

# Revisiting the Methodology of Long-Run Event Studies

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November 21, 2014

# Introduction

## The generic research question

- ▶ Are there long-run (1-5 years) abnormal stock returns following particular corporate events?
- ▶ E.g. acquisitions, share repurchases, seasoned equity offerings, dividend initiation/omission, stock splits, etc.

## Measure of abnormal returns

The Buy-and-Hold Abnormal Return (BHAR) for sample firm (stock)  $i$  is given by

$$BHAR_{i\tau} = \prod_{t=1}^{\tau} [1 + R_{it}] - \prod_{t=1}^{\tau} [1 + E(R_{it})]$$

where  $\tau$  is the number of post-event periods.

- ▶  $E(R_{it})$  may be the return on a single stock, the mean return on a handful of stocks or the return on a large portfolio.
- ▶ For a discussion of BHARs vs. Cumulative Abnormal Returns (CARs), see Barber and Lyon (1997).

# Multiple Control Firms

## Method I: Matching Characteristics

- ▶ Given a sample firm-year-month, identify closest size, book-to-market and beta matches and compute a BHAR for each.
- ▶ **Key:** we require that control firms be in the same size decile as the sample firm, or a higher one.
- ▶ **Replacement:** for each characteristic (size, book-to-market, beta), identify nine more matches (“backups”); place them on a stack, with the closest match on the top; if the sample (control) firm delists, “pop” a backup off the stack and fill the sample’s (control’s) return with the backup’s return; continue as needed.

## Method II: Maximal $R^2$

Given a sample firm-year-month, identify 10 closest size (market cap), 10 book-to-market and 10 beta matches. Find the combination of matches that maximizes the  $R^2$  of the regression of sample firm’s returns on matches’ returns.

# The Test

## BHARs

Denote the BHAR associated with sample firm  $i$  and matching characteristic  $m$  by  $\hat{\mu}_{im}$ . Organize the BHARs into the following vector:

$$\hat{\Gamma}' = (\hat{\mu}_{11}, \dots, \hat{\mu}_{1M}, \dots, \hat{\mu}_{N1}, \dots, \hat{\mu}_{NM})$$

where  $M$  is the number of matching characteristics (for us,  $M = 3$ ) and  $N$  is the number of observations (for us,  $N = 200$ ).

## Test Statistic

Assume  $(\mu_{\cdot,1}, \dots, \mu_{\cdot,M}) \sim \mathcal{N}(0, \Sigma_{M \times M})$ . Let  $S$  be an estimate of  $\Sigma_{M \times M}$ . The Wald statistic is given by

$$W = (\mathbf{1}\hat{\Gamma})'[A(S \otimes I)A']^{-1}(\mathbf{1}\hat{\Gamma})$$

where  $\mathbf{1}$  is a  $MN \times 1$  row vector of ones. Under the distributional assumption, we have that  $W \sim \chi^2(1)$ .

This is just the statistic you would use to test whether the sum of (well-behaved) regression coefficients is zero.

# Benchmarking

## Barber and Lyon (1997) and Lyon, Barber and Tsai (1999)

- ▶ Control firm BAHs aren't skewed, but aren't "powerful" either.
- ▶ Portfolio BHAs are "powerful," but also skewed ( $t$ -test has the wrong size).
- ▶ Solution: use size/book-to-market portfolio, but instead of conventional tests, use either a
  - ▶ bootstrapped skewness adjusted  $t$ -test or a
  - ▶ empirical  $p$ -value test (calculate  $p$ -values using empirical distribution).

## Notes

The bootstrapped skewness adjusted  $t$ -test becomes misspecified when the data is extended to 2013; the empirical  $p$ -value test continues to perform well.

# Simulation Specs

## Data

- ▶ CRSP firms (stocks) with available Compustat data from 1963 to 2013 (2.2m firm-year-months before restrictions; 1.5m after)
- ▶ **Restrictions:**
  - ▶ Five years of pre-event returns (to get beta – this is enforced after decile ranks have been assigned)
  - ▶ A pre-event value of common equity (to get book-to-market)

## Simulation

- ▶ We simulate **10,000** event studies consisting of **200** firm-year-months each (for the empirical  $p$ -value method, we will only simulate 1,000 event studies).
- ▶ In each simulated study, we test the null hypothesis of zero abnormal **1 year** returns.

# Random Samples (Fama-French Deciles 1A-10)

FAMA-FRENCH SIZE DECILES 1A - 10

METHOD	SPEC					
	EXP. RET.	1 CONTROL	PORTFOLIO	PORTFOLIO	PORTFOLIO	3 BIG CONTROLS
	FACTORS	SIZE/BTOM	SIZE/BTOM	SIZE/BTOM	SIZE/BTOM	BETA, SIZE, BTOM
	TEST	T-STAT	T-STAT	SKEW ADJ. T	EMPIRICAL P	WALD-STAT
POWER	INDUCED AR					
	-20.0%	91.26	95.06	75.45	100.00	94.24
	-15.0%	76.83	88.06	65.58	97.00	84.96
	-10.0%	47.43	68.36	45.77	78.60	61.81
	-5.0%	15.76	30.91	19.09	31.00	26.69
	0.0%	4.67	5.77	6.71	3.80	5.54
	5.0%	16.15	17.31	27.26	14.50	18.12
	10.0%	47.10	69.90	76.21	56.50	62.78
	15.0%	76.78	97.26	97.68	90.80	93.05
	20.0%	91.75	99.79	99.96	98.50	98.96
SIZE	SIG. LEVEL					
	99.5%	0.43	0.11	1.02	0.30	0.16
	97.5%	2.43	0.99	3.66	1.60	1.54
	95.0%	5.25	2.69	6.57	3.60	3.94
	0.5%	0.45	1.65	0.79	0.40	0.85
	2.5%	2.24	4.78	3.05	2.20	4.00
	5.0%	4.68	7.95	5.57	3.70	7.15
BHAR	STATISTIC					
	OBS.	1,492,879	1,493,492	1,493,492	1,493,492	1,476,879
	MEDIAN	-0.0001	-0.0534	-0.0534	-0.0534	-0.0120
	MEAN	0.0009	0.0012	0.0012	0.0012	0.0025
	STD.	0.8623	0.6550	0.6550	0.6550	0.8419
	SKEW	2.3697	15.8366	15.8366	15.8366	7.0999

# Whence Skewness?

SIZE DECILE SUMMARY STATS (2013 VALUES IN \$MIL)

DECILE	MONTHLY RETURNS			MEDIAN			2013	
	MEAN	STD. DEV.	SKEWNESS	SIZE	ASSETS	BOOK	DECILE	NO. FIRMS
1A	-0.0057	0.2182	0.0898	16.3	33.7	15.5	31.2	1482
1B	0.0065	0.1880	0.1164	46.9	101.9	34.7	63.4	1595
1C	0.0096	0.1681	0.1102	85.6	139.6	57.6	117.0	1536
1D	0.0121	0.1592	0.1030	166.2	258.9	100.0	207.7	1572
1E	0.0141	0.1497	0.0961	260.3	314.8	139.4	319.4	1551
2	0.0174	0.1464	0.0822	445.1	505.0	201.1	611.9	2226
3	0.0182	0.1328	0.0659	788.8	760.0	304.8	1002.4	1740
4	0.0186	0.1234	0.0536	1258.5	1065.8	448.4	1566.9	1578
5	0.0188	0.1173	0.0484	1879.9	1934.8	726.6	2347.3	1290
6	0.0185	0.1103	0.0391	2768.6	2769.5	802.7	3340.7	1104
7	0.0168	0.1035	0.0364	4108.9	3940.6	1308.6	5166.7	1092
8	0.0167	0.0986	0.0335	6921.1	5799.0	1898.2	9292.9	1026
9	0.0159	0.0913	0.0254	13345.6	10339.1	3948.1	21144.7	1038
10	0.0152	0.0822	0.0218	43495.7	46734.0	15203.8	401730.1	960



# Random Samples (Fama-French Deciles 1C-10)

FAMA-FRENCH SIZE DECILES 1C - 10

METHOD	SPEC					
	EXP. RET.	1 CONTROL	PORTFOLIO	PORTFOLIO	PORTFOLIO	3 BIG CONTROLS
	FACTORS	SIZE/BTOM	SIZE/BTOM	SIZE/BTOM	SIZE/BTOM	BETA, SIZE, BTOM
	TEST	T-STAT	T-STAT	SKEW ADJ. T	EMPIRICAL P	WALD-STAT
POWER	INDUCED AR					
	-20.0%	94.03	97.00	79.92	100.00	95.51
	-15.0%	82.25	91.75	72.07	97.50	87.78
	-10.0%	52.36	73.76	52.72	83.50	63.72
	-5.0%	18.07	34.42	22.24	34.80	24.14
	0.0%	4.65	5.93	6.03	5.70	4.80
	5.0%	19.05	20.16	29.49	18.80	25.12
	10.0%	53.21	76.23	80.21	63.20	75.31
	15.0%	82.93	98.76	98.69	95.70	97.38
	20.0%	94.68	99.91	99.98	99.50	99.58
SIZE	SIG. LEVEL					
	99.5%	0.46	0.06	0.98	0.40	0.26
	97.5%	2.36	0.90	2.99	2.80	2.27
	95.0%	5.01	2.46	5.46	5.40	4.77
	0.5%	0.50	1.43	0.69	0.70	0.57
	2.5%	2.29	5.03	3.04	2.90	2.53
	5.0%	5.06	8.41	5.95	5.00	4.92
BHAR	STATISTIC					
	OBS.	1,281,017	1,281,245	1,281,245	1,281,245	1,267,099
	MEDIAN	-0.0004	-0.0482	-0.0482	-0.0482	-0.0062
	MEAN	0.0012	-0.0003	-0.0003	-0.0003	0.0066
	STD.	0.7798	0.5991	0.5991	0.5991	0.7675
	SKEW	4.9388	16.8507	16.8507	16.8507	7.4484

# Biased Samples: Small Firms (Fama French Deciles 1C-1E)

FAMA-FRENCH SIZE DECILES 1C - 1D

METHOD	SPEC	1 CONTROL		PORTFOLIO		3 BIG CONTROLS	
	EXP. RET.	SIZE/BTOM	SIZE/BTOM	SIZE/BTOM	SIZE/BTOM	BETA, SIZE, BTOM	
	FACTORS	T-STAT	T-STAT	SKEW ADJ. T	EMPIRICAL P	WALD-STAT	
	TEST						
POWER	INDUCED AR						
	-20.0%	83.23	90.79	67.48	100.00	90.20	
	-15.0%	63.08	78.68	54.39	87.50	76.81	
	-10.0%	33.77	54.32	33.48	64.20	52.27	
	-5.0%	11.74	22.63	13.17	22.30	22.45	
	0.0%	5.03	5.25	5.93	4.50	5.87	
	5.0%	12.59	14.69	23.98	14.50	10.84	
	10.0%	35.17	56.80	65.77	41.10	42.97	
	15.0%	62.94	92.56	94.25	81.00	80.81	
	20.0%	83.01	99.64	99.72	97.70	96.92	
SIZE	SIG. LEVEL						
	99.5%	0.46	0.15	1.23	0.40	0.10	
	97.5%	2.58	1.34	3.83	2.30	1.11	
	95.0%	5.36	3.59	6.71	5.50	2.88	
	0.5%	0.46	1.27	0.46	0.40	1.56	
	2.5%	2.45	3.91	2.10	2.20	4.76	
	5.0%	4.72	6.96	4.35	3.80	8.23	
BHAR	STATISTIC						
	OBS.	230,081	230,081	230,081	230,081	227,585	
	MEDIAN	-0.0015	-0.0755	-0.0755	-0.0755	-0.0278	
	MEAN	0.0005	0.0047	0.0047	0.0047	-0.0024	
	STD.	0.9915	0.7336	0.7336	0.7336	0.9662	
	SKEW	-0.2780	6.1016	6.1016	6.1016	1.2154	

# Biased Samples: Large Firms (Fama French Deciles 9-10)

FAMA-FRENCH SIZE DECILES 9 - 10

METHOD	SPEC					
	EXP. RET.	1 CONTROL	PORTFOLIO	PORTFOLIO	PORTFOLIO	3 BIG CTRLS
	FACTORS	SIZE/BTOM	SIZE/BTOM	SIZE/BTOM	SIZE/BTOM	BETA, SIZE, BTOM
	TEST	T-STAT	T-STAT	SKEW ADJ. T	EMPIRICAL P	WALD-STAT
POWER	INDUCED AR					
	-20.0%	99.60	99.68	93.27	100.00	99.59
	-15.0%	99.06	99.38	93.37	99.70	99.24
	-10.0%	91.00	96.96	87.69	98.90	95.54
	-5.0%	41.78	65.50	51.17	68.40	56.27
	0.0%	4.82	6.35	5.74	5.40	5.01
	5.0%	44.71	51.91	55.26	58.10	57.40
	10.0%	93.98	99.17	99.00	97.50	98.48
	15.0%	99.88	100.00	100.00	100.00	99.93
	20.0%	99.99	100.00	100.00	100.00	100.00
SIZE	SIG. LEVEL					
	99.5%	0.57	0.11	0.59	0.50	0.28
	97.5%	2.82	0.92	2.24	2.30	2.17
	95.0%	5.52	2.37	4.14	5.10	4.44
	0.5%	0.38	1.57	0.98	0.90	0.74
	2.5%	2.00	5.43	3.50	3.10	2.84
	5.0%	4.28	9.29	6.69	5.20	5.50
BHAR	STATISTIC					
	OBS.	166,446	166,674	166,674	166,674	164,776
	MEDIAN	0.0007	-0.0243	-0.0243	-0.0243	0.0000
	MEAN	0.0020	-0.0034	-0.0034	-0.0034	0.0012
	STD.	0.4167	0.3393	0.3393	0.3393	0.4381
	SKEW	2.7429	6.0198	6.0198	6.0198	-0.0650

# Conclusions

## Items we're still working on:

- ▶ The test is misspecified in high/low book-to-market and high/low momentum samples. We're looking for solutions.
- ▶ Preliminary results suggest that the test is robust to clustering in time, but more work needs to be done.

## Things we've learned:

- ▶ The size/power tradeoff is persistent: multiple control firm matching increases the power of the test, but often results in misspecification.
- ▶ Of the two methods proposed by Lyon, Barber and Tsai, only the empirical  $p$ -value test survives during the post-1994 period.