend. The technique they consider explicitly estimates the abnormal return covariance across each pair of event firms. For a sample size of N firms, this approach requires estimating $\frac{N(N+1)}{2}$ variance and covariance terms. Since the length of the sample period is relatively small, it is difficult to precisely estimate such a large number of parameters.⁴

In contrast, our approach uses the serial correlation of portfolio returns to the extent that holding periods overlap, rather than the covariances across individual observations in the sample. As a result, the number of parameters that we require is far smaller than the approach that LBT consider. In addition, the number of parameters that we need to estimate does not increase as the sample size grows. For example, the SC_t statistic requires estimating only $H-1$ serial covariances and one variance term. The HSC_t statistic requires estimating a larger number of variance and covariance terms. However, as in White (1980), we only need to consistently estimate the product in equation (3) rather than each of the individual terms between all pairs of event firms. Consequently, the larger number of individual variance and

⁴ LBT's sample period includes 258 months. If there are $N=200$ event firms, LBT's procedure requires estimating 20,100 terms in the variance-covariance matrix. However, there are only $200 \times 258 = 51,600$ monthly stock returns available.

covariance parameters that we need to estimate in HSC_V does not necessarily add to its estimation error.⁵

Although the procedure that we illustrate here weights each monthly cohort proportional to the number of stocks in the cohort, our approach can be adapted to any weighting scheme that the empiricist chooses to use. The proportional weighting scheme that we use is common in the literature (for example, see Loughran and Ritter (2000)). However, Fama (1998) recommends a calendar time approach where each month is given equal weight, regardless of the number of observations in each month. If the empiricist chooses to weight each month equally, then the weight for each monthly cohort should be set equal to one over the number of months in the sample period. Our results are not sensitive to the particular weights assigned to each monthly cohort.

C. Critical values with pseudoportfolios

In addition to the t -statistics, we also examine the empirical distribution of long-run abnormal returns under the null hypothesis for each of the test statistics that we study in this paper. For each event firm in our sample with event month t , we randomly select with replacement a firm that is in the same size/BM portfolio (one of the 70 portfolios) in that month. We then estimate the long-run abnormal return test statistic based on the appropriate methodology, and this yields one value of the test statistic.

Table I summarizes the twelve statistical methods that we evaluate in this paper. The first two methods use the conventional t -statistic, first with size/BM portfolio benchmarks and then with size/BM individual firm benchmarks. The next two methods use the same

⁵ In fact, we cannot rely on the consistency of the estimate of any of the individual terms in the variance-covariance matrix in equation (3) because we use only one observation to compute each term. See White (1980) for a further discussion of this point in the context of his heteroskedasticity consistent standard error estimator.

conventional t -statistic and benchmarks, but utilize the critical values from the distribution of the test statistics across the pseudoportfolios. We refer to these critical values as empirical critical values.

LBT use the first three methods listed in Table I, and we present them here for direct comparison. The next four methods use the autocorrelation-consistent test statistics that we propose. The first two use the SC_t statistic with size/BM portfolio benchmarks and with control firm benchmarks. The latter two methods use the same two benchmarks and the empirical p values from pseudoportfolios. The last four statistical approaches are identical, except they utilize the heteroskedasticity serial correlation consistent HSC_t statistic instead the SC_t statistic.

D. Bootstrap experiment

To test the specification of the new test statistics that we propose, we conduct 1,000 simulations of N event firms. We first consider cases where both firm identity and event month are randomly chosen. Later we allow for two types of nonrandomness in the sample. In one case we constrain the firms to be clustered within industries. In the second nonrandom case, we include the same firm in the sample on multiple occasions within an H-month holding period. In our random sample and in our industry-clustered sample, we do not allow multiple occurrences of the same firm within the H-month holding period. Therefore, both of these samples do not include overlapping returns for the same event firms.

When testing a hypothesis at the α significance level, a well-specified test should reject the null $1,000\alpha$ times. The test is conservative (under-rejects) if the null is rejected fewer than 1000α times, and the test over-rejects if the null is rejected more than 1000α times.

We examine the specification of each of our test statistics at the 1 percent, 5 percent, and 10 percent levels. In addition, we check the performance of each test methodology with nine experiments using three event sample sizes (200 firms, 500 firms, and 1,000 firms) and three long-run holding period horizons (1 year, 3 years, and 5 years).

III. Random Sample Results

A. Critical values

Before explicitly examining the sizes of our test statistics, we first consider the critical values of the distribution of the t -statistics in random samples. We run 1,000 simulations and generate the tests statistics for each run. Table II reports the two-tailed critical values for these 1,000 t -statistics using random samples. In large samples, the two-tail critical values for the test statistics at the 1 percent, 5 percent, and 10 percent level would be 2.33, 1.96, and 1.65. However, we do not know the small sample distribution. The critical values in Table II could be used to gauge the divergence of the small sample distribution from the large sample limits. The critical values we tabulate here would also be useful to researchers who wish to run the SC_t or HSC_t tests but who do not want to generate pseudoportfolios and the corresponding empirical critical values.

The first pattern that is evident from Table II is that the left tail critical values for the conventional t -statistic with benchmark portfolios are larger in absolute value than the right tail critical values. For this test methodology, for a three-year holding period and 200 event firms, Panel B of Part 1 gives the 5 percent two-tailed critical values of -2.45 and 1.85 . This result indicates that when benchmark portfolios are used, the resulting t -statistic is positively skewed, because of the skewness of the abnormal return distribution.

The five percent critical values for the SC_t-statistic with 200 event firms (see Panel B of Part 1) are -1.75 and 1.55 . These values are smaller in absolute value than 1.96 , indicating that the sizes of the SC_t tests are smaller than the tabulated values. Consequently, the SC_t test tends to under-reject when tabulated critical values are used. Out of these three tests, the HSC *t*-statistic usually has the most extreme critical values. This indicates that the sizes of the HSC_t tests are higher than they should be, if we were to use the tabulated distribution of the test statistic. For example, for the HSC_t-statistic with benchmark portfolios, a five-year holding period and 1,000 event firms, Panel C of Part 3 of Table II reports 5 percent two-tailed critical values of -2.65 and 2.45 . These are higher than the standard 1.96 critical value.

The distributions of the SC_t statistic and the HSC_t statistic present an interesting contrast. The SC_t statistic has a tighter distribution than the standard normal distribution, while the HSC_t statistic has a wider distribution. This difference is due to the fact that the variance estimate under the SC procedure is on average larger than the variance estimate under the HSC procedure. To understand the difference intuitively, note that the SC procedure assigns equal weights to all observations to first get the sample estimate of variances and covariances. Therefore, this procedure does not explicitly account for the fact that the monthly cohorts with fewer event firms would have larger variances than the monthly cohorts with larger numbers of event firms.

However, under the HSC procedure, the weight for each monthly cohort is inversely proportional to square of the number of firms in each monthly cohort. Therefore, the return variances of the smaller cohorts would have less of an effect on the estimate of the sample

mean standard error than the variances of larger cohorts. As a result, the variance estimate under the HSC procedure is on average large than that under the SC procedure.

B. Specification tests in random samples

Table III presents the specification of our twelve statistical procedures. The results of our first three statistical methods are fairly close to those reported in Table III of LBT. For example, in Part 1 of Table III we report that the size of the conventional t -statistic with benchmark portfolios and 200 event firms is 4.8 percent and 1.0 percent for a one-year holding period, 5.8 percent and 1.6 percent for a three-year period, and 7.2 percent and 1.2 percent for a five-year period. LBT find corresponding sizes of 4.9 percent and 0.9 percent for a one-year period, 6.8 percent and 0.6 percent for a three-year period, and 6.1 percent and 0.5 percent for a five-year period.

The first four test methodologies based on conventional t -statistics perform reasonably well in random samples. There is some evidence of positive skewness in the first two procedures. Of course, the empirical distribution reflects the skewness and hence the sizes of the tests are fairly close to the theoretical significance level.

The rejection rates of the two SC_t tests using the tabulated t -distribution are significantly lower than the theoretical significance levels.⁶ With 200 event firms and a five-year holding period for the SC_t-statistic using benchmark firms, Panel C of Part 1 of Table III reports rejection rates using a 5 percent significance level of 0.71 percent and 0.40 percent. Low rejection rates are found for all three holding periods and all three event firm sizes. However, when we use the empirical critical values for the SC_t-statistics, the tests appear

⁶ Our SC_t and HSC_t estimators do not guarantee positive definiteness of the variance-covariance matrix in small samples. In our experiments, the quadratic product of w and the sample variance-covariance matrix was negative in two to four percent of the simulation runs. We discarded these simulations.

reasonably well specified. For the same case as before but with empirical critical values, the rejection rates are 1.92 percent and 3.23 percent, which add up very close to 5 percent.

In contrast to the first two SC_t tests, the first two HSC_t tests have significantly higher sizes compared to theoretical significance levels. For 200 event firms, a five-year holding period, and using the HSC_t-statistic with benchmark portfolios, Panel C of Part 1 gives rejection rates of 3.32 percent and 3.42 percent. Once again however, the HSC_t tests appear reasonably well specified when we use the empirical critical values. In the same case as before but using empirical p values, the rejection rates are 1.55 percent and 3.01 percent.

Overall, the specifications of the SC_t-statistic and HSC_t-statistic with empirical critical value methodologies appear at least as good as LBT's recommended procedures (the bootstrapped version of a skewness-adjusted t-statistic and the empirical p value using benchmark portfolios) in random samples.

C. Specification tests in nonrandom samples

C.1. Industry clustering

It should not be surprising that the distributions of the test statistics correspond to the distribution in a random sample, as long as the event firms are selected at random. Under this scenario, we calibrate the distribution of the test statistic in a random sample and examine the test size using empirical cutoffs, also in a random sample. However, the test size becomes an issue when we consider a more realistic scenario where the event firms come from a nonrandom sample but the empirical distribution is calibrated using a random sample. For instance, LBT find that the distribution of the test statistics that they recommend is severely misspecified when the event firms are clustered within industries. This section examines the

performance of the test statistics that we propose with the same kind of industry clustering as in LBT.

To form industry-clustered samples, each simulation begins with a randomly selected two-digit SIC code. All firms are required to have this selected two-digit SIC code. Once a firm enters that sample, we do not allow it to reenter until the end of the holding period. When we run out of firms in the randomly selected industry, we select another two-digit SIC code to complete the sample. If we do not find enough sample firms with these two SIC codes, we discard all event firms and start the simulation over. In our simulation runs, when the number of event firms is 200 or 500, on average 90 percent of our simulations include a single industry, and the remaining ten percent include two industries. For the 1,000 event firm case, we start by randomly selecting two two-digit SIC codes, so all of these simulations are drawn from two industries.

Table IV presents the results of our statistical tests with industry-clustered samples. In this table and all subsequent tables, we report only tests that use empirical critical values since the tabulated values do not accurately capture the small sample distribution even in the case of random samples. The rejection rates with the conventional t -tests are substantially larger than the theoretical levels. For instance, for a five-year holding period and 200 event firms, the left- and right-tail rejection rates for the 5 percent conventional t -test with portfolio benchmarks is 26.2 percent and 9.2 percent. These rejection rates are somewhat larger than those reported by LBT. One possible reason for this difference is that our industry clustering may be more concentrated than LBT's. LBT does not report how often their 200-firm sample is drawn from one industry versus two industries.

The level of misspecification generally increases as the holding period and the number of event firms increase. This is illustrated by the rise in conventional t -test rejection rates when going from the 200 event firm experiment (Part 1 of Table IV) to the 500 event firm experiment (Part 2). For the 1000-firm experiment (Part 3), rejection rates are lower because this sample is less industry concentrated than the 200-firm and 500-firm samples.

The rejection rates with the SC_ t -statistics are far less than the rejection rates with the conventional t -statistics, although the rates are greater than the theoretical levels. For example, at the five percent significance level, Panel C of Part 1 of Table IV reports that the SC_ t test with control portfolios has rejection rates of 3.42 and 6.03 percent. The specifications of these tests are also substantially better than the bootstrapped skewness adjusted t -statistic that LBT recommend, which has rejection rates of 10.5 percent and 15.9 percent at the 5 percent significance level in the 200-firm, five-year holding period experiment.⁷

The HSC_ t tests tend to under-reject with empirical critical values. For example, the rejection rates at the five percent significance level are 1.33 percent and 1.53 percent for the 200 firm sample and five-year holding period. The HSC_ t test would be a conservative test for the industry controlled sample while the other tests tend to reject in excess of the theoretical levels.

Overall, the results here indicate that the actual sizes of both the SC_ t test and the HSC_ t are closer to the theoretical levels than the conventional t -test. If one would prefer to err on the conservative side, one should choose the HSC- t test.

Intuitively, the reason why the empirical critical values for the conventional t -statistics are misspecified in industry clustered samples is because they do not account for the

⁷ See Table VII of LBT for rejection rates of all their tests in industry-clustered samples.

fact that the standard deviations are larger in these samples than in random samples. For example, the empirical critical value methodology uses the critical value calibrated using random samples, where the abnormal returns have a tighter distribution than in industry clustered samples.

Our approach, on the other hand, is relatively robust because we allow for correlation across observations. Therefore, the standard error reflects the properties of the sample and it would be larger if a sample is concentrated in any particular industry, or if it is tilted towards any unobservable common factors. As a result, the distributions of the test statistics we propose are similar in random samples and nonrandom samples.

C.1. Overlapping returns

Another instance where the LBT tests are misspecified is when the same event firms enter the sample on multiple occasions during the holding period. Here again, because the holding periods overlap for the same firms, the standard errors in a random sample understate the true standard errors. This subsection examines the performance of the autocorrelation-consistent test statistics we propose when there are repeat observations in the sample.

To construct the sample with overlapping returns, we randomly select $\frac{N}{2}$ firms from the population, each with its own event month τ . Then for each of these firms, we randomly choose a second event month between $\tau - (H-1)$ and $\tau + (H-1)$, where $H = 12, 36, \text{ or } 60$ depending on the holding period of the experiment. The second event month guarantees that the same firm is in the sample twice and with at least one month of overlapping returns. We repeat this procedure in each of our 1,000 simulations, and Table V reports the rejection rates.

Once again, for the first three tests, the rejection rates exceed the rates in random samples. For example, for a 200-firm sample and a five-year holding period, Panel C of Part 1 in Table V gives left- and right-tail rejection rates for the 5 percent significance level tabulated conventional t-test with benchmark portfolios of 12.4 percent and 2.1 percent, compared with LBT's 10.6 percent and 1.9 percent. At the 5 percent significance level, LBT's bootstrapped skewness-adjusted t-statistic and empirical p-value conventional t-statistic with benchmark portfolios have total rejection rates between 10 and 12 percent. Although these two tests reject about twice as often as they should, they do not over-reject as much as they do in industry-clustered samples.

Our new SC_t and HSC_t tests provide a substantial reduction in rejection rates in samples with overlapping returns. The size of the SC_t test, on the other hand, is very close to the theoretical significance level. For instance, in Panel C of Part 1 of Table IV, the SC_t test with benchmark portfolios rejects the null at the five percent significance level in a total of 5.62 percent of experiments. Therefore, the actual rejection levels are not far from the theoretical levels, and this test appears well specified across all three holding periods and all three event firm sizes.

Here again, the HSC_t tests tend to be a bit conservative but close to the theoretical levels. For example, the total rejection rates at the five percent significance levels are about three to four percent.

D. Power

Our results so far indicate that rejection rates with the SC_t and HSC_t test statistics are closer to the theoretical levels under the null hypothesis. However, researchers are also

interested in the power of the tests because even well specified tests would lose their appeal if they are unable to detect violations of the null hypothesis. This subsection evaluates the power of various tests. We confine our power analysis to the random sample case since we know that the *t*-tests are misspecified in nonrandom samples.

To evaluate power, we add a constant level of abnormal return to each of the event firms in our random samples for all 1,000 simulations. Table VI reports the rejection rates at the five percent theoretical significance level for three event firm sizes (200, 500, and 1,000 firms) and three holding periods (1, 3, and 5 years). The null hypothesis is that the mean sample long-run abnormal return is zero across all 1,000 simulations, and the added level of annual abnormal returns ranges from –15 percent to 15 percent in increments of 5 percent. The power of all twelve tests generally increases as the number of firms and as the length of the holding period increases.

When fixed amounts of abnormal returns are added to random samples, the rejection rates of the conventional *t*-tests are generally close to those reported in LBT. With 200 event firms and a one-year holding period, the conventional *t*-test with benchmark firms and tabulated critical values has percentage rejection rates of 74.1, 42.0, 14.4, 4.8, 14.6, 39.5, and 71.5 (see Panel A of Part 1 of Table VI). By comparison, Figure 1 in LBT shows percentage rejection rates for the same test that as approximately 72, 39, 16, 5, 14, 43, and 73.

The power of the SC_*t* and HSC_*t* tests is comparable to the power of the conventional *t*-tests. For example, with 200 event firms, a five-year holding period, and an induced level of annual abnormal return of –5 percent, Panel C of Part 1 of Table VI reports that the rejection rates for the conventional *t*-tests ranges from 18.9 percent to 39.3 percent.

For the SC_t test, the rejection rate ranges from 18.6 percent to 52.0 percent. For the HSC_t test, the rejection rate ranges from 21.1 percent to 48.8 percent.

LBT highlight the improved power of their bootstrapped skewness-adjusted t -statistic and the conventional t -statistic using empirical p -values. Based on LBT's Figure 1, the rejection rates of these two tests in the 200-firm, one-year holding period, -5 percent induced abnormal return experiment is approximately 20 percent and 30 percent respectively. For the same experiment, Panel A of Part 1 of Table VI reports that the rejection rate for the SC_t tests ranges from 11.2 percent to 27.4 percent. The rejection rate for the HSC_t tests ranges from 15.0 to 35.5 percent. So in general, the power of the SC_t and HSC_t tests appear to be about as good as the two statistical approaches that LBT most strongly recommend.

IV. Conclusions

A number of papers in the literature examine the long-run performance following events such as new issues, stock repurchases and stock splits to examine whether the market reacts efficiently to these events. Recent long-run performance studies typically use the tests recommended by Lyon Barber and Tsai (1999) to test the hypothesis that the abnormal returns following the events are not different from zero. However, it is well known that the LBT tests are misspecified in nonrandom samples.

To address the shortcomings of the LBT methodology, this paper proposes two new autocorrelation-consistent test statistics. We find that both these tests are well specified in nonrandom samples. In particular, we find that the tests are well specified when the sample is concentrated in certain industries and when the sample contains the same observations on multiple occasions. We also find that the power of the test statistics we propose is similar to

that of the LBT tests. Therefore, in future work, we recommend our proposed SC_t and HSC_t test methodologies when assessing long-run performance.

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Table I
Summary of Statistical Tests

This table summarizes the twelve statistical methods that are evaluated. Standard error is the traditional standard error computed across all event firm abnormal returns and is given by equation (1) in the main text. SC_V is the serial correlation consistent variance-covariance matrix given by equation (2) in the main text, and HSC_V is the heteroskedasticity serial correlation consistent variance covariance matrix given by equation (3) in the main text. (T) indicates that critical values are based on the tabulated distribution of the t -statistic, while (E) indicates that critical values are based on the empirical distribution of the t -statistics from 1,000 pseudoportfolios as described in section IIC of the paper.

Method description	Benchmark	Critical Values Based on	Test Statistic
t -statistic (T)	Size/BM portfolio	Tabulated distribution of t -statistic	$t = \frac{\overline{AR}_{\text{sample}}(H)}{\text{standard error}}$
t -statistic (T)	Size/BM-matched control firm	Tabulated distribution of t -statistic	$t = \frac{\overline{AR}_{\text{sample}}(H)}{\text{standard error}}$
t -statistic (E)	Size/BM portfolio	Empirical distribution of the t -statistics using bootstrap	Not applicable
t -statistic (E)	Size/BM-matched control firm	Empirical distribution of the t -statistics using bootstrap	Not applicable
Serial Correlation consistent SC t -statistic (T)	Size/BM portfolio	Tabulated distribution of t -statistic	$SC_t = \frac{\overline{AR}_{\text{sample}}(H)}{\sqrt{w' SC_V w}}$
Serial Correlation consistent SC t -statistic (T)	Size/BM-matched control firm	Tabulated distribution of t -statistic	$SC_t = \frac{\overline{AR}_{\text{sample}}(H)}{\sqrt{w' SC_V w}}$
Serial Correlation consistent SC t -statistic (E)	Size/BM portfolio	Empirical distribution of the tests statistics using bootstrap	Not applicable
Serial Correlation consistent SC t -statistic (E)	Size/BM-matched control firm	Empirical distribution of the tests statistics using bootstrap	Not applicable
Heteroskedasticity and Serial Correlation consistent HSC t -statistic (T)	Size/BM portfolio	Tabulated distribution of t -statistic	$HSC_t = \frac{\overline{AR}_{\text{sample}}(H)}{\sqrt{w' HSC_V w}}$
Heteroskedasticity and Serial Correlation consistent HSC t -statistic (T)	Size/BM-matched control firm	Tabulated distribution of t -statistic	$HSC_t = \frac{\overline{AR}_{\text{sample}}(H)}{\sqrt{w' HSC_V w}}$
Heteroskedasticity and Serial Correlation consistent HSC t -statistic (E)	Size/BM portfolio	Empirical distribution of the tests statistics using bootstrap	Not applicable
Heteroskedasticity and Serial Correlation consistent HSC t -statistic (E)	Size/BM-matched control firm	Empirical distribution of the tests statistics using bootstrap	Not applicable

Table II
Critical Values in Random Samples

This table presents two-tailed critical values for 1,000 random samples of 200 firms (Part 1), 500 firms (Part 2), and 1,000 firms (Part 3) to reject the null hypothesis of no annual (Panel A), three-year (Panel B), and five-year (Panel C) buy-and-hold abnormal return (AR) at the significance levels of 1 percent, 5 percent and 10 percent. (T) indicates that critical values are based on the tabulated distribution of the t-statistic, while (E) indicates that critical values are based on the empirical distribution of the t-statistics from 1,000 pseudoportfolios as described in section IIC of the paper.

Part 1: 200 firms		Two-Tailed Significance Level					
Statistic	Benchmark	1%		5%		10%	
		Empirical Cumulative Density Function (%)					
		0.5	99.5	2.5	97.5	5.0	95.0
Panel A: One-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	-3.55	2.25	-2.35	1.75	-2.05	1.45
<i>t</i> -statistic (E)	Size/BM control firm	-2.35	2.45	-1.75	2.05	-1.45	1.85
SC <i>t</i> -statistic (E)	Size/BM portfolio	-2.25	1.75	-1.85	1.35	-1.65	1.25
SC <i>t</i> -statistic (E)	Size/BM control firm	-2.05	2.05	-1.65	1.65	-1.45	1.45
HSC <i>t</i> -statistic (E)	Size/BM portfolio	-2.85	2.75	-2.35	1.85	-2.05	1.65
HSC <i>t</i> -statistic (E)	Size/BM control firm	-2.45	2.65	-2.05	2.05	-1.75	1.75
Panel B: Three-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	-3.15	2.55	-2.45	1.85	-2.05	1.65
<i>t</i> -statistic (E)	Size/BM control firm	-2.65	2.55	-1.95	2.05	-1.65	1.65
SC <i>t</i> -statistic (E)	Size/BM portfolio	-2.05	1.85	-1.75	1.55	-1.65	1.35
SC <i>t</i> -statistic (E)	Size/BM control firm	-2.15	1.75	-1.55	1.55	-1.45	1.35
HSC <i>t</i> -statistic (E)	Size/BM portfolio	-3.25	3.35	-2.45	2.15	-2.05	1.75
HSC <i>t</i> -statistic (E)	Size/BM control firm	-2.95	3.15	-2.25	2.15	-1.95	1.85
Panel C: Five-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	-3.65	2.15	-2.75	1.65	-2.25	1.45
<i>t</i> -statistic (E)	Size/BM control firm	-2.65	2.75	-1.95	1.95	-1.65	1.65
SC <i>t</i> -statistic (E)	Size/BM portfolio	-1.85	1.85	-1.55	1.35	-1.45	1.25
SC <i>t</i> -statistic (E)	Size/BM control firm	-2.15	1.95	-1.45	1.45	-1.35	1.35
HSC <i>t</i> -statistic (E)	Size/BM portfolio	-4.85	3.25	-2.15	2.25	-1.85	1.75
HSC <i>t</i> -statistic (E)	Size/BM control firm	-4.05	2.85	-2.05	2.05	-1.75	1.75

Table II (continued)

Part 2: 500 firms		Two-Tailed Significance Level					
Statistic	Benchmark	1%		5%		10%	
		0.5	99.5	2.5	97.5	5.0	95.0
Empirical Cumulative Density Function (%)							
Panel A: One-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	-2.75	2.25	-2.25	1.85	-1.85	1.65
<i>t</i> -statistic (E)	Size/BM control firm	-2.65	2.45	-1.95	1.95	-1.55	1.65
SC <i>t</i> -statistic (E)	Size/BM portfolio	-2.35	1.65	-1.95	1.45	-1.75	1.25
SC <i>t</i> -statistic (E)	Size/BM control firm	-2.05	2.05	-1.55	1.65	-1.35	1.35
HSC <i>t</i> -statistic (E)	Size/BM portfolio	-2.95	2.75	-2.45	2.15	-2.15	1.75
HSC <i>t</i> -statistic (E)	Size/BM control firm	-2.85	2.95	-2.25	2.25	-1.95	1.95
Panel B: Three-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	-2.75	2.25	-2.25	1.65	-1.95	1.45
<i>t</i> -statistic (E)	Size/BM control firm	-2.75	2.35	-1.95	1.95	-1.65	1.65
SC <i>t</i> -statistic (E)	Size/BM portfolio	-1.75	1.55	-1.55	1.35	-1.45	1.25
SC <i>t</i> -statistic (E)	Size/BM control firm	-1.85	1.85	-1.55	1.35	-1.45	1.25
HSC <i>t</i> -statistic (E)	Size/BM portfolio	-3.55	3.35	-2.35	2.25	-2.05	1.95
HSC <i>t</i> -statistic (E)	Size/BM control firm	-4.35	3.95	-2.25	2.45	-1.85	1.95
Panel C: Five-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	-3.15	2.05	-2.35	1.55	-1.75	1.35
<i>t</i> -statistic (E)	Size/BM control firm	-2.35	2.35	-1.95	1.85	-1.65	1.55
SC <i>t</i> -statistic (E)	Size/BM portfolio	-2.05	2.25	-1.45	1.25	-1.35	1.15
SC <i>t</i> -statistic (E)	Size/BM control firm	-1.65	1.65	-1.45	1.35	-1.25	1.25
HSC <i>t</i> -statistic (E)	Size/BM portfolio	-4.45	6.05	-2.35	2.65	-1.85	1.95
HSC <i>t</i> -statistic (E)	Size/BM control firm	-3.05	5.15	-2.35	2.45	-1.95	1.85

Table II (continued)

Part 3: 1,000 firms		Two-Tailed Significance Level					
Statistic	Benchmark	1%		5%		10%	
		0.5	99.5	2.5	97.5	5.0	95.0
Theoretical Cumulative Density Function (%)							
Panel A: One-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	-2.85	2.25	-2.05	1.75	-1.65	1.55
<i>t</i> -statistic (E)	Size/BM control firm	-2.65	2.65	-1.95	1.95	-1.65	1.65
SC <i>t</i> -statistic (E)	Size/BM portfolio	-2.15	2.05	-1.85	1.65	-1.65	1.45
SC <i>t</i> -statistic (E)	Size/BM control firm	-2.15	2.05	-1.75	1.65	-1.55	1.45
HSC <i>t</i> -statistic (E)	Size/BM portfolio	-3.05	3.65	-2.35	2.35	-2.05	1.95
HSC <i>t</i> -statistic (E)	Size/BM control firm	-3.45	3.65	-2.45	2.25	-2.05	1.85
Panel B: Three-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	-2.65	2.15	-1.95	1.75	-1.65	1.55
<i>t</i> -statistic (E)	Size/BM control firm	-2.45	2.45	-1.85	1.95	-1.65	1.55
SC <i>t</i> -statistic (E)	Size/BM portfolio	-2.05	1.75	-1.65	1.55	-1.45	1.35
SC <i>t</i> -statistic (E)	Size/BM control firm	-1.85	1.85	-1.55	1.55	-1.45	1.35
HSC <i>t</i> -statistic (E)	Size/BM portfolio	-2.95	4.75	-2.35	2.15	-2.05	1.75
HSC <i>t</i> -statistic (E)	Size/BM control firm	-5.25	4.15	-2.65	2.25	-2.15	1.85
Panel C: Five-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	-2.85	2.45	-2.05	1.65	-1.65	1.35
<i>t</i> -statistic (E)	Size/BM control firm	-2.35	2.65	-1.95	1.95	-1.65	1.55
SC <i>t</i> -statistic (E)	Size/BM portfolio	-2.25	1.95	-1.45	1.25	-1.35	1.15
SC <i>t</i> -statistic (E)	Size/BM control firm	-2.55	1.55	-1.55	1.35	-1.45	1.25
HSC <i>t</i> -statistic (E)	Size/BM portfolio	-3.55	4.55	-2.65	2.45	-2.05	1.85
HSC <i>t</i> -statistic (E)	Size/BM control firm	-5.35	3.15	-2.45	2.25	-2.15	1.75

Table III
Size of Alternative Test Statistics in Random Samples

This table presents the percentage of 1,000 random samples of 200 firms (Part 1), 500 firms (Part 2), and 1,000 firms (Part 3) that reject the null hypothesis of no annual (Panel A), three-year (Panel B), and five-year (Panel C) buy-and-hold abnormal return (AR) at the theoretical significance levels of 1 percent, 5 percent and 10 percent in favor of the alternative hypothesis of a significantly negative AR (i.e., calculated p value is less than 0.5 percent at the 1 percent significance level) or a significantly positive AR (calculated p value is greater than 99.5 percent at the 1 percent significance level). The statistics and benchmarks are described in detail in the main text. (T) indicates that critical values are based on the tabulated distribution of the t-statistic, while (E) indicates that critical values are based on the empirical distribution of the t-statistics from 1,000 pseudoportfolios as described in section IIC of the paper.

Part 1: 200 firms		Two-Tailed Theoretical Significance Level					
Statistic	Benchmark	1%		5%		10%	
		0.5	99.5	2.5	97.5	5.0	95.0
Panel A: One-year ARs							
<i>t</i> -statistic (T)	Size/BM portfolio	1.30	0.00	4.80	1.00	8.30	3.20
<i>t</i> -statistic (T)	Size/BM control firm	0.20	0.40	1.80	3.00	3.50	6.50
<i>t</i> -statistic (E)	Size/BM portfolio	0.50	1.00	2.10	3.20	3.80	6.40
<i>t</i> -statistic (E)	Size/BM control firm	0.20	0.50	1.20	3.40	3.20	7.00
SC <i>t</i> -statistic (T)	Size/BM portfolio	0.10	0.00	2.20	0.30	4.70	1.10
SC <i>t</i> -statistic (T)	Size/BM control firm	0.00	0.00	0.80	0.80	2.60	2.70
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.20	0.60	1.80	2.60	4.30	5.70
SC <i>t</i> -statistic (E)	Size/BM control firm	0.40	0.50	2.10	2.70	4.30	5.70
HSC <i>t</i> -statistic (T)	Size/BM portfolio	1.40	0.60	5.51	2.30	10.32	5.61
HSC <i>t</i> -statistic (T)	Size/BM control firm	0.50	0.60	3.80	4.00	6.41	7.21
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.40	0.50	1.90	3.31	4.31	6.31
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.20	0.60	1.70	3.10	4.10	5.81
Panel B: Three-year ARs							
<i>t</i> -statistic (T)	Size/BM portfolio	2.10	0.50	5.80	1.60	9.60	4.20
<i>t</i> -statistic (T)	Size/BM control firm	0.70	0.50	2.50	2.50	5.70	4.70
<i>t</i> -statistic (E)	Size/BM portfolio	0.30	1.30	2.40	4.90	4.70	7.80
<i>t</i> -statistic (E)	Size/BM control firm	0.50	0.70	2.20	3.50	4.40	6.10
SC <i>t</i> -statistic (T)	Size/BM portfolio	0.10	0.40	0.81	0.40	3.52	1.71
SC <i>t</i> -statistic (T)	Size/BM control firm	0.40	0.00	0.60	0.20	1.90	2.00
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.40	1.01	2.42	4.93	4.93	8.06
SC <i>t</i> -statistic (E)	Size/BM control firm	0.60	0.50	2.90	3.50	5.21	6.01
HSC <i>t</i> -statistic (T)	Size/BM portfolio	1.23	1.54	5.23	3.89	8.40	7.58
HSC <i>t</i> -statistic (T)	Size/BM control firm	1.64	1.23	5.03	4.00	8.52	8.42
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.10	0.31	3.48	3.48	5.23	6.45
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.10	0.51	2.67	2.26	5.13	6.47
Panel C: Five-year ARs							
<i>t</i> -statistic (T)	Size/BM portfolio	3.60	0.10	7.20	1.20	10.60	2.80
<i>t</i> -statistic (T)	Size/BM control firm	0.70	0.60	2.60	1.70	5.50	4.30
<i>t</i> -statistic (E)	Size/BM portfolio	0.40	1.10	2.90	4.30	5.20	6.40
<i>t</i> -statistic (E)	Size/BM control firm	0.70	0.60	2.50	2.40	5.30	5.70
SC <i>t</i> -statistic (T)	Size/BM portfolio	0.20	0.20	0.30	0.40	0.71	0.61
SC <i>t</i> -statistic (T)	Size/BM control firm	0.40	0.10	0.71	0.40	1.01	0.71
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.51	0.61	1.41	4.34	4.44	7.78
SC <i>t</i> -statistic (E)	Size/BM control firm	0.61	0.71	1.92	3.23	5.25	5.85
HSC <i>t</i> -statistic (T)	Size/BM portfolio	1.04	1.66	3.32	3.42	7.77	5.91
HSC <i>t</i> -statistic (T)	Size/BM control firm	1.15	0.94	3.66	3.87	7.11	6.17
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.52	0.31	1.55	3.01	4.15	5.60
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.42	0.10	1.78	2.20	4.29	5.02

Table III (continued)

Part 2: 500 firms		Two-Tailed Theoretical Significance Level					
Statistic	Benchmark	1%		5%		10%	
		Theoretical Cumulative Density Function (%)					
		0.5	99.5	2.5	97.5	5.0	95.0
Panel A: One-year ARs							
<i>t</i> -statistic (T)	Size/BM portfolio	1.20	0.00	4.30	1.20	7.80	3.70
<i>t</i> -statistic (T)	Size/BM control firm	0.90	0.20	2.70	2.40	4.80	5.20
<i>t</i> -statistic (E)	Size/BM portfolio	0.20	0.80	1.80	3.90	4.10	7.40
<i>t</i> -statistic (E)	Size/BM control firm	0.50	0.50	2.70	3.70	4.60	6.20
SC <i>t</i> -statistic (T)	Size/BM portfolio	0.20	0.00	2.00	0.30	6.10	0.90
SC <i>t</i> -statistic (T)	Size/BM control firm	0.00	0.00	0.80	0.70	2.20	2.60
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.40	0.50	2.50	3.90	4.90	7.00
SC <i>t</i> -statistic (E)	Size/BM control firm	0.40	0.50	2.10	3.20	4.80	5.10
HSC <i>t</i> -statistic (T)	Size/BM portfolio	1.80	1.40	7.40	3.90	10.90	7.40
HSC <i>t</i> -statistic (T)	Size/BM control firm	1.10	1.40	5.01	5.41	7.51	8.41
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.20	0.30	2.40	3.70	5.30	6.30
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.20	0.40	2.10	2.80	4.20	5.61
Panel B: Three-year ARs							
<i>t</i> -statistic (T)	Size/BM portfolio	1.50	0.30	5.10	1.50	6.80	3.20
<i>t</i> -statistic (T)	Size/BM control firm	0.60	0.30	2.60	1.40	5.90	4.40
<i>t</i> -statistic (E)	Size/BM portfolio	0.20	0.90	2.70	2.90	5.00	7.10
<i>t</i> -statistic (E)	Size/BM control firm	0.50	0.40	2.10	2.70	4.60	5.60
SC <i>t</i> -statistic (T)	Size/BM portfolio	0.00	0.00	0.20	0.00	1.70	0.20
SC <i>t</i> -statistic (T)	Size/BM control firm	0.00	0.00	0.10	0.20	1.20	0.80
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.30	0.20	1.40	2.30	3.80	5.70
SC <i>t</i> -statistic (E)	Size/BM control firm	0.10	0.50	2.00	2.30	4.01	5.11
HSC <i>t</i> -statistic (T)	Size/BM portfolio	1.23	1.85	5.86	4.94	9.47	8.54
HSC <i>t</i> -statistic (T)	Size/BM control firm	1.33	2.15	3.68	5.31	7.87	8.17
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.31	0.10	1.95	2.57	4.42	6.07
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.20	0.41	1.43	2.45	2.55	5.82
Panel C: Five-year ARs							
<i>t</i> -statistic (T)	Size/BM portfolio	1.90	0.00	4.10	0.80	7.40	2.10
<i>t</i> -statistic (T)	Size/BM control firm	0.30	0.20	2.70	1.80	5.80	3.40
<i>t</i> -statistic (E)	Size/BM portfolio	0.20	0.40	2.10	2.80	3.50	5.80
<i>t</i> -statistic (E)	Size/BM control firm	0.10	0.40	1.70	2.40	4.90	4.10
SC <i>t</i> -statistic (T)	Size/BM portfolio	0.20	0.30	0.50	0.71	1.01	1.21
SC <i>t</i> -statistic (T)	Size/BM control firm	0.00	0.10	0.00	0.20	0.20	0.51
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.50	1.21	2.42	2.62	4.74	5.55
SC <i>t</i> -statistic (E)	Size/BM control firm	0.20	0.40	1.41	2.53	3.54	4.24
HSC <i>t</i> -statistic (T)	Size/BM portfolio	2.34	2.66	4.89	6.16	9.25	9.99
HSC <i>t</i> -statistic (T)	Size/BM control firm	1.37	2.43	5.17	4.11	9.39	8.12
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.32	0.96	2.23	3.19	4.25	6.59
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.11	0.63	1.37	2.43	3.48	5.17

Table III (continued)

Part 3: 1,000 firms		Two-Tailed Theoretical Significance Level					
Statistic	Benchmark	1%		5%		10%	
		Theoretical Cumulative Density Function (%)					
		0.5	99.5	2.5	97.5	5.0	95.0
Panel A: One-year ARs							
<i>t</i> -statistic (T)	Size/BM portfolio	0.90	0.30	2.90	1.00	6.10	2.40
<i>t</i> -statistic (T)	Size/BM control firm	0.70	0.30	2.70	1.90	5.10	4.30
<i>t</i> -statistic (E)	Size/BM portfolio	0.00	0.50	1.60	3.50	2.70	6.40
<i>t</i> -statistic (E)	Size/BM control firm	0.40	0.60	2.30	2.80	4.40	5.20
SC <i>t</i> -statistic (T)	Size/BM portfolio	0.10	0.00	1.20	0.40	4.10	1.80
SC <i>t</i> -statistic (T)	Size/BM control firm	0.00	0.20	1.20	1.00	3.00	3.10
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.10	1.10	1.20	3.70	3.40	6.60
SC <i>t</i> -statistic (E)	Size/BM control firm	0.40	0.50	2.10	3.30	4.40	6.00
HSC <i>t</i> -statistic (T)	Size/BM portfolio	0.90	1.80	5.60	4.10	9.60	6.90
HSC <i>t</i> -statistic (T)	Size/BM control firm	2.01	1.71	5.92	4.81	9.63	7.42
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.20	0.50	1.60	3.30	3.40	6.40
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.30	0.70	2.31	2.81	4.71	5.12
Panel B: Three-year ARs							
<i>t</i> -statistic (T)	Size/BM portfolio	0.80	0.30	3.00	1.50	5.30	3.80
<i>t</i> -statistic (T)	Size/BM control firm	0.40	0.20	2.10	2.20	5.80	3.70
<i>t</i> -statistic (E)	Size/BM portfolio	0.10	0.50	1.70	3.20	3.20	6.20
<i>t</i> -statistic (E)	Size/BM control firm	0.30	0.60	1.60	3.00	4.50	5.40
SC <i>t</i> -statistic (T)	Size/BM portfolio	0.20	0.00	0.60	0.10	2.11	1.40
SC <i>t</i> -statistic (T)	Size/BM control firm	0.30	0.00	0.30	0.30	1.81	1.81
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.70	0.60	1.60	3.81	4.11	5.92
SC <i>t</i> -statistic (E)	Size/BM control firm	0.40	0.40	1.91	3.22	3.93	5.54
HSC <i>t</i> -statistic (T)	Size/BM portfolio	1.23	1.44	5.64	3.79	8.92	6.77
HSC <i>t</i> -statistic (T)	Size/BM control firm	2.27	1.75	5.87	4.43	9.37	7.52
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.10	0.41	2.05	2.15	4.62	4.51
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.41	0.31	1.85	2.47	4.33	5.25
Panel C: Five-year ARs							
<i>t</i> -statistic (T)	Size/BM portfolio	0.80	0.20	3.10	0.90	6.40	2.70
<i>t</i> -statistic (T)	Size/BM control firm	0.30	0.60	2.60	2.20	5.70	3.60
<i>t</i> -statistic (E)	Size/BM portfolio	0.00	0.80	1.10	3.20	3.20	5.90
<i>t</i> -statistic (E)	Size/BM control firm	0.20	0.70	1.70	3.00	4.00	5.00
SC <i>t</i> -statistic (T)	Size/BM portfolio	0.31	0.10	0.81	0.51	1.42	0.71
SC <i>t</i> -statistic (T)	Size/BM control firm	0.41	0.10	0.81	0.10	1.53	0.20
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.61	0.51	2.24	2.24	4.17	4.58
SC <i>t</i> -statistic (E)	Size/BM control firm	0.71	0.20	2.95	2.14	5.50	4.58
HSC <i>t</i> -statistic (T)	Size/BM portfolio	2.75	2.11	6.34	4.65	10.47	7.29
HSC <i>t</i> -statistic (T)	Size/BM control firm	2.42	1.79	6.20	3.79	10.83	7.26
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.21	0.21	2.43	1.90	5.71	4.44
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.53	0.11	2.10	1.89	4.63	3.79

Table IV
Size of Alternative Test Statistics in Industry-Clustered Samples

This table presents the percentage of 1,000 random samples of 200 firms (Part 1), 500 firms (Part 2), and 1,000 firms (Part 3) that reject the null hypothesis of no annual (Panel A), three-year (Panel B), and five-year (Panel C) buy-and-hold abnormal return (AR) at the theoretical significance levels of 1 percent, 5 percent and 10 percent in favor of the alternative hypothesis of a significantly negative AR (i.e., calculated p value is less than 0.5 percent at the 1 percent significance level) or a significantly positive AR (calculated p value is greater than 99.5 percent at the 1 percent significance level). In the 200 firm and 500 firm samples, all firms are selected from two randomly chosen industries (based on two-digit SIC codes). In the 1,000-firm sample, all firms are selected from four randomly chosen industries (based on two-digit SIC codes). The statistics and benchmarks are described in detail in the main text. The critical values are based on the distribution of the tests statistics in the bootstrap experiment using a random sample of firms (see Table II).

Part 1: 200 firms		Two-Tailed Theoretical Significance Level					
Statistic	Benchmark	1%		5%		10%	
		Theoretical Cumulative Density Function (%)					
		0.5	99.5	2.5	97.5	5.0	95.0
Panel A: One-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	2.20	3.20	7.50	7.80	12.90	12.40
<i>t</i> -statistic (E)	Size/BM control firm	0.90	0.90	5.10	3.60	7.60	5.80
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.30	0.90	3.60	4.40	6.50	7.70
SC <i>t</i> -statistic (E)	Size/BM control firm	0.30	0.30	1.90	3.20	4.00	5.60
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.10	0.10	2.20	3.00	4.90	6.11
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.30	0.40	1.30	2.40	3.40	5.51
Panel B: Three-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	5.60	7.10	12.70	12.40	18.10	16.00
<i>t</i> -statistic (E)	Size/BM control firm	2.20	3.20	6.80	6.70	11.60	9.30
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.50	0.60	4.70	6.21	7.31	11.01
SC <i>t</i> -statistic (E)	Size/BM control firm	0.40	0.40	2.40	3.30	6.11	7.41
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.00	0.30	0.91	2.22	3.63	6.25
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.10	0.00	1.42	2.22	4.65	4.95
Panel C: Five-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	9.60	9.50	18.80	14.90	22.90	18.00
<i>t</i> -statistic (E)	Size/BM control firm	6.00	4.20	14.20	8.40	19.10	11.10
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.10	1.01	3.42	6.03	8.94	10.35
SC <i>t</i> -statistic (E)	Size/BM control firm	0.71	0.30	5.66	3.23	11.41	5.45
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.10	0.10	1.01	1.01	2.12	4.04
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.31	0.00	1.33	1.53	4.09	4.19

Table IV (continued)

Part 2: 500 firms		Two-Tailed Theoretical Significance Level					
Statistic	Benchmark	1%		5%		10%	
		Theoretical Cumulative Density Function (%)					
		0.5	99.5	2.5	97.5	5.0	95.0
Panel A: One-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	9.40	4.30	17.20	13.20	21.80	16.60
<i>t</i> -statistic (E)	Size/BM control firm	5.00	1.40	12.80	5.70	17.50	9.10
SC <i>t</i> -statistic (E)	Size/BM portfolio	1.10	1.20	3.10	6.00	6.20	10.20
SC <i>t</i> -statistic (E)	Size/BM control firm	0.80	0.70	3.00	3.90	7.20	7.80
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.20	0.50	1.80	2.50	4.40	5.20
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.30	0.60	2.20	3.10	4.90	5.10
Panel B: Three-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	15.20	11.30	24.90	24.10	29.40	30.50
<i>t</i> -statistic (E)	Size/BM control firm	8.60	3.90	18.90	10.00	24.10	14.00
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.50	2.61	3.71	10.23	7.52	16.15
SC <i>t</i> -statistic (E)	Size/BM control firm	0.40	0.80	2.60	4.50	6.41	8.01
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.00	0.40	0.70	2.51	2.91	5.53
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.30	0.10	1.52	1.62	3.14	4.16
Panel C: Five-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	15.80	17.50	25.50	27.70	30.00	33.60
<i>t</i> -statistic (E)	Size/BM control firm	10.00	5.10	19.20	11.80	24.40	16.90
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.10	0.50	2.90	5.60	7.40	10.90
SC <i>t</i> -statistic (E)	Size/BM control firm	0.10	0.20	3.01	3.31	7.02	6.62
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.00	0.20	0.00	0.90	0.60	2.31
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.30	0.00	0.80	1.10	2.21	2.51

Table IV (continued)

Part 3: 1,000 firms		Two-Tailed Theoretical Significance Level					
Statistic	Benchmark	1%		5%		10%	
		Theoretical Cumulative Density Function (%)					
		0.5	99.5	2.5	97.5	5.0	95.0
Panel A: One-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	4.60	6.40	10.20	16.70	14.30	23.70
<i>t</i> -statistic (E)	Size/BM control firm	2.40	2.40	6.40	8.30	9.30	12.20
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.40	2.10	1.60	6.00	3.70	11.20
SC <i>t</i> -statistic (E)	Size/BM control firm	0.20	1.30	2.90	4.70	5.20	7.70
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.00	0.30	0.30	1.30	1.60	3.80
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.00	0.10	1.40	1.70	3.00	5.00
Panel B: Three-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	4.50	24.80	7.60	40.20	9.50	46.40
<i>t</i> -statistic (E)	Size/BM control firm	2.60	7.90	5.90	18.00	8.40	24.40
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.30	1.70	0.90	9.00	1.70	16.20
SC <i>t</i> -statistic (E)	Size/BM control firm	0.30	0.80	1.40	4.50	2.90	8.30
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.00	0.00	0.30	1.10	0.50	3.11
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.30	0.20	0.61	1.32	2.13	3.24
Panel C: Five-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	5.30	28.70	8.70	35.40	10.70	39.50
<i>t</i> -statistic (E)	Size/BM control firm	3.50	16.10	7.30	26.70	10.80	31.80
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.10	1.20	2.20	7.71	3.70	12.31
SC <i>t</i> -statistic (E)	Size/BM control firm	0.10	0.70	1.60	5.01	4.90	9.01
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.00	0.30	0.61	1.11	1.01	2.63
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.00	0.00	0.30	0.10	1.11	2.32

Table V
Size of Alternative Test Statistics in Samples with Overlapping Returns

The sample of firms is constructed in two steps. First, 100 event months in Part 1 (500 event months in Part 2) are randomly selected. For each of these event months, a second event month is selected within 12 months of the original event month (either before or after) to guarantee the presence of overlapping returns. This table presents the percentage of 1,000 random samples of 200 firms (Part 1) and 1,000 firms (Part 2) that reject the null hypothesis of no annual (Panel A), three-year (Panel B), and five-year (Panel C) buy-and-hold abnormal return (AR) at the theoretical significance levels of 1 percent, 5 percent and 10 percent in favor of the alternative hypothesis of a significantly negative AR (i.e., calculated p value is less than 0.5 percent at the 1 percent significance level) or a significantly positive AR (calculated p value is greater than 99.5 percent at the 1 percent significance level). The statistics and benchmarks are described in detail in the main text. The critical values are based on the distribution of the tests statistics in the bootstrap experiment using a random sample of firms (see Table II).

Part 1: 200 firms		Two-Tailed Theoretical Significance Level					
		1%		5%		10%	
		Theoretical Cumulative Density Function (%)					
Statistic	Benchmark	0.5	99.5	2.5	97.5	5.0	95.0
Panel A: One-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	1.50	2.40	6.00	5.70	9.50	9.80
<i>t</i> -statistic (E)	Size/BM control firm	1.40	2.00	5.20	6.00	8.10	9.60
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.20	0.90	2.90	2.80	5.40	4.90
SC <i>t</i> -statistic (E)	Size/BM control firm	0.40	0.80	2.40	3.70	5.00	6.80
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.20	0.60	1.80	1.50	4.30	3.30
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.00	0.40	1.60	2.30	3.30	5.10
Panel B: Three-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	0.60	2.70	4.10	7.80	7.30	12.70
<i>t</i> -statistic (E)	Size/BM control firm	1.10	1.50	5.40	5.70	9.40	8.50
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.40	1.30	2.11	3.91	5.62	7.32
SC <i>t</i> -statistic (E)	Size/BM control firm	0.50	1.00	2.41	2.81	5.22	5.92
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.20	0.31	1.53	2.54	4.48	4.58
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.20	0.31	2.14	1.94	3.98	4.59
Panel C: Five-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	0.80	2.40	4.70	8.20	9.10	12.10
<i>t</i> -statistic (E)	Size/BM control firm	1.50	0.70	4.10	3.50	6.90	6.10
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.80	0.30	2.81	2.81	6.03	6.43
SC <i>t</i> -statistic (E)	Size/BM control firm	0.60	0.81	2.72	2.92	5.44	4.94
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.21	0.51	1.44	1.44	3.19	4.73
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.21	0.21	1.66	2.28	3.83	4.46

Table V (continued)

Part 2: 500 firms		Two-Tailed Theoretical Significance Level					
Statistic	Benchmark	1%		5%		10%	
		Theoretical Cumulative Density Function ()					
		0.5	99.5	2.5	97.5	5.0	95.0
Panel A: One-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	1.90	2.50	5.20	7.70	8.40	11.80
<i>t</i> -statistic (E)	Size/BM control firm	0.90	1.20	4.70	5.50	7.30	8.70
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.40	1.00	2.30	4.40	4.50	8.10
SC <i>t</i> -statistic (E)	Size/BM control firm	0.30	0.70	1.70	2.90	3.90	6.10
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.00	0.40	1.40	2.70	3.10	4.60
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.00	0.10	1.30	1.60	2.90	3.90
Panel B: Three-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	1.60	2.50	4.80	7.40	8.00	10.80
<i>t</i> -statistic (E)	Size/BM control firm	1.30	1.60	4.50	5.10	7.20	8.70
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.20	1.10	2.30	4.00	4.70	7.51
SC <i>t</i> -statistic (E)	Size/BM control firm	0.70	0.30	2.71	2.81	5.11	5.81
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.30	0.20	1.73	1.83	3.76	4.78
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.31	0.41	2.55	2.04	4.49	3.88
Panel C: Five-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	1.00	2.40	3.90	6.60	7.70	11.30
<i>t</i> -statistic (E)	Size/BM control firm	1.40	1.20	5.40	4.60	8.30	8.50
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.50	0.91	2.92	3.72	5.73	7.04
SC <i>t</i> -statistic (E)	Size/BM control firm	0.30	0.50	3.63	2.62	7.55	5.64
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.52	0.31	1.86	2.27	3.93	4.24
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.21	0.41	2.57	2.16	4.52	4.52

Table V (continued)

Part 3: 1,000 firms		Two-Tailed Theoretical Significance Level					
Statistic	Benchmark	1%		5%		10%	
		Theoretical Cumulative Density Function ()					
		0.5	99.5	2.5	97.5	5.0	95.0
Panel A: One-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	1.10	1.90	4.10	7.80	7.80	12.20
<i>t</i> -statistic (E)	Size/BM control firm	1.50	1.60	3.70	6.70	6.20	11.00
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.40	1.30	1.70	5.00	4.20	7.90
SC <i>t</i> -statistic (E)	Size/BM control firm	0.60	0.40	1.80	2.50	4.30	5.70
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.10	0.20	0.90	3.40	2.70	6.11
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.10	0.00	1.70	1.10	3.00	4.00
Panel B: Three-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	1.40	2.90	5.30	8.70	8.80	12.10
<i>t</i> -statistic (E)	Size/BM control firm	0.80	1.30	3.60	5.40	7.20	9.20
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.50	0.60	3.11	4.21	7.11	6.61
SC <i>t</i> -statistic (E)	Size/BM control firm	0.40	1.10	2.40	3.40	5.01	6.71
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.41	0.10	2.16	1.44	4.95	3.81
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.21	0.62	2.87	3.18	5.44	5.85
Panel C: Five-year ARs							
<i>t</i> -statistic (E)	Size/BM portfolio	1.40	2.50	4.10	6.90	7.20	10.50
<i>t</i> -statistic (E)	Size/BM control firm	1.00	0.70	4.80	4.00	8.00	7.20
SC <i>t</i> -statistic (E)	Size/BM portfolio	0.30	0.70	1.91	4.73	4.13	8.26
SC <i>t</i> -statistic (E)	Size/BM control firm	0.50	0.81	2.52	4.04	5.15	6.26
HSC <i>t</i> -statistic (E)	Size/BM portfolio	0.00	0.10	2.18	2.18	4.47	4.16
HSC <i>t</i> -statistic (E)	Size/BM control firm	0.21	0.32	2.32	1.58	4.21	4.21

Table VI
Power of Alternative Tests in Random Samples

The percentage of 1,000 random samples of 200 firms (Part 1), 500 firms (Part 2), and 1,000 firms (Part 3) rejecting the null hypothesis of no annual (Panel A), three-year (Panel B), and five-year (Panel C) abnormal return at various induced levels of annual abnormal return (-15, -10, -5, 5, 10, and 15 percent). The statistics and benchmarks are described in detail in the main text. The critical values are based on the distribution of the tests statistics under the null hypothesis with a bootstrap experiment using a random sample of firms (see Table II).

Part 1: 200 firms		Induced Level of Annual Abnormal Return						
Statistic	Benchmark	-15%	-10%	-5%	0	5%	10%	15%
Panel A: One-year ARs								
<i>t</i> -statistic (E)	Size/BM portfolio	82.6	52.6	20.4	5.3	34.1	83.5	99.1
<i>t</i> -statistic (E)	Size/BM control firm	72.8	40.3	12.8	4.6	16.9	42.9	74.2
SC <i>t</i> -statistic (E)	Size/BM portfolio	82.6	60.1	26.8	4.4	30.9	79.2	97.4
SC <i>t</i> -statistic (E)	Size/BM control firm	71.6	46.4	17.3	4.8	18.5	45.9	73.2
HSC <i>t</i> -statistic (E)	Size/BM portfolio	82.5	59.6	25.2	5.2	27.0	72.9	95.0
HSC <i>t</i> -statistic (E)	Size/BM control firm	67.5	39.6	15.0	4.8	16.2	42.2	68.1
Panel B: Three-year ARs								
<i>t</i> -statistic (E)	Size/BM portfolio	81.3	61.3	25.6	7.3	55.2	99.7	100.0
<i>t</i> -statistic (E)	Size/BM control firm	78.4	51.8	22.1	5.7	24.6	68.7	94.1
SC <i>t</i> -statistic (E)	Size/BM portfolio	86.6	72.0	46.3	7.4	55.2	95.2	100.0
SC <i>t</i> -statistic (E)	Size/BM control firm	79.5	61.0	32.6	6.4	33.5	72.0	91.4
HSC <i>t</i> -statistic (E)	Size/BM portfolio	83.2	68.4	39.0	7.0	40.5	89.3	99.5
HSC <i>t</i> -statistic (E)	Size/BM control firm	70.5	51.0	23.4	4.9	26.2	62.1	86.4
Panel C: Five-year ARs								
<i>t</i> -statistic (E)	Size/BM portfolio	69.1	50.2	23.2	7.2	59.6	99.9	100.0
<i>t</i> -statistic (E)	Size/BM control firm	68.8	46.7	18.9	4.9	24.9	73.6	95.3
SC <i>t</i> -statistic (E)	Size/BM portfolio	83.3	71.8	52.0	5.8	61.1	97.3	99.9
SC <i>t</i> -statistic (E)	Size/BM control firm	76.1	61.7	37.6	5.1	42.6	77.9	94.3
HSC <i>t</i> -statistic (E)	Size/BM portfolio	78.5	65.6	40.5	4.6	42.2	90.7	99.3
HSC <i>t</i> -statistic (E)	Size/BM control firm	64.4	47.9	21.1	4.0	28.9	65.2	88.7

Table VI (continued)

Part 2: 500 firms		Induced Level of Annual Abnormal Return						
Statistic	Benchmark	-15%	-10%	-5%	0	5%	10%	15%
Panel A: One-year ARs								
<i>t</i> -statistic (E)	Size/BM portfolio	96.7	85.3	39.9	5.7	61.9	99.6	100.0
<i>t</i> -statistic (E)	Size/BM control firm	94.4	73.7	24.6	6.4	30.3	79.4	96.1
SC <i>t</i> -statistic (E)	Size/BM portfolio	95.8	82.5	41.6	6.4	55.9	96.5	99.9
SC <i>t</i> -statistic (E)	Size/BM control firm	91.1	69.7	28.0	5.3	31.6	72.6	93.1
HSC <i>t</i> -statistic (E)	Size/BM portfolio	94.3	82.1	39.4	6.1	44.3	93.3	99.6
HSC <i>t</i> -statistic (E)	Size/BM control firm	88.5	62.6	22.6	4.9	24.9	66.6	90.1
Panel B: Three-year ARs								
<i>t</i> -statistic (E)	Size/BM portfolio	97.3	89.8	47.3	5.6	87.8	100.0	100.0
<i>t</i> -statistic (E)	Size/BM control firm	96.8	84.1	35.0	4.8	46.6	93.3	99.8
SC <i>t</i> -statistic (E)	Size/BM portfolio	95.6	88.7	62.2	3.7	81.1	99.8	100.0
SC <i>t</i> -statistic (E)	Size/BM control firm	94.1	82.5	47.0	4.3	52.1	90.2	98.8
HSC <i>t</i> -statistic (E)	Size/BM portfolio	94.9	84.6	51.9	4.5	64.1	97.9	100.0
HSC <i>t</i> -statistic (E)	Size/BM control firm	89.9	71.0	32.4	3.9	39.7	84.4	96.2
Panel C: Five-year ARs								
<i>t</i> -statistic (E)	Size/BM portfolio	92.8	80.3	40.4	4.9	93.1	100.0	100.0
<i>t</i> -statistic (E)	Size/BM control firm	92.0	77.3	31.6	4.1	47.0	94.7	99.8
SC <i>t</i> -statistic (E)	Size/BM portfolio	93.0	85.8	64.1	5.0	84.9	100.0	100.0
SC <i>t</i> -statistic (E)	Size/BM control firm	90.8	79.1	51.0	3.9	56.2	89.4	98.5
HSC <i>t</i> -statistic (E)	Size/BM portfolio	89.4	79.4	52.1	5.4	61.8	97.4	100.0
HSC <i>t</i> -statistic (E)	Size/BM control firm	79.2	63.0	26.7	3.8	37.4	80.0	95.6

Table VI (continued)

Part 3: 1,000 firms		Induced Level of Annual Abnormal Return						
Statistic	Benchmark	-15%	-10%	-5%	0	5%	10%	15%
Panel A: One-year ARs								
<i>t</i> -statistic (E)	Size/BM portfolio	99.6	96.9	61.8	5.1	89.1	100.0	100.0
<i>t</i> -statistic (E)	Size/BM control firm	99.4	93.7	42.9	5.1	50.9	95.2	99.9
SC <i>t</i> -statistic (E)	Size/BM portfolio	98.4	94.7	63.4	4.9	80.5	100.0	100.0
SC <i>t</i> -statistic (E)	Size/BM control firm	97.8	90.0	46.3	5.4	48.6	90.8	98.4
HSC <i>t</i> -statistic (E)	Size/BM portfolio	98.7	95.0	61.3	4.9	70.4	100.0	100.0
HSC <i>t</i> -statistic (E)	Size/BM control firm	97.9	84.2	38.9	5.1	40.7	86.4	98.5
Panel B: Three-year ARs								
<i>t</i> -statistic (E)	Size/BM portfolio	99.7	98.6	74.0	4.9	99.8	100.0	100.0
<i>t</i> -statistic (E)	Size/BM control firm	99.5	96.4	59.9	4.6	71.0	99.7	100.0
SC <i>t</i> -statistic (E)	Size/BM control firm	98.5	90.6	56.9	0.6	54.7	93.9	99.4
SC <i>t</i> -statistic (E)	Size/BM portfolio	99.2	96.8	78.4	5.4	95.3	100.0	100.0
HSC <i>t</i> -statistic (E)	Size/BM control firm	99.1	94.2	67.9	5.1	68.2	97.4	99.7
HSC <i>t</i> -statistic (E)	Size/BM portfolio	99.2	94.8	70.2	4.2	86.3	100.0	100.0
<i>t</i> -statistic (E)	Size/BM control firm	97.2	87.8	49.5	4.3	53.3	94.3	99.7
Panel C: Five-year ARs								
<i>t</i> -statistic (E)	Size/BM portfolio	98.8	95.0	67.3	4.3	99.9	100.0	100.0
<i>t</i> -statistic (E)	Size/BM control firm	98.6	93.4	52.8	4.7	71.3	99.1	99.9
SC <i>t</i> -statistic (E)	Size/BM portfolio	98.0	94.3	80.0	4.5	94.5	100.0	100.0
SC <i>t</i> -statistic (E)	Size/BM control firm	97.0	91.4	68.9	5.1	70.8	96.3	99.6
HSC <i>t</i> -statistic (E)	Size/BM portfolio	96.6	92.0	69.1	4.3	80.5	99.9	100.0
HSC <i>t</i> -statistic (E)	Size/BM control firm	93.4	81.9	44.4	4.0	54.5	93.4	99.2