# 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 $t < 3$
- Replicated anomalies much weaker than originally reported
- Similar replication results in the original samples: 293 (66%) with $t < 1.96$, 387 (86.6%) with $t < 3$

# Outline

1 Motivating Replication

2 Replicating Procedures

3 447 Anomalies

4 Replication Results

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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

## ETFGI: $5.15 trillion worldwide in ETF/ETPs as of January 2018

April 6, 2017, 1:02 PM EDT Corrected April 13, 2017, 12:37 PM EDT

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

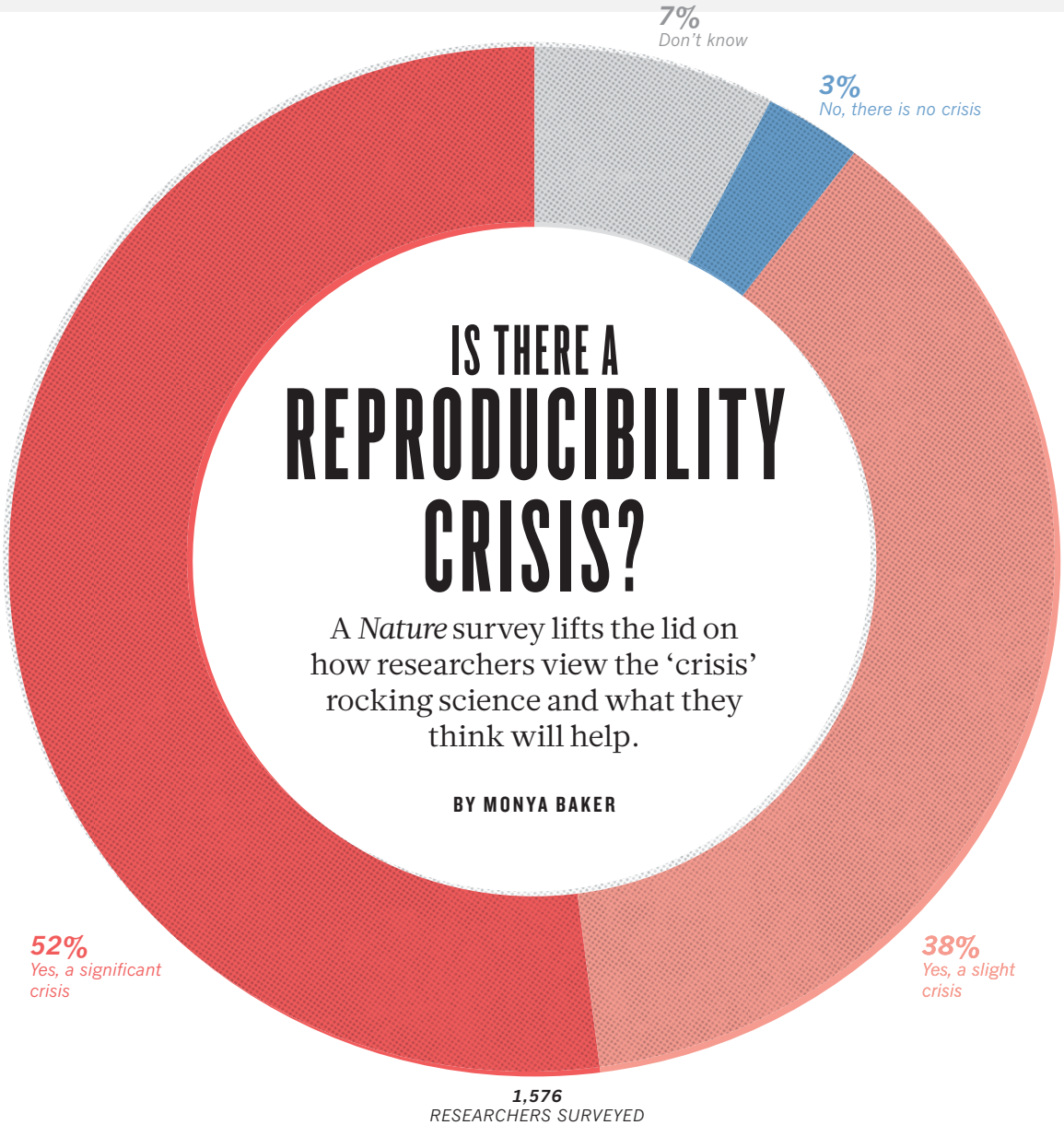
It's hard to beat the market, but we keep trying—and believing in—new products that promise to outperform.

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."

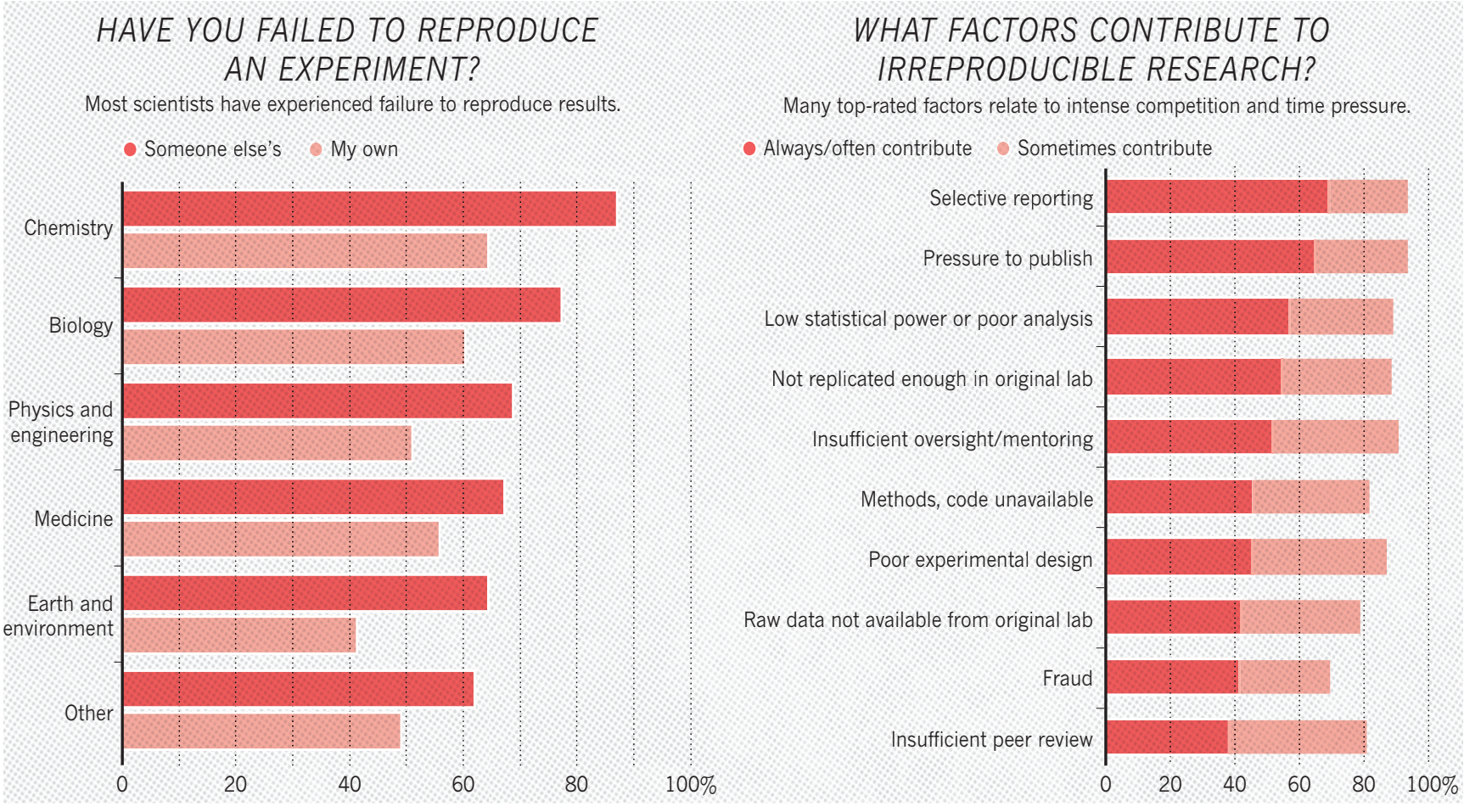
# Motivation

## Evidence: Baker (2016, *Nature*)



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# Motivation

## Ioannidis (2005, "Why most published research findings are false")

Studies are more likely false when:

- Samples are smaller
- The effects are smaller
- There are many but fewer theoretically predicted relations
- Flexibility is greater in designs, variable definitions, and specifications
- There are greater financial interest and bias
- More independent teams are involved

Most, if not all, apply to the anomalies literature

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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 do something again in exactly the same way

Statistical replication: Different sample, but the identical model and underlying population

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)"

Use the same definition in all eight articles on replication:

- Berry, Coffman, Hanley, Gihleb, and Wilson (2017)
- Sukhtankar (2017)
- Hamermesh (2017)
- Coffman, Niederle, and Wilson (2017)
- Duvendack, Palmer-Jones, and Reed (2017)
- Hoffler (2017)
- Anderson and Kichkha (2017)
- Chang and Li (2017)

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

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) |

# 447 Anomalies

## 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) |

# 447 Anomalies

## Six categories of anomalies

| | |
|---|---|
| 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) |

# 447 Anomalies

## Six categories of anomalies

| | |
|---|---|
| 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) |

# 447 Anomalies

## 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

1 Motivating Replication

2 Replicating Procedures

3 447 Anomalies

4 Replication Results

# Replication Results

## Overview based on NYSE breakpoints and value-weights

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 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: How equal-weighting "inflates" anomalies?

181 (40%) not 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

| | 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

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

| | $Dp^q1$ | $Dp^q6$ | $Dp^q12$ | Op | $Op^q1$ | $Op^q6$ | $Op^q12$ | $Nop^q1$ | $Nop^q6$ | $Nop^q12$ | Sr | Sg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $m$ | 0.26 | 0.19 | 0.20 | 0.37 | 0.10 | 0.10 | 0.17 | 0.22 | 0.25 | 0.31 | −0.20 | −0.01 |
| $t_m$ | 1.02 | 0.76 | 0.85 | 1.70 | 0.42 | 0.52 | 0.87 | 0.91 | 1.14 | 1.48 | −1.08 | −0.08 |
| | $Ocp^q12$ | $Ebp^q1$ | $Ebp^q6$ | $Ebp^q12$ | Ndp | $Ndp^q1$ | $Ndp^q6$ | $Ndp^q12$ | Ltg1 | Ltg6 | Ltg12 | $Ocp^q6$ |
| $m$ | 0.41 | 0.27 | 0.26 | 0.35 | 0.31 | 0.17 | 0.18 | 0.27 | −0.03 | −0.04 | −0.01 | 0.51 |
| $t_m$ | 1.71 | 1.00 | 1.01 | 1.44 | 1.62 | 0.71 | 0.77 | 1.22 | −0.09 | −0.10 | −0.02 | 1.89 |

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

| | Ia$^{q}$1 | 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 (distress) anomalies not replicated

| | 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 |

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

- +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

# Replication Results

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

| | 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, 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, 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 |
| | $\text{Lm}^{12}$1 | $\text{Lm}^{12}$6 | $\text{Lm}^{12}$12 | $\beta^{\text{ret}}$1 | $\beta^{\text{ret}}$6 | $\beta^{\text{ret}}$12 | $\beta^{\text{lcc}}$1 | $\beta^{\text{lcc}}$6 | $\beta^{\text{lcc}}$12 | $\beta^{\text{lrc}}$1 | $\beta^{\text{lrc}}$6 | $\beta^{\text{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 |
| | $\beta^{\text{lcr}}$1 | $\beta^{\text{lcr}}$6 | $\beta^{\text{lcr}}$12 | $\beta^{\text{net}}$1 | $\beta^{\text{net}}$6 | $\beta^{\text{net}}$12 | Srev | $\beta^{\text{lev}}$1 | $\beta^{\text{lev}}$6 | $\beta^{\text{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, from 0.18% ($t = 0.93$) to 0.85% ($t = 4.4$), 8 out of 9 measures significant

# 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 |

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 $t < 3$
- Replicated anomalies much weaker than originally reported
- Similar replication results in the original samples: 293 (66%) with $t < 1.96$, 387 (86.6%) with $t < 3$

Capital markets are more efficient than previously recognized

A different rationale for asset management from behavioral finance

In a world with cross-sectionally varying expected returns, the market factor is only one of several dimensions in the cross section

Plenty of room for asset management in relatively efficient equity markets, to help investors achieve better risk-return tradeoff