Replicating Anomalies

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Most anomalies fail to replicate

Results

Replicate the published anomalies literature with 447 variables, controlling for microcaps via NYSE breakpoints and value-weights

- 286 (64%) with $t < 1.96$, 380 (85%) with $t < 3$, significant anomaly magnitudes much lower than originally reported
- Similar replication results in the original samples: 293 (66%) with $t < 1.96$, 387 (86.6%) with $t < 3$
- Out of 161, the q-factor model reduces 115 to insignificance ($t < 1.96$), 150 with $t < 3$

Outline

Outline

Lo and MacKinlay 1990, Fama 1998, Conrad, Cooper, and Kaul 2003, Schwert 2003, McLean and Pontiff 2016

Harvey, Liu, and Zhu 2016:

- 27–53% of 296 anomalies are false, adjusting for multi-testing
- Two publication biases: Hard to publish a nonresult, difficult to publish replication studies in finance and economics

Harvey 2017: P-hacking, selecting sample criteria and test specifications until insignificant results become significant

Motivation

Asset management:
$4.47 trillion worldwide in ETF/ETPs as of September 2017 per ETFGI

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Investors Always Think They're Getting Ripped Off. Here's Why They're Right

It's hard to beat the market, but we keep trying—and believing in—new products that promise to outperform.

By Peter Coy

Coy (2017): "Researchers have more knobs to twist in search of a prized 'anomaly...' They can vary the period, the set of securities under consideration, or even the statistical method. Negative findings go in a file drawer; positive ones get submitted to a journal (tenure!) or made into an ETF whose performance we rely on for retirement."

Outline

Fama (1998): Value weights accurately capture the wealth effect experienced by investors

Fama and French (2008): Microcaps are 60% of firms but only 3% of market cap, highest equal-weighted returns, largest cross-sectional dispersions in returns and anomaly variables

Many ways of overweighting microcaps:

- NYSE-Amex-NASDAQ breakpoints with equal-weights
- Cross-sectional regressions

Pure replication: To make or do something again in exactly the same way (Merriam Webster Online Dictionary)

Scientific replication: Different sample, different population, and perhaps similar but not identical model

- "[A]ppears much more suited in type to our methods of research and, indeed, comprises most of what economists view as replication (p. 716, our emphasis)"

See also the May 2017 issue of *American Economic Review*

Outline

Category	Number
Momentum	57
Value-versus-growth	68
Investment	38
Profitability	79
Intangibles	103
Trading frictions	102

Exclude financial firms and firms with negative book equity

Panel A: Momentum (57)

Sue1, Sue6, Sue12	Earnings surprise (1-, 6-, 12-month), Foster, Olsen, and Shevlin (1984)
Abr1, Abr6, Abr12	Cumulative abnormal stock returns around earnings announcements (1-, 6-, 12-month), Chan, Jegadeesh, and Lakonishok (1996)
Re1, Re6, Re12	Revisions in analysts' earnings forecasts (1-, 6-, 12-month), Chan, Jegadeesh, and Lakonishok (1996)
$R^6$1, $R^6$6, $R^6$12	Price momentum (6-month prior returns, 1-, 6-, 12-month), Jegadeesh and Titman (1993)
R^{11}1, R^{11}6, R^{11}12	Price momentum (11-month prior returns, 1-, 6-, 12-month), Fama and French (1996)
Im1, Im6, Im12	Industry momentum (1-, 6-, 12-month), Moskowitz and Grinblatt (1999)
Rs1, Rs6, Rs12	Revenue surprise (1-, 6-, 12-month), Jegadeesh and Livnat (2006)
Tes1, Tes6, Tes12	Tax expense surprise (1-, 6-, 12-month), Thomas and Zhang (2011)
dEf1, dEf6, dEf12	Analysts' forecast change (1-, 6-, 12-month), Hawkins, Chamberlin, and Daniel (1984)
Nei1, Nei6, Nei12	# consecutive quarters with earnings increases (1-, 6-, 12-month), Barth, Elliott, and Finn (1999)

52w1, 52w6, 52w12	52-week high (1-, 6-, and 12-month), George and Hwang (2004)
$\epsilon^{11}1$, $\epsilon^{11}6$, $\epsilon^{11}12$	11-month residual momentum (1-, 6-, 12-month), Blitz, Huij, and Martens (2011)
$\epsilon^{6}1$, $\epsilon^{6}6$, $\epsilon^{6}12$	6-month residual momentum (1-, 6-, 12-month), Blitz, Huij, and Martens (2011)
Sm1, Sm6, Sm12	Segment momentum (1-, 6-, 12-month), Cohen and Lou (2012)
Ilr1, Ilr6, Ilr12	Industry lead-lag effect in prior returns (1-, 6-, 12-month), Hou (2007)
Ile1, Ile6, Ile12	Industry lead-lag effect in earnings surprises (1-, 6-, 12-month), Hou (2007)
Cm1, Cm6, Cm12	Customer momentum (1-, 6-, 12-month), Cohen and Frazzini (2008)
Sim1, Sim6, Sim12	Supplier industries momentum (1-, 6-, 12-month), Menzly and Ozbas (2010)
Cim1, Cim6, Cim12	Customer industries momentum (1-, 6-, 12-month), Menzly and Ozbas (2010)

Panel B: Value-versus-growth (68)

Bm	Book-to-market equity, Rosenberg, Reid, and Lanstein (1985)
Bmj	Book-to-June-end market equity, Asness and Frazzini (2013)
Bm^q1, Bm^q6, Bm^q12	Book-to-current market equity (1-, 6-, 12-month), Asness and Frazzini (2013)
Dm	Debt-to-market, Bhandari (1988)
Dm^q1, Dm^q6, Dm^q12	Debt-to-market (1-, 6-, 12-month)
Am	Assets-to-market, Fama and French (1992)
Am^q1, Am^q6, Am^q12	Assets-to-market (1-, 6-, 12-month)
Rev1, Rev6, Rev12	Reversal (1-, 6-, 12-month), De Bondt and Thaler (1985)
Ep	Earnings-to-price, Basu (1983)
Ep^q1, Ep^q6, Ep^q12	Earnings-to-price (1-, 6-, 12-month)
Efp1, Efp6, Efp12	Analysts' earnings forecasts-to-price (1-, 6-, 12-month), Elgers, Lo, and Pfeiffer (2001)
Cp	Cash flow-to-price, Lakonishok, Shleifer, and Vishny (1994)
Cp^q1, Cp^q6, Cp^q12	Cash flow-to-price (1-, 6-, 12-month)
Dp	Dividend yield, Litzenberger and Ramaswamy (1979)
Dp^q1, Dp^q6, Dp^q12	Dividend yield (1-, 6-, 12-month)

Op	Payout yield, Boudoukh, Michaely, Richardson, and Roberts (2007)
Op^{q}1, Op^{q}6, Op^{q}12	Payout yield (1-, 6-, 12-month)
Nop	Net payout yield, Boudoukh, Michaely, Richardson, and Roberts (2007)
Nop^{q}1, Nop^{q}6, Nop^{q}12	Net payout yield (1-, 6-, 12-month)
Sr	Five-year sales growth rank, Lakonishok, Shleifer, and Vishny (1994)
Sg	Annual sales growth, Lakonishok, Shleifer, and Vishny (1994)
Em	Enterprise multiple, Loughran and Wellman (2011)
Em^{q}1, Em^{q}6, Em^{q}12	Enterprise multiple (1-, 6-, 12-month)
Sp	Sales-to-price, Barbee, Mukherji, and Raines (1996)
Sp^{q}1, Sp^{q}6, Sp^{q}12	Sales-to-price (1-, 6-, 12-month)
Ocp	Operating cash flow-to-price, Desai, Rajgopal, and Venkatachalam (2004)
Ocp^{q}1, Ocp^{q}6, Ocp^{q}12	Operating cash flow-to-price (1-, 6-, 12-month)

Ir	Intangible return, Daniel and Titman (2006)
Vhp	Intrinsic value-to-market, Frankel and Lee (1998)
Vfp	Analysts-based intrinsic value-to-market, Frankel and Lee (1998)
Ebp	Enterprise book-to-price, Penman, Richardson, and Tuna (2007)
$Ebp^{q}1$, $Ebp^{q}6$, $Ebp^{q}12$	Enterprise book-to-price (1-, 6-, 12-month)
Ndp	Net debt-to-price, Penman, Richardson, and Tuna (2007)
$Ndp^{q}1$, $Ndp^{q}6$, $Ndp^{q}12$	Net debt-to-price (1-, 6-, 12-month)
Dur	Equity duration, Dechow, Sloan, and Soliman (2004)
Ltg1, Ltg6, Ltg12	Long-term analysts' growth forecasts, La Porta (1996)

Panel C: Investment (38)

Aci	Abnormal corporate investment, Titman, Wei, and Xie (2004)
I/A	Investment-to-assets, Cooper, Gulen, and Schill (2008)
Ia^q1, Ia^q6, Ia^q12	Investment-to-assets (1-, 6-, 12-month)
dPia	Changes in PPE and inventory/assets, Lyandres, Sun, and Zhang (2008)
Noa	Net operating assets, Hirshleifer, Hou, Teoh, and Zhang (2004)
dNoa	Changes in net operating assets, Hou, Xue, and Zhang (2015)
dLno	Change in long-term net operating assets, Fairfield, Whisenant, and Yohn (2003)
Ig	Investment growth, Xing (2008)
2Ig	Two-year investment growth, Anderson and Garcia-Feijoo (2006)
3Ig	Three-year investment growth, Anderson and Garcia-Feijoo (2006)
Nsi	Net stock issues, Pontiff and Woodgate (2008)
dIi	% change in investment − % change in industry investment, Abarbanell and Bushee (1998)
Cei	Composite equity issuance, Daniel and Titman (2006)
Cdi	Composite debt issuance, Lyandres, Sun, and Zhang (2008)
Ivg	Inventory growth, Belo and Lin (2011)

447 Anomalies

Six categories of anomalies

Ivc	Inventory changes, Thomas and Zhang (2002)
Oa	Operating accruals, Sloan (1996)
Ta	Total accruals, Richardson, Sloan, Soliman, and Tuna (RSST, 2005)
dWc	Change in net non-cash working capital, RSST (2005)
dCoa	Change in current operating assets, RSST (2005)
dCol	Change in current operating liabilities, RSST (2005)
dNco	Change in net non-current operating assets, RSST (2005)
dNca	Change in non-current operating assets, RSST (2005)
dNcl	Change in non-current operating liabilities, RSST (2005)
dFin	Change in net financial assets, RSST (2005)
dSti	Change in short-term investments, RSST (2005)
dLti	Change in long-term investments, RSST (2005)
dFnl	Change in financial liabilities, RSST (2005)
dBe	Change in common equity, RSST (2005)
Dac	Discretionary accruals, Xie (2001)
Poa, Pta, Pda	Percent operating, total, discretionary accruals, Hafzalla, Lundholm, and Van Winkle (2011)
Nxf, Nef, Ndf	Net external, equity, debt financing, Bradshaw, Richardson, and Sloan (2006)

Panel D: Profitability (78)

Roe1, Roe6, Roe12	Return on equity (1-, 6-, 12-month), Hou, Xue, and Zhang (2015)
dRoe1, dRoe6, dRoe12	4-quarter Change in Roe (1-, 6-, 12-month)
Roa1, Roa6, Roa12	Return on assets (1-, 6-, 12-month), Balakrishnan, Bartov, and Faurel (2010)
dRoa1, dRoa6, dRoa12	4-quarter Change in Roa (1-, 6-, 12-month)
Rna	Return on net operating assets, Soliman (2008)
Pm	Profit margin, Soliman (2008)
Ato	Asset turnover, Soliman (2008)
Cto	Capital turnover, Haugen and Baker (1996)
Rna^q1, Rna^q6, Rna^q12	Return on net operating assets (1-, 6-, 12-month)
Pm^q1, Pm^q6, Pm^q12	Profit margin (1-, 6-, 12-month)
Ato^q1, Ato^q6, Ato^q12	Asset turnover (1-, 6-, 12-month)
Cto^q1, Cto^q6, Cto^q12	Capital turnover (1-, 6-, 12-month)
Gpa	Gross profits-to-assets, Novy-Marx (2013)
Gla	Gross profits-to-lagged assets

Gla^q1, Gla^q6, Gla^q12	Gross profits-to-lagged assets (1-, 6-, 12-month)
Ope	Operating profits-to-equity, Fama and French (2015)
Ole	Operating profits-to-lagged equity
Ole^q1, Ole^q6, Ole^q12	Operating profits-to-lagged equity (1-, 6-, 12-month)
Opa	Operating profits-to-assets, Ball, Gerakos, Linnainmaa, and Nikolaev (2015)
Ola	Operating profits-to-lagged assets
Ola^q1, Ola^q6, Ola^q12	Operating profits-to-lagged assets (1-, 6-, 12-month)
Cop	Cash-based operating profitability, Ball, Gerakos, Linnainmaa, and Nikolaev (2015b)
Cla	Cash-based operating profits-to-lagged assets
Cla^q1, Cla^q6, Cla^q12	Cash-based operating profits-to-lagged assets (1-, 6-, 12-month)
F	Fundamental (F) score, Piotroski (2000)
F^q1, F^q6, F^q12	Quarterly F-score (1-, 6-, 12-month)
Fp1, Fp6, Fp12	Failure probability (1-, 6-, 12-month), Campbell, Hilscher, and Szilagyi (2008)
O	O-score, Dichev (1998)
O^q1, O^q6, O^q12	Quarterly O-score (1-, 6-, 12-month)

Z	Z-score, Dichev (1998)
Z^q1, Z^q6, Z^q12	Quarterly Z-score (1-, 6-, 12-month)
G	Growth score, Mohanram (2005)
Cr1, Cr6, Cr12	Credit ratings (1-, 6-, 12-month), Avramov, Chordia, Jostova, and Philipov (2009)
Tbi	Taxable income-to-book income, Green, Hand, and Zhang (2013)
Tbi^q1, Tbi^q6, Tbi^q12	Quarterly taxable income-to-book income (1-, 6-, 12-month)
Bl	Book leverage, Fama and French (1992)
Bl^q1, Bl^q6, Bl^q12	Quarterly book leverage (1-, 6-, 12-month)
Sg^q1, Sg^q6, Sg^q12	Quarterly sales growth (1-, 6-, 12-month)

Panel E: Intangibles (103)

Oca	Organizational capital-to-assets, Eisfeldt and Papanikolaou (2013)
Ioca	Industry-adjusted organizational capital-to-assets, Eisfeldt and Papanikolaou (2013)
Adm	Advertising expense-to-market, Chan, Lakonishok, and Sougiannis (2001)
gAd	Growth in advertising expense, Lou (2014)
Rdm	R&D-to-market, Chan, Lakonishok, and Sougiannis (2001)
Rdm^q1, Rdm^q6, Rdm^q12	Quarterly R&D-to-market (1-, 6-, 12-month)
Rds	R&D-to-sales, Chan, Lakonishok, and Sougiannis (2001)
Rds^q1, Rds^q6, Rds^q12	Quarterly R&D-to-sales (1-, 6-, 12-month)
Ol	Operating leverage, Novy-Marx (2011)
Ol^q1, Ol^q6, Ol^q12	Quarterly operating leverage (1-, 6-, 12-month)
Hn	Hiring rate, Belo, Lin, and Bazdresch (2014)
Rca	R&D capital-to-assets, Li (2011)
Bca	Brand capital-to-assets, Belo, Lin, and Vitorino (2014)
Aop	Analysts optimism, Frankel and Lee (1998)

Pafe	Predicted analysts forecast error, Frankel and Lee (1998)
Parc	Patent-to-R&D capital, Hirshleifer, Hsu, and Li (2013)
Crd	Citations-to-R&D expense, Hirshleifer, Hsu, and Li (2013)
Hs	Industry concentration (sales), Hou and Robinson (2006)
Ha	Industry concentration (total assets), Hou and Robinson (2006)
He	Industry concentration (book equity), Hou and Robinson (2006)
Age1, Age6, Age12	Firm age (1-, 6-, 12-month), Jiang, Lee, and Zhang (2005)
D1	Price delay based on R^2, Hou and Moskowitz (2005)
D2	Price delay based on slopes, Hou and Moskowitz (2005)
D3	Price delay based on slopes adjusted for standard errors, Hou and Moskowitz (2005)
dSi	% change in sales − % change in inventory, Abarbanell and Bushee (1998)
dSa	% change in sales − % change in accounts receivable, Abarbanell and Bushee (1998)
dGs	% change in gross margin − % change in sales, Abarbanell and Bushee (1998)

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Six categories of anomalies

dSs	% change in sales − % change in SG&A, Abarbanell and Bushee (1998)
Etr	Effective tax rate, Abarbanell and Bushee (1998)
Lfe	Labor force efficiency, Abarbanell and Bushee (1998)
Ana1, Ana6, Ana12	Analysts coverage (1-, 6-, 12-month), Elgers, Lo, and Pfeiffer (2001)
Tan	Tangibility of assets, Hahn and Lee (2009)
Tan^{q}1, Tan^{q}6, Tan^{q}12	Quarterly tangibility (1-, 6-, 12-month)
Rer	Real estate ratio, Tuzel (2010)
Kz	The Kaplan-Zingales index, Lamont, Polk, and Saa-Requejo (2001)
Kz^{q}1, Kz^{q}6, Kz^{q}12	Quarterly Kaplan-Zingales index (1-, 6-, 12-month)
Ww	The Whited-Wu (2006) index
Ww^{q}1, Ww^{q}6, Ww^{q}12	Quarterly Whited-Wu index (1-, 6-, 12-month)
Sdd	Secured debt-to-total debt, Valta (2016)
Cdd	Convertible debt-to-total debt, Valta (2016)
Vcf1, Vcf6, Vcf12	Cash flow volatility (1-, 6-, 12-month), Huang (2009)
Cta1, Cta6, Cta12	Cash-to-assets (1-, 6-, 12-month), Palazzo (2012)

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Gind	Corporate governance, Gompers, Ishii, and Metrick (2003)
Acq, Acq^{q}1, Acq^{q}6, Acq^{q}12	Accrual quality (1-, 6-, 12-month) Francis, Lafond, Olsson, and Schipper (2005)
Eper	Earnings persistence, Francis, Lafond, Olsson, and Schipper (2004)
Eprd	Earnings predictability, Francis, Lafond, Olsson, and Schipper (2004)
Esm	Earnings smoothness, Francis, Lafond, Olsson, and Schipper (2004)
Evr	Value relevance of earnings, Francis, Lafond, Olsson, and Schipper (2004)
Etl	Earnings timeliness, Francis, Lafond, Olsson, and Schipper (2004)
Ecs	Earnings conservatism, Francis, Lafond, Olsson, and Schipper (2004)
Frm	Pension funding rate (scaled by market equity), Franzoni and Martin (2006)
Fra	Pension funding rate (scaled by assets), Franzoni and Martin (2006)

Ala	Asset liquidity (scaled by book assets), Ortiz-Molina and Phillips (2014)
Alm	Asset liquidity (scaled by market assets), Ortiz-Molina and Phillips (2014)
Ala^q1, Ala^q6, Ala^q12	Asset liquidity (book assets) (1-, 6-, 12-month)
Alm^q1, Alm^q6, Alm^q12	Asset liquidity (market assets) (1-, 6-, 12-month)
Dis1, Dis6, Dis12	Dispersion of analysts' earnings forecasts (1-, 6-, 12-month) Diether, Malloy, and Scherbina (2002)
Dlg1, Dlg6, Dlg12	Dispersion in analyst long-term growth forecasts (1-, 6-, 12-month) Anderson, Ghysels, and Juergens (2005)
Dls1, Dls6, Dls12	Disparity between long- and short-term earnings growth forecasts (1-, 6-, 12-month), Da and Warachka (2011)
Ob	Order backlog, Rajgopal, Shevlin, and Venkatachalam (2003)

R_a^1	12-month-lagged return, Heston and Sadka (2008)
R_n^1	Year 1–lagged return, nonannual, Heston and Sadka (2008)
$R_a^{[2,5]}$	Years 2–5 lagged returns, annual, Heston and Sadka (2008)
$R_n^{[2,5]}$	Years 2–5 lagged returns, nonannual, Heston and Sadka (2008)
$R_a^{[6,10]}$	Years 6–10 lagged returns, annual, Heston and Sadka (2008)
$R_n^{[6,10]}$	Years 6–10 lagged returns, nonannual, Heston and Sadka (2008)
$R_a^{[11,15]}$	Years 11–15 lagged returns, annual, Heston and Sadka (2008)
$R_n^{[11,15]}$	Years 11–15 lagged returns, nonannual, Heston and Sadka (2008)
$R_a^{[16,20]}$	Years 16–20 lagged returns, annual, Heston and Sadka (2008)
$R_n^{[16,20]}$	Years 16–20 lagged returns, nonannual, Heston and Sadka (2008)

Panel F: Trading frictions (102)

Me	Market equity, Banz (1981)
Iv	Idiosyncratic volatility, Ali, Hwang, and Trombley (2003)
Ivff1, Ivff6, Ivff12	Idiosyncratic volatility per the 3-factor model (1-, 6-, 12-month), Ang, Hodrick, Xing, and Zhang (2006)
Ivc1, Ivc6, Ivc12	Idiosyncratic volatility per the CAPM (1-, 6-, 12-month)
Ivq1, Ivq6, Ivq12	Idiosyncratic volatility per the q-factor model (1-, 6-, 12-month)
Tv1, Tv6, Tv12	Total volatility (1-, 6-, 12-month), Ang, Hodrick, Xing, and Zhang (2006)
Sv1, Sv6, Sv12	Systematic volatility (1-, 6-, 12-month), Ang, Hodrick, Xing, and Zhang (2006)
$\beta 1$, $\beta 6$, $\beta 12$	Market beta (1-, 6-, 12-month), Fama and MacBeth (1973)
$\beta^{FP}1$, $\beta^{FP}6$, $\beta^{FP}12$	The Frazzini-Pedersen (2014) beta (1-, 6-, 12-month)
$\beta^{D}1$, $\beta^{D}6$, $\beta^{D}12$	The Dimson (1979) beta (1-, 6-, 12-month)
Srev	Short-term reversal, Jegadeesh (1990)
Tur1, Tur6, Tur12	Share turnover (1-, 6-, 12-month), Datar, Naik, and Radcliffe (1998)

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Cvt1, Cvt6, Cvt12	Coefficient of variation for share turnover (1-, 6-, 12-month), Chordia, Subrahmanyam, and Anshuman (2001)
Dtv1, Dtv6, Dtv12	Dollar trading volume (1-, 6-, 12-month), Brennan, Chordia, and Subrahmanyam (1998)
Cvd1, Cvd6, Cvd12	Coefficient of variation for dollar trading volume (1-, 6-, 12-month), Chordia, Subrahmanyam, and Anshuman (2001)
Pps1, Pps6, Pps12	Share price (1-, 6-, 12-month), Miller and Scholes (1982)
Ami1, Ami6, Ami12	Absolute return-to-volume (1-, 6-, 12-month), Amihud (2002)
$Lm^1$1, $Lm^1$6, $Lm^1$12	Prior 1-month turnover-adjusted number of zero daily trading volume (1-, 6-, 12-month), Liu (2006)
$Lm^6$1, $Lm^6$6, $Lm^6$12	Prior 6-month turnover-adjusted number of zero daily trading volume (1-, 6-, 12-month), Liu (2006)
Lm^{12}1, Lm^{12}6, Lm^{12}12	Prior 12-month turnover-adjusted number of zero daily trading volume (1-, 6-, 12-month), Liu (2006)
Mdr1, Mdr6, Mdr12	Maximum daily return (1-, 6-, 12-month), Bali, Cakici, and Whitelaw (2011)
Ts1, Ts6, Ts12	Total skewness (1-, 6-, 12-month), Bali, Engle, and Murray (2015)
Isc1, Isc6, Isc12	Idiosyncratic skewness per the CAPM (1-, 6-, 12-month)

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Six categories of anomalies

Isff1, Isff6, Isff12	Idiosyncratic skewness per the 3-factor model (1-, 6-, 12-month)
Isq1, Isq6, Isq12	Idiosyncratic skewness per the q-factor model (1-, 6-, 12-month)
Cs1, Cs6, Cs12	Coskewness (1-, 6-, 12-month), Harvey and Siddique (2000)
$\beta^{-}1$, $\beta^{-}6$, $\beta^{-}12$	Downside beta (1-, 6-, 12-month), Ang, Chen, and Xing (2006)
Tail1, Tail6, Tail12	Tail risk (1-, 6-, 12-month), Kelly and Jiang (2014)
$\beta^{\text{ret}}1$, $\beta^{\text{ret}}6$, $\beta^{\text{ret}}12$	Liquidity beta (return-return) (1-, 6-, 12-month), Acharya and Pedersen (2005)
$\beta^{\text{lcc}}1$, $\beta^{\text{lcc}}6$, $\beta^{\text{lcc}}12$	Liquidity beta (illiquidity-illiquidity) (1-, 6-, 12-month), Acharya and Pedersen (2005)
$\beta^{\text{lrc}}1$, $\beta^{\text{lrc}}6$, $\beta^{\text{lrc}}12$	Liquidity beta (return-illiquidity) (1-, 6-, 12-month), Acharya and Pedersen (2005)
$\beta^{\text{lcr}}1$, $\beta^{\text{lcr}}6$, $\beta^{\text{lcr}}12$	Liquidity beta (illiquidity-return) (1-, 6-, 12-month), Acharya and Pedersen (2005)
$\beta^{\text{net}}1$, $\beta^{\text{net}}6$, $\beta^{\text{net}}12$	Net liquidity beta (1-, 6-, 12-month), Acharya and Pedersen (2005)
Shl1, Shl6, Shl12	The high-low bid-ask spread estimator (1-, 6-, 12-month), Corwin and Schultz (2012)
Sba1, Sba6, Sba12	Bid-ask spread (1-, 6-, 12-month), Hou and Loh (2015)
$\beta^{\text{Lev}}1$, $\beta^{\text{Lev}}6$, $\beta^{\text{Lev}}12$	Leverage beta (1-, 6-, 12-month), Adrian, Etula, and Muir (2014)

Outline

Despite our low t-cutoff of 1.96, 286 anomalies (64%) cannot be replicated, 380 (85%) with $t < 3$

Anomalies that cannot be replicated across categories:

	Number	%
Momentum	20	35%
Value-versus-growth	37	54%
Investment	11	29%
Profitability	46	58%
Intangibles	77	75%
Trading frictions	95	93%

Replication Results

Similar results in the original samples

Anomalies existed, but are traded away once publicized?

In the original samples, 293 anomalies (66%) cannot be replicated ($t < 1.96$), 387 (86.6%) with $t < 3$

	Number	%
Momentum	24	42%
Value-versus-growth	44	65%
Investment	13	34%
Profitability	38	48%
Intangibles	81	79%
Trading frictions	93	91%

Replication Results

NYSE-Amex-NASDAQ breakpoints and equal-weights: Quantifying how equal-weighting "inflates" anomalies

181 anomalies (40%) cannot be replicated ($t < 1.96$),
241 (54%) with $t < 3$

	Number	%
Momentum	9	16%
Value-versus-growth	14	21%
Investment	1	3%
Profitability	36	46%
Intangibles	59	57%
Trading frictions	62	61%

The inflation rate on the average absolute return spread is 42%, ranging from 27% for momentum and 56% for trading frictions

Replication Results

Momentum anomalies not replicated, NYSE breakpoints and value-weights

	Sue6	Sue12	Re12	$R^{11}12$	Rs6	Rs12	Tes1	Tes6	Tes12	Nei12
m	0.19	0.11	0.28	0.43	0.14	0.06	0.26	0.28	0.18	0.14
t_m	1.65	1.00	1.47	1.92	1.01	0.44	1.56	1.90	1.34	1.36
	52w1	52w12	$\epsilon^6 1$	Sm6	Sm12	Ile6	Ile12	Cm6	Sim6	Sim12
m	0.14	0.45	0.20	0.09	0.14	0.27	0.11	0.18	0.12	0.15
t_m	0.43	1.88	1.20	0.88	1.87	1.79	0.84	1.83	1.11	1.80

Chan, Jegadeesh, and Lakonishok (1996): Buy-and-hold Sue return of 1.13% with equal-weights

Jegadeesh and Livnat (2006): Buy-and-hold Rs return of 0.73% with NYSE-Amex-NASDAQ breakpoints and equal-weights

Thomas and Zhang (2011): Buy-and-hold Tes return of 1.3% with NYSE-Amex-NASDAQ breakpoints and equal-weights

Replication Results

Value-versus-growth anomalies not replicated, NYSE breakpoints and value-weights

	$Bm^{q}1$	$Bm^{q}6$	Dm	$Dm^{q}1$	$Dm^{q}6$	$Dm^{q}12$	Am	$Am^{q}1$	$Am^{q}6$	$Am^{q}12$	Efp6	Efp12	Dp
m	0.46	0.45	0.31	0.30	0.27	0.32	0.36	0.37	0.42	0.40	0.43	0.40	0.21
t_m	1.79	1.90	1.59	1.26	1.17	1.50	1.72	1.33	1.58	1.69	1.78	1.71	0.86
	$Dp^{q}1$	$Dp^{q}6$	$Dp^{q}12$	Op	$Op^{q}1$	$Op^{q}6$	$Op^{q}12$	$Nop^{q}1$	$Nop^{q}6$	$Nop^{q}12$	Sr	Sg	$Ocp^{q}6$
m	0.26	0.19	0.20	0.37	0.10	0.10	0.17	0.22	0.25	0.31	−0.20	−0.01	0.51
t_m	1.02	0.76	0.85	1.70	0.42	0.52	0.87	0.91	1.14	1.48	−1.08	−0.08	1.89
	$Ocp^{q}12$	$Ebp^{q}1$	$Ebp^{q}6$	$Ebp^{q}12$	Ndp	$Ndp^{q}1$	$Ndp^{q}6$	$Ndp^{q}12$	Ltg1	Ltg6	Ltg12		
m	0.41	0.27	0.26	0.35	0.31	0.17	0.18	0.27	−0.03	−0.04	−0.01		
t_m	1.71	1.00	1.01	1.44	1.62	0.71	0.77	1.22	−0.09	−0.10	−0.02		

Lakonishok, Shleifer, and Vishny (1994): −0.61% for Sr with NYSE-Amex breakpoints and equal-weights (no NASDAQ)

Penman, Richardson, and Tuna (2007): 0.73% for Ndp with NYSE-Amex-NASDAQ breakpoints and equal-weights

Replication Results

Investment anomalies not replicated, NYSE breakpoints and value-weights

	Ia^q1	3Ig	Cdi	Ta	dCol	dNcl	dSti	dLti	dBe	Nxf	Nef
m	−0.32	−0.21	−0.00	−0.23	−0.11	−0.11	0.15	−0.22	−0.31	−0.27	−0.17
t_m	−1.72	−1.46	−0.01	−1.63	−0.76	−0.95	0.98	−1.44	−1.89	−1.44	−0.86

Richardson, Sloan, Soliman, and Tuna (2005): −1.11% (size-adjusted) for Ta with NYSE-Amex-NASDAQ breakpoints and equal-weights

Bradshaw, Richardson, and Sloan (2006): −1.29% (size-adjusted) for Nxf and −0.93% for Nef with NYSE-Amex-NASDAQ breakpoints and equal-weights

Replication Results

Profitability anomalies not replicated, NYSE breakpoints and value-weights

	Roe6	Roe12	Roa6	Roa12	dRoa12	Rna	Pm	Ato	Cto	Rna^{q}1	Rna^{q}12	Pm^{q}1
m	0.42	0.24	0.39	0.25	0.21	0.12	0.01	0.32	0.27	0.43	0.35	0.35
t_m	1.95	1.19	1.78	1.26	1.78	0.63	0.03	1.76	1.60	1.95	1.63	1.59
	Pm^{q}6	Pm^{q}12	Gla	Ope	Ole	Ole^{q}12	Opa	Ola	F	Fp	Fp^{q}1	Fp^{q}12
m	0.17	0.18	0.16	0.25	0.07	0.35	0.37	0.20	0.29	−0.38	−0.48	−0.36
t_m	0.82	0.89	1.04	1.20	0.37	1.78	1.87	1.07	1.06	−1.28	−1.43	−1.25
	O	O^{q}1	O^{q}6	O^{q}12	Z	Z^{q}1	Z^{q}6	Z^{q}12	G	Cr1	Cr6	Cr12
m	−0.06	−0.36	−0.21	−0.14	−0.00	0.01	−0.03	−0.09	0.27	0.04	0.01	0.01
t_m	−0.30	−1.57	−0.96	−0.64	−0.02	0.06	−0.15	−0.46	1.35	0.12	0.02	0.03
	Tbi	Tbi^{q}1	Tbi^{q}6	Bl	Bl^{q}1	Bl^{q}6	Bl^{q}12	Sg^{q}1	Sg^{q}6	Sg^{q}12		
m	0.16	0.17	0.21	−0.02	0.10	0.13	0.10	0.32	0.14	−0.06		
t_m	1.20	1.28	1.84	−0.10	0.58	0.73	0.55	1.81	0.86	−0.40		

Replication Results

The distress anomaly virtually nonexistent

Campbell, Hilscher, and Szilagyi (2008): Fp -0.81% in the 1981–2003 sample with NYSE-Amex-NASDAQ breakpoints

- We find $+0.69\%$ per month for Fp from 7/1976 to 12/1980

Dichev (1998): -1.17% for the highest-10%-minus-lowest-70% O portfolio with NYSE-Amex-NASDAQ breakpoints and equal-weights

Avramov, Chordia, Jostova, and Philipov (2009): -1.09% for Cr with NYSE-Amex-NASDAQ breakpoints and equal-weights

Replication Results

Intangibles, 77 out of 103 (75%) not replicated, prominent examples

	Variable	Authors	Original estimates	Our estimates	Original methods
Dis	Dispersion of analysts forecasts	Diether, Malloy, Scherbina (2002)	−0.79% (−2.88)	−0.24% (−0.89)	All breakpoints, equal-weights, $5 price screen
Gind	Corporate governance	Gompers, Ishii, Metrick (2003)	−0.71% (−2.73)	0.02% (0.06)	Carhart alpha
Acq	Accruals quality	Francis, LaFond, Olsson, Schipper (2005)		−0.07% (−0.36)	E/P as cost of equity

Replication Results

Trading frictions, 95 out of 102 (93%) not replicated, including the low volatility anomaly

	Iv	Ivff1	Ivff6	Ivff12	Ivc1	Ivc6	Ivc12	Ivq1
m	−0.22	−0.51	−0.33	−0.18	−0.48	−0.32	−0.20	−0.48
t_m	−0.66	−1.62	−1.11	−0.62	−1.48	−1.07	−0.69	−1.53
	Ivq6	Ivq12	Tv1	Tv6	Tv12	Sv1	Sv6	Sv12
m	−0.30	−0.19	−0.40	−0.25	−0.20	−0.53	−0.19	−0.16
t_m	−1.05	−0.68	−1.16	−0.77	−0.62	−2.47	−1.36	−1.43

15 out of 16 idiosyncratic, total, and systematic volatility measures are insignificant with NYSE breakpoints, similar with equal-weights

Ang, Hodrick, Xing, and Zhang (2006): $-1.06\%, -0.97\%, -1.04\%$ ($t = -3.1, -2.86, -3.9$) for Ivff1, Tv1, and Sv1, respectively, with NYSE-Amex-NASDAQ breakpoints

Replication Results

Traditional liquidity measures decimated:
43 out of 46 (93%) not replicated with value-weights, 100% with t-cutoff = 3

	Tur1	Tur6	Tur12	Cvt1	Cvt6	Cvt12	Dtv1	Dtv6	Dtv12	Cvd1	Cvd6	Cvd12
m	−0.15	−0.14	−0.10	0.13	0.11	0.17	−0.27	−0.37	−0.42	0.10	0.12	0.18
t_m	−0.57	−0.53	−0.38	0.87	0.73	1.26	−1.45	−1.99	−2.28	0.65	0.85	1.25
	Pps1	Pps6	Pps12	Ami1	Ami6	Ami12	$\text{Lm}^1$1	$\text{Lm}^1$6	$\text{Lm}^1$12	$\text{Lm}^6$1	$\text{Lm}^6$6	$\text{Lm}^6$12
m	−0.02	0.04	−0.04	0.28	0.37	0.42	−0.07	0.21	0.20	0.38	0.35	0.30
t_m	−0.06	0.15	−0.14	1.31	1.73	1.99	−0.33	0.95	0.93	1.82	1.67	1.40
	Lm^{12}1	Lm^{12}6	Lm^{12}12	β^{ret}1	β^{ret}6	β^{ret}12	β^{lcc}1	β^{lcc}6	β^{lcc}12	β^{lrc}1	β^{lrc}6	β^{lrc}12
m	0.38	0.33	0.24	0.04	0.01	0.19	0.34	0.31	0.31	0.05	0.02	0.05
t_m	1.78	1.57	1.13	0.12	0.03	1.13	1.54	1.45	1.49	0.17	0.07	0.17
	β^{lcr}1	β^{lcr}6	β^{lcr}12	β^{net}1	β^{net}6	β^{net}12	Srev	β^{lev}1	β^{lev}6	β^{lev}12		
m	0.06	−0.02	−0.05	0.14	0.15	0.10	−0.26	0.43	0.30	0.25		
t_m	0.46	−0.17	−0.49	0.41	0.47	0.32	−1.31	1.78	1.31	1.15		

Cross-sectional regressions:

- Datar, Naik, and Radcliffe (1998, share turnover)
- Chordia, Subrahmanyam, and Anshuman (2001, dollar trading volume and its coefficient of variation)
- Amihud (2002, absolute return-to-volume)
- Acharya and Pedersen (2005, liquidity betas)

Jegadeesh (1990): NYSE-Amex-NASDAQ breakpoints and equal-weights, -1.99% ($t = -12.55$)

Liu (2006): NYSE breakpoints and equal-weights, up to 0.85% ($t = 4.4$), 8 out of 9 measures significant

Adrian, Etula, Muir (2014): Me-Bm-R^{11} portfolios as basis assets

Replication Results

Replicated anomalies: Magnitudes much lower than originally reported

	Anomaly	Original authors	Original estimates	Our estimates	Original methods
Abr6	Abnormal returns around earnings announcements	Chan, Jegadeesh, Lakonishok (1996)	0.98%	0.30% (3.24)	Buy-and-hold, equal-weights
Abr12	Abnormal returns around earnings announcements	Chan, Jegadeesh, Lakonishok (1996)	0.69%	0.22% (2.84)	Buy-and-hold, equal-weights
Re6	Revisions in analysts' earnings forecasts	Chan, Jegadeesh, Lakonishok	1.28%	0.54% (2.49)	Buy-and-hold, equal-weights
Re12	Revisions in analysts' earnings forecasts	Chan, Jegadeesh, Lakonishok	0.81%	0.28% (1.47)	Buy-and-hold, equal-weights

Replication Results

Replicated anomalies: Magnitudes much lower than originally reported

	Anomaly	Original authors	Original estimates	Our estimates	Original methods
$R^6 6$	Prior 6-month returns, 6-month holding period	Jegadeesh, Titman (1993)	1.10% (3.61)	0.82% (3.49)	NYSE-Amex breakpoints, equal-weights
$R^6 12$	Prior 6-month returns, 12-month holding period	Jegadeesh, Titman (1993)	0.90% (3.54)	0.55% (2.90)	NYSE-Amex breakpoints, equal-weights
Cm1	Customer momentum, 1-month holding period	Cohen, Frazzini (2008)	1.58% (3.79)	0.79% (3.74)	All breakpoints, value-weights, \$5 price screen

Replication Results

Replicated anomalies: Magnitudes much lower than originally reported

	Anomaly	Original authors	Original estimates	Our estimates	Original methods
Cp	Cash flow-to-price	Lakonishok, Shleifer, Vishny (1994)	0.83%	0.49% (2.47)	NYSE-Amex breakpoints, equal-weights
Ocp	Operating cash flow-to-price	Desai, Rajgopal, Venkatachalam (2004)	1.24% (2.65)	0.77% (3.50)	All breakpoints, equal-weights
I/A	Investment-to-assets	Cooper, Gulen, Schill (2008)	−1.05% (−5.04)	−0.46% (−2.92)	All breakpoints, value-weights
			−1.73% (−8.45)		All breakpoints, equal-weights
Oa	Operating accruals	Sloan (1996)	−0.87% (−4.71)	−0.27% (−2.13)	NYSE-Amex breakpoints, equal-weights, size-adjusted

Outline

The Fama-French (1993) 3-factor model: MKT, SMB, HML

The Carhart (1997) 4-factor model: MKT, SMB, HML, UMD

The Hou-Xue-Zhang (2015) q-factor model:
MKT, the Size factor, the Investment factor, the Roe factor

The Fama-French (2015) 5-factor model:
MKT, SMB, HML, CMA, RMW

q-factor Regressions

Factor spanning tests, 1967–2014

	Average returns	Carhart alphas	5-factor alphas	q-factor alphas
The investment factor	0.43	0.29	0.12	
	(5.08)	(4.57)	(3.35)	
The Roe factor	0.56	0.51	0.45	
	(5.24)	(5.58)	(5.60)	
RMW	0.27			0.04
	(2.58)			(0.42)
CMA	0.34			0.01
	(3.63)			(0.32)
UMD	0.67			0.11
	(3.66)			(0.43)

Out of 161, 46 q-factor alphas significant, 11 with $t \geq 3$

Form a composite measure for each category of q-anomalies by averaging a stock's NYSE percentile rankings:

	Mom	VvG	Inv	Prof	Intan	Fric	All
m	1.10	0.60	0.60	0.71	1.08	0.14	1.66
t_m	5.72	2.94	4.27	4.17	6.92	0.92	10.28
α_q	0.86	0.41	0.69	0.58	0.85	0.16	1.40
t_q	3.67	2.09	4.28	4.11	5.08	1.52	7.48

Replicate the published anomalies literature with 447 variables, controlling for microcaps via NYSE breakpoints and value-weights

- 286 (64%) with $t < 1.96$, 380 (85%) with $t < 3$; magnitudes of replicated anomalies much lower than originally reported
- Similar replication results in the original samples: 293 (66%) insignificant, 387 (86.6%) with $t < 3$
- Out of 161, 46 q-factor alphas significant (11 with $t \geq 3$)

Equity markets are more efficient than previously recognized

Relative market efficiency doesn't mean holding the market index, which is only one of several (many?) dimensions in the cross section

A multifactor world: Investment, Roe, value, and momentum are equilibrium phenomena that are persistent but time-varying

Plenty of room for asset management in terms of helping investors achieve better risk-return tradeoff