q^5

Kewei Hou[1] Haitao Mo[2] Chen Xue[3] Lu Zhang[1]

[1]Ohio State

[2]LSU

[3]U. of Cincinnati

2019 JHU Carey Finance Conference
June 28, 2019

Augmenting the Hou-Xue-Zhang (2015) q-factor model with an expected growth factor to form the q^5 model:

$$\begin{aligned} E[R_i - R_f] &= \beta^i_{\text{MKT}}\, E[\text{MKT}] + \beta^i_{\text{Me}}\, E[R_{\text{Me}}] \\ &\quad + \beta^i_{\text{I/A}}\, E[R_{\text{I/A}}] + \beta^i_{\text{Roe}}\, E[R_{\text{Roe}}] + \beta^i_{\text{Eg}}\, E[R_{\text{Eg}}] \end{aligned}$$

Stress-testing factor models with a large set of 150 anomalies:

- The q^5 model improves on the q-factor model substantially
- The q-factor model already compares favorably with the Fama-French (2018) 6-factor model

Outline

Outline

The Expected Growth Factor

Economic foundation, Cochrane (1991)

In the multiperiod investment framework:

$$r_{t+1} \approx \frac{X_{t+1} + (1-\delta)\left[1 + a\left(I_{t+1}/A_{t+1}\right)\right]}{1 + a\left(I_t/A_t\right)}$$

The "dividend yield" component, $X_{t+1}/[1 + a\left(I_t/A_t\right)]$, motivates the q-factor model

The "capital gain" component roughly proportional to investment-to-assets growth, $\left(I_{t+1}/A_{t+1}\right)/\left(I_t/A_t\right)$

Forecast $d^{\tau}I/A$, τ-year ahead investment-to-assets changes, with monthly cross-sectional regressions

Motivating predictors based on a priori conceptual arguments:

- Tobin's q: Erickson and Whited (2000)
- Cash flows: Fazzari, Hubbard, and Petersen (1988)
- Change in return on equity: Liu, Whited, and Zhang (2009)

Cash flows: We use the cash-based operating profitability from Ball, Gerakos, Linnainmaa, and Nikolaev (2016)

- Total revenue minus cost of goods sold, minus SG&A, plus R&D, minus change in accounts receivable, minus change in inventory, minus change in prepaid expenses, plus change in deferred revenue, plus change in trade accounts payable, and plus change in accrued expenses, all scaled by book assets

dRoe: Capturing short-term dynamics of investment growth

The Expected Growth Factor

Monthly cross-sectional regressions of future investment-to-assets changes, 7/1963–12/2018

τ	$\log(q)$	Cop	dRoe	R^2	Pearson	Rank
1	−0.03	0.52	0.77	6.42	0.14	0.21
	(−5.63)	(12.75)	(7.62)		[0.00]	[0.00]
2	−0.07	0.70	0.91	8.61	0.15	0.22
	(−9.76)	(12.34)	(10.07)		[0.00]	[0.00]
3	−0.09	0.75	0.72	8.98	0.15	0.22
	(−12.39)	(12.17)	(8.60)		[0.00]	[0.00]

Relatively reliable out-of-sample correlations with subsequent, realized investment-to-assets changes

The Expected Growth Factor

Properties of the expected growth deciles, 1/1967–12/2018

Low	2	3	4	5	6	7	8	9	High	H−L
Average excess returns, $\overline{R}$										
−0.12	0.20	0.28	0.42	0.45	0.49	0.56	0.64	0.77	0.95	1.07
−0.40	0.84	1.21	2.00	2.36	2.61	3.00	3.54	4.17	4.69	6.48
The expected 1-year-ahead growth, $E_t[\mathrm{d}^1\mathrm{I}/\mathrm{A}]$										
−15.21	−7.67	−5.61	−4.20	−3.03	−1.97	−0.86	0.47	2.52	7.65	22.87
−36.75	−31.37	−25.19	−20.56	−15.96	−11.01	−5.08	3.01	16.53	37.98	45.21
Average future 1-year-ahead realized growth, $\mathrm{d}^1\mathrm{I}/\mathrm{A}$										
−16.69	−12.30	−4.11	−3.56	−1.10	−0.43	−0.32	0.64	1.57	5.96	22.65
−11.71	−8.36	−7.15	−5.22	−2.24	−0.90	−0.71	1.18	3.59	9.07	14.72

$E_t[\mathrm{d}^1\mathrm{I}/\mathrm{A}]$ and $\mathrm{d}^1\mathrm{I}/\mathrm{A}$ aligned at the portfolio level (Corr = 0.64)

The Expected Growth Factor

R_{Eg}, independent 2×3 monthly sorts on size and $E_t[d^1 I/A]$, 1/1967–12/2018

$\overline{R}_{Eg}$	α	β_{Mkt}	β_{Me}	$\beta_{I/A}$	β_{Roe}	R^2
0.84	0.67	−0.11	−0.09	0.21	0.30	0.44
(10.27)	(9.75)	(−6.38)	(−3.56)	(4.86)	(9.13)	

α	β_{Mkt}	β_{Me}	$\beta_{I/A}$	β_{Roe}	$\beta_{\log(q)}$	R^2
0.67	−0.11	−0.09	0.23	0.30	−0.02	0.44
(9.80)	(−6.40)	(−3.61)	(4.72)	(8.83)	(−0.48)	

α	β_{Mkt}	β_{Me}	$\beta_{I/A}$	β_{Roe}	β_{Cop}	R^2
0.37	−0.02	−0.02	0.31	0.14	0.60	0.65
(6.35)	(−1.66)	(−0.54)	(9.51)	(4.37)	(10.63)	

α	β_{Mkt}	β_{Me}	$\beta_{I/A}$	β_{Roe}	β_{dRoe}	R^2
0.63	−0.11	−0.10	0.18	0.23	0.16	0.46
(8.56)	(−6.62)	(−3.93)	(3.57)	(5.00)	(2.41)	

Results robust to the use of percentile rankings and composite score across $\log(q)$, Cop, and dRoe

Outline

8 competing factor models:

- The q-factor model, the q^5 model
- The Fama-French 5-factor model, the 6-factor model, the alternative 6-factor model with RMWc
- The Stambaugh-Yuan 4-factor model
- The Barillas-Shanken 6-factor model, including MKT, SMB, $R_{\mathrm{I/A}}$, R_{Roe}, the Asness-Frazzini monthly formed HML, UMD
- The Daniel-Hirshleifer-Sun 3-factor model

Use the replicated Stambaugh-Yuan and Daniel-Hirshleifer-Sun models via the common construction (Hou et al. 2019)

Stress Tests

The playing field, monthly Sharpe ratios for factors and factor models

Individual factors							
R_{Mkt}	R_{Me}	$R_{I/A}$	R_{Roe}	R_{Eg}	SMB	HML	CMA
0.11	0.09	0.20	0.22	0.44	0.07	0.11	0.15
RMW	RMWc	UMD	HML^m	MGMT	PERF	FIN	PEAD
0.12	0.19	0.15	0.08	0.20	0.16	0.10	0.32
Factor models							
q	q^5	FF5	FF6	FF6c	BS6	SY4	DHS
0.42	0.63	0.32	0.37	0.43	0.48	0.41	0.42

150 anomalies with NYSE breakpoints and value-weighted returns significant at the 5% level (Hou, Xue, and Zhang 2019)

- Momentum: 39
- Value-versus-growth: 15
- Investment: 26
- Profitability: 40
- Intangibles: 27
- Trading frictions: 3

Stress Tests

Testing deciles, momentum (39)

Sue1	Earnings surprise (1-month holding period), Foster, Olsen, and Shevlin (1984)
Abr6	Cumulative abnormal returns around earnings announcements (6-month holding period), Chan, Jegadeesh, and Lakonishok (1996)
Re1	Revisions in analysts' forecasts (1-month holding period), Chan, Jegadeesh, and Lakonishok (1996)
$R^6 1$	Price momentum (6-month prior returns, 1-month holding period), Jegadeesh and Titman (1993)
Abr1	Cumulative abnormal returns around earnings announcements (1-month holding period), Chan, Jegadeesh, and Lakonishok (1996)
Abr12	Cumulative abnormal returns around earnings announcements (12-month holding period), Chan, Jegadeesh, and Lakonishok (1996)
Re6	Revisions in analysts' forecasts (6-month holding period), Chan, Jegadeesh, and Lakonishok (1996)
$R^6 6$	Price momentum (6-month prior returns, 6-month holding period), Jegadeesh and Titman (1993)

Stress Tests

Testing deciles, momentum (39)

$R^6 12$	Price momentum (6-month prior returns, 12-month holding period), Jegadeesh and Titman (1993)
$R^{11} 6$	Price momentum, (11-month prior returns, 6-month holding period), Fama and French (1996)
Im1	Industry momentum, (1-month holding period), Moskowitz and Grinblatt (1999)
Im12	Industry momentum (12-month holding period), Moskowitz and Grinblatt (1999)
dEf1	Analysts' forecast change (1-month hold period), Hawkins, Chamberlin, and Daniel (1984)
$R^{11} 1$	Price momentum (11-month prior returns, 1-month holding period), Fama and French (1996)
$R^{11} 12$	Price momentum, (11-month prior returns, 12-month holding period), Fama and French (1996)
Im6	Industry momentum, (6-month holding period), Moskowitz and Grinblatt (1999)
Rs1	Revenue surprise (1-month holding period), Jegadeesh and Livnat (2006)
dEf6	Analysts' forecast change (6-month hold period), Hawkins, Chamberlin, and Daniel (1984)

Stress Tests

Testing deciles, momentum (39)

dEf12	Analysts' forecast change (12-month hold period), Hawkins, Chamberlin, and Daniel (1984)
52w6	52-week high (6-month holding period), George and Hwang (2004))
$\epsilon^6 6$	Six-month residual momentum (6-month holding period), Blitz, Huij, and Martens (2011)
$\epsilon^{11} 1$	11-month residual momentum, 1-month, Blitz, Huij, and Martens (2011)
$\epsilon^{11} 12$	11-month residual momentum, 12-month, Blitz, Huij, and Martens (2011)
Nei1	# consecutive quarters with earnings increases (1-month holding period), Barth, Elliott, and Finn (1999)
52w12	52-week high (12-month holding period), George and Hwang (2004)
$\epsilon^6 12$	Six-month residual momentum (12-month holding period), Blitz, Huij, and Martens (2011)
$\epsilon^{11} 6$	11-month residual momentum, 6-month, Blitz, Huij, and Martens (2011)
Sm1	Segment momentum 1-month, Cohen and Lou (2012)

Sm12	Segment momentum, 12-month, Cohen and Lou (2012)
Ilr6	Industry lead-lag effect in prior returns, 6-month, Hou (2007)
Ile1	Industry lead-lag effect in earnings news, 1-month, Hou (2007)
Cm12	Customer momentum, 12-month Cohen and Frazzini (2008)
Cim1	Customer industries momentum, 1-month, Menzly and Ozbas (2010)
Cim12	Customer industries momentum, 12-month, Menzly and Ozbas (2010)
Ilr1	Industry lead-lag effect in prior returns, 1-month, Hou (2007)
Ilr12	Industry lead-lag effect in prior returns, 12-month, Hou (2007)
Cm1	Customer momentum, 1-month Cohen and Frazzini (2008)
Sim1	Supplier industries momentum, 1-month, Menzly and Ozbas (2010)
Cim6	Customer industries momentum, 6-month, Menzly and Ozbas (2010)

Stress Tests

Testing deciles, value-versus-growth (15)

Bm	Book-to-market equity, Rosenberg, Reid, and Lanstein (1985)
$Ep^{q}6$	Quarterly earnings-to-price (6-month holding period)
$Cp^{q}1$	Quarterly cash flow-to-price (1-month holding period)
Nop	Net payout yield, Boudoukh, Michaely Richardson, and Roberts (2007)
$Em^{q}1$	Quarterly enterprise multiple (1-month holding period)
$Sp^{q}1$	Quarterly sales-to-price (1-month holding period)
$Sp^{q}12$	Quarterly sales-to-price (12-month holding period)
$Ocp^{q}1$	Operating cash flow-to-price (1-month holding period)
$Ep^{q}1$	Quarterly earnings-to-price (1-month holding period)
$Ep^{q}12$	Quarterly earnings-to-price (12-month holding period)
$Cp^{q}6$	Quarterly cash flow-to-price (6-month holding period)
Em	Enterprise multiple, Loughran and Wellman (2011)
Sp	Sales-to-price Barbee, Mukherji, and Raines (1996))
$Sp^{q}6$	Quarterly sales-to-price (6-month holding period)
Ocp	Operating cash flow-to-price, Desai, Rajgopal, and Venkatachalam (2004)

Stress Tests

Testing deciles, investment (26)

I/A	Investment-to-assets, Cooper, Gulen, and Schill (2008)
Ia^q12	Quarterly investment-to-assets (12-month holding period)
Noa	Net operating assets, Hirshleifer Hou, Teoh, and Zhang (2004)
Ig	Investment growth Xing (2008)
Nsi	Net stock issues Pontiff and Woodgate (2008)
dIi	% change in investment− % change in industry investment, Abarbanell and Bushee (1998)
Ivg	Inventory growth Belo and Lin (2011)
Ia^q6	Quarterly investment-to-assets (6-month holding period)
dPia	(Changes in PPE and inventory)/assets Lyandres, Sun, and Zhang (2008)
dNoa	Changes in net operating assets, Hirshleifer, Hou, Teoh, and Zhang (2004)
2Ig	Two-year investment growth Anderson and Garcia-Feijoo (2006)
Cei	Composite equity issuance Daniel and Titman (2006)
dLno	Change in long-term net operating assets, Fairfield, Whisenant, and Yohn (2003)
Ivc	Inventory changes Thomas and Zhang (2002)

Oa	Operating accruals Sloan (1996)
dCoa	Change in current operating assets, Richardson, Sloan, Soliman, and Tuna (2005)
dNca	Change in non-current operating assets, Richardson, Sloan, Soliman, and Tuna (2005)
dFnl	Change in financial liabilities Richardson, Sloan, Soliman, and Tuna (2005)
Dac	Discretionary accruals Xie (2001)
Pta	Percent total accruals, Hafzalla, Lundholm, and Van Winkle (2011)
dWc	Change in net non-cash working capital, Richardson, Sloan, Soliman, and Tuna (2005)
dNco	Change in net non-current operating assets, Richardson, Sloan, Soliman, and Tuna (2005)
dFin	Change in net financial assets Richardson, Sloan, Soliman, and Tuna (2005)
dBe	Change in common equity, Richardson Sloan, Soliman, and Tuna (2005)
Poa	Percent operating accruals, Hafzalla, Lundholm, and Van Winkle (2011)
Pda	Percent discretionary accruals

Roe1	Return on equity, 1-month, Hou, Xue, and Zhang (2015)
dRoe1	Change in Roe, 1-month horizon
dRoe12	Change in Roe, 12-month horizon
dRoa1	Change in Roa, 1-month horizon
Ato	Asset turnover Soliman (2008)
$\text{Rna}^{q}1$	Return on net operating assets, 1-month horizon
$\text{Ato}^{q}1$	Quarterly asset turnover, 1-month horizon
Roe6	Return on equity, 6-month, Hou, Xue, and Zhang (2015)
dRoe6	Change in Roe, 6-month horizon
Roa1	Return on assets, 1-month horizon, Balakrishnan, Bartov, and Faurel (2010)
dRoa6	Change in Roa, 6-month horizon
Cto	Capital turnover Haugen and Baker (1996)
$\text{Rna}^{q}6$	Return on net operating assets, 6-month horizon
$\text{Ato}^{q}6$	Quarterly asset turnover, 6-month horizon

Ato^q12	Quarterly asset turnover, 12-month horizon
Cto^q6	Quarterly capital turnover, 6-month horizon
Gpa	Gross profits-to-assets, Novy-Marx (2013)
Gla^q6	Gross profits-to-lagged assets, 6-month horizon
Ole^q1	Operating profits-to-lagged equity, 1-month horizon
Opa	Operating profits-to-assets, Ball, Gerakos, Linnainmaa, and Nikolaev (2015)
Ola^q6	Operating profits-to-lagged assets, 6-month horizon
Cto^q1	Quarterly capital turnover, 1-month horizon
Cto^q12	Quarterly capital turnover, 12-month horizon
Gla^q1	Gross profits-to-lagged assets, 1-month horizon
Gla^q12	Gross profits-to-lagged assets, 12-month horizon
Ole^q6	Operating profits-to-lagged equity , 6-month horizon
Ola^q1	Operating profits-to-lagged assets, 1-month horizon
Ola^q12	Operating profits-to-lagged assets, 12-month horizon

Cop	Cash-based operating profitability, Ball, Gerakos, Linnainmaa, and Nikolaev (2016)
Cla^{q}1	Cash-based operating profits-to-lagged assets, 1-month horizon
Cla^{q}12	Cash-based operating profits-to-lagged assets, 12-month horizon
F^{q}6	Quarterly F-score, 6-month horizon
Fp^{q}6	Failure probability, 6-month horizon Campbell, Hilscher, and Szilagyi (2008)
Tbi^{q}12	Quarterly taxable income-to-book income 12-month horizon
Cla	Cash-based operating profits-to-lagged assets
Cla^{q}6	Cash-based operating profits-to-lagged assets, 6-month horizon
F^{q}1	Quarterly F-score, 1-month horizon
F^{q}12	Quarterly F-score, 12-month horizon
O^{q}1	Quarterly O-score 1-month horizon
Sg^{q}1	Quarterly sales growth 1-month horizon

Stress Tests

Testing deciles, intangibles (27)

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)	Rdm	R&D-to-market, Chan, Lakonishok, and Sougiannis (2001)
Rdm^q1	Quarterly R&D-to-market, 1-month horizon	Rdm^q6	Quarterly R&D-to-market, 6-month horizon
Rdm^q12	Quarterly R&D-to-market, 12-month horizon	Rds^q6	Quarterly R&D-to-sales 6-month horizon
Rds^q12	Quarterly R&D-to-sales, 12-month horizon	Ol	Operating leverage, Novy-Marx (2011)
Ol^q1	Quarterly operating leverage, 1-month horizon	Ol^q6	Quarterly operating leverage, 6-month horizon
Ol^q12	Quarterly operating leverage, 12-month horizon	Hs	Industry concentration (sales), Hou and Robinson (2006)
Rer	Real estate ratio, Tuzel (2010)	Eprd	Earnings predictability, Francis, Lafond, Olsson, and Schipper (2004)

Stress Tests

Testing deciles, intangibles and trading frictions (3)

Etl	Earnings timeliness, Francis, Lafond, Lafond, Olsson, and Schipper (2004)	$\text{Alm}^{q}1$	Asset liquidity (market assets) 1-month horizon
$\text{Alm}^{q}6$	Asset liquidity (market assets) 6-month horizon	$\text{Alm}^{q}12$	Asset liquidity (market assets) 12-month horizon
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)	$R_{a}^{[6,10]}$	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)
$R_{a}^{[16,20]}$	Years 16–20 lagged returns, annual Heston and Sadka (2008)		

Trading frictions (3)

Dtv12	Dollar trading volume, 12-month horizon, Brennan, Chordia, and Subrahmanyam (1998))	Isff1	Idiosyncratic skewness per the FF 3-factor model, 1-month horizon
Isq1	Idiosyncratic skewness, per the q-factor model, 1-month horizon		

Stress Tests

Relative performance of factor models, 1/1967–12/2018

	$\overline{\lvert\alpha_{H-L}\rvert}$	$\#_{\lvert t\rvert\geq 1.96}$	$\#_{\lvert t\rvert\geq 3}$	$\overline{\lvert\alpha\rvert}$	$\#^{GRS}_{p<5\%}$
			All (150)		
q	0.28	52	25	0.11	101
q^5	0.19	23	6	0.10	57
FF5	0.43	100	69	0.13	112
FF6	0.30	74	37	0.11	91
FF6c	0.27	59	25	0.11	71
BS6	0.29	63	37	0.13	132
SY4	0.29	64	25	0.11	87
DHS	0.37	70	33	0.14	97

Stress Tests

Relative performance of factor models, 1/1967–12/2018

	$\overline{\lvert\alpha_{H-L}\rvert}$	$\#_{\lvert t\rvert\geq 1.96}$	$\#_{\lvert t\rvert\geq 3}$	$\overline{\lvert\alpha\rvert}$	$\#^{GRS}_{p<5\%}$
	Momentum (39)				
q	0.25	11	3	0.10	24
q^5	0.17	4	1	0.09	15
FF5	0.62	37	29	0.15	36
FF6	0.27	19	6	0.10	21
FF6c	0.24	14	5	0.09	18
BS6	0.23	12	4	0.12	33
SY4	0.32	19	6	0.10	23
DHS	0.25	10	3	0.14	26

Stress Tests

Relative performance of factor models, 1/1967–12/2018

	$\overline{\lvert\alpha_{H-L}\rvert}$	$\#_{\lvert t\rvert\geq 1.96}$	$\#_{\lvert t\rvert\geq 3}$	$\overline{\lvert\alpha\rvert}$	$\#^{GRS}_{p<5\%}$
	Value-versus-growth (15)				
q	0.21	1	0	0.11	8
q^5	0.22	3	0	0.13	7
FF5	0.15	2	0	0.10	7
FF6	0.19	4	0	0.10	9
FF6c	0.17	3	0	0.10	6
BS6	0.23	6	2	0.13	14
SY4	0.24	4	1	0.12	9
DHS	0.78	15	13	0.23	15

Stress Tests

Relative performance of factor models, 1/1967–12/2018

	$\overline{\lvert\alpha_{H-L}\rvert}$	$\#_{\lvert t\rvert\geq 1.96}$	$\#_{\lvert t\rvert\geq 3}$	$\overline{\lvert\alpha\rvert}$	$\#^{GRS}_{p<5\%}$
	Investment (26)				
q	0.22	9	4	0.10	19
q^5	0.10	1	0	0.08	6
FF5	0.24	10	7	0.09	17
FF6	0.22	10	6	0.09	16
FF6c	0.18	8	2	0.08	7
BS6	0.22	8	6	0.11	24
SY4	0.19	8	3	0.09	17
DHS	0.34	20	4	0.10	22

Stress Tests

Relative performance of factor models, 1/1967–12/2018

	$\overline{\lvert\alpha_{H-L}\rvert}$	$\#_{\lvert t\rvert\geq 1.96}$	$\#_{\lvert t\rvert\geq 3}$	$\overline{\lvert\alpha\rvert}$	$\#^{GRS}_{p<5\%}$
	Profitability (40)				
q	0.25	16	6	0.10	28
q^5	0.14	5	1	0.09	14
FF5	0.43	32	23	0.12	32
FF6	0.31	26	13	0.10	25
FF6c	0.26	18	7	0.10	21
BS6	0.31	20	12	0.12	37
SY4	0.29	20	9	0.10	24
DHS	0.18	6	1	0.09	13

	$\overline{\lvert\alpha_{H-L}\rvert}$	$\#_{\lvert t\rvert\geq 1.96}$	$\#_{\lvert t\rvert\geq 3}$	$\overline{\lvert\alpha\rvert}$	$\#^{GRS}_{p<5\%}$
	Intangibles (27)				
q	0.47	13	11	0.18	19
q^5	0.36	8	4	0.15	13
FF5	0.50	17	9	0.16	18
FF6	0.48	13	11	0.17	18
FF6c	0.50	14	11	0.17	18
BS6	0.49	15	11	0.20	21
SY4	0.38	11	6	0.15	12
DHS	0.60	16	10	0.19	18

Stress Tests

Relative performance of factor models

	$\overline{\lvert\alpha_{H-L}\rvert}$	$\#_{\lvert t\rvert\geq 1.96}$	$\#_{\lvert t\rvert\geq 3}$	$\overline{\lvert\alpha\rvert}$	$\#^{GRS}_{p<5\%}$
	Trading frictions (3)				
q	0.24	2	1	0.10	3
q^5	0.19	2	0	0.08	2
FF5	0.22	2	1	0.07	2
FF6	0.20	2	1	0.07	2
FF6c	0.20	2	0	0.07	1
BS6	0.23	2	2	0.09	3
SY4	0.18	2	0	0.09	2
DHS	0.50	3	2	0.18	3

Stress Tests

Explaining the composite score deciles, 1/1967–12/2018

All (150): $\overline{R} = 1.69$ $(t = 9.62)$

	α_{H-L}	t_{H-L}	$\overline{\lvert\alpha\rvert}$	p_{GRS}
q	0.86	5.64	0.16	0.00
q^5	0.37	2.62	0.10	0.01
FF5	1.33	7.94	0.25	0.00
FF6	0.94	7.46	0.16	0.00
FF6c	0.82	6.77	0.14	0.00
BS6	0.68	4.85	0.13	0.00
SY4	0.90	7.61	0.16	0.00
DHS	0.74	4.98	0.14	0.00

Momentum (39): $\overline{R} = 1.09$ $(t = 4.21)$

	α_{H-L}	t_{H-L}	$\overline{\lvert\alpha\rvert}$	p_{GRS}
q	0.35	1.04	0.10	0.08
q^5	−0.25	−0.85	0.10	0.35
FF5	1.21	3.74	0.27	0.00
FF6	0.33	2.08	0.09	0.06
FF6c	0.29	1.82	0.10	0.04
BS6	0.21	1.26	0.09	0.07
SY4	0.43	1.93	0.10	0.01
DHS	−0.36	−1.49	0.16	0.00

Value-versus-growth (15): $\overline{R} = 0.70$ $(t = 3.47)$

	α_{H-L}	t_{H-L}	$\overline{\lvert\alpha\rvert}$	p_{GRS}
q	0.28	1.48	0.13	0.00
q^5	0.38	2.14	0.16	0.00
FF5	0.04	0.30	0.11	0.00
FF6	0.19	1.58	0.10	0.00
FF6c	0.12	1.05	0.10	0.00
BS6	−0.16	−1.17	0.12	0.00
SY4	0.34	2.20	0.14	0.00
DHS	0.98	5.34	0.31	0.00

Investment (26): $\overline{R} = 0.66$ $(t = 4.44)$

	α_{H-L}	t_{H-L}	$\overline{\lvert\alpha\rvert}$	p_{GRS}
q	0.25	2.61	0.10	0.00
q^5	0.06	0.54	0.06	0.15
FF5	0.29	3.11	0.08	0.00
FF6	0.27	2.84	0.07	0.01
FF6c	0.27	2.62	0.06	0.06
BS6	0.18	1.73	0.09	0.00
SY4	0.10	1.00	0.07	0.01
DHS	0.55	3.83	0.12	0.00

Profitability (40): $\overline{R} = 0.80$ $(t = 4.64)$

	α_{H-L}	t_{H-L}	$\overline{\lvert\alpha\rvert}$	p_{GRS}
q	0.28	2.31	0.07	0.01
q^5	−0.14	−1.21	0.08	0.09
FF5	0.60	5.35	0.12	0.00
FF6	0.43	3.94	0.09	0.00
FF6c	0.30	2.30	0.07	0.09
BS6	0.34	2.61	0.09	0.00
SY4	0.37	2.86	0.09	0.00
DHS	−0.09	−0.56	0.07	0.35

Intangibles (27): $\overline{R} = 0.94$ $(t = 5.27)$

	α_{H-L}	t_{H-L}	$\overline{\lvert\alpha\rvert}$	p_{GRS}
q	0.42	2.62	0.18	0.00
q^5	0.50	3.19	0.19	0.00
FF5	0.43	3.24	0.18	0.00
FF6	0.54	4.25	0.20	0.00
FF6c	0.57	4.17	0.21	0.00
BS6	0.26	1.85	0.15	0.00
SY4	0.46	3.16	0.18	0.00
DHS	0.89	5.24	0.28	0.00

Trading frictions (3): $\overline{R} = 0.23$ $(t = 1.77)$

	α_{H-L}	t_{H-L}	$\overline{\lvert\alpha\rvert}$	p_{GRS}
q	0.16	1.80	0.10	0.00
q^5	0.15	1.60	0.08	0.06
FF5	0.14	1.80	0.08	0.05
FF6	0.12	1.53	0.07	0.07
FF6c	0.12	1.34	0.06	0.28
BS6	0.14	1.60	0.11	0.00
SY4	0.13	1.50	0.09	0.01
DHS	0.57	4.29	0.13	0.00

Outline

Individual Factor Regressions

Examples, 1/1967–12/2018

	Sue1	$R^6 6$	Bm	Oa	dFin	Dac	Cop	Rdm
$\overline{R}$	0.45	0.83	0.43	−0.29	0.27	−0.45	0.68	0.73
$t_{\overline{R}}$	3.50	3.66	2.14	−2.36	2.43	−3.47	3.94	2.96
α_q	0.05	0.30	0.11	−0.57	0.41	−0.74	0.75	0.81
α_{q^5}	−0.07	−0.16	0.05	−0.20	0.14	−0.31	0.11	0.27
t_q	0.39	1.04	0.71	−4.25	2.97	−5.33	5.57	3.64
t_{q^5}	−0.52	−0.64	0.32	−1.30	0.97	−2.16	0.96	1.24
α_{FF6}	0.26	0.19	−0.09	−0.48	0.46	−0.69	0.75	0.68
α_{FF6c}	0.22	0.16	−0.09	−0.32	0.34	−0.59	0.55	0.79
t_{FF6}	2.23	1.92	−0.82	−3.49	3.81	−5.08	6.44	3.24
t_{FF6c}	1.84	1.57	−0.74	−2.13	2.63	−4.12	4.75	3.64

The q^5 model outperforms the Fama-French 6-factor model in a large-scale empirical horse race