Quantitative Asset Management

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Lecture 3: Momentum

1. Momentum
   Jegadeesh and Titman (1993, JF)
2. Momentum and Autocorrelation
   Lewellen (2002, RFS)
3. Value and Momentum Everywhere
   Asness, Moskowitz, and Pedersen (2013, JF)
4. Momentum Crashes
   Daniel and Moskowitz (2016, JFE)

Returns to Buying Winners and Selling Losers: Implication for Stock Market Efficiency

Jegadeesh and Titman (1993, JF)

Summary

- Strategy: buy winner and sell losers
- Positive returns
- Systematic risk?
- Delayed price reaction?

Original Strategy

- Past returns based on past J months

  1, 2, 3, or 4 quarters
- Hold position for K months

  1, 2, 3, or 4 quarters
- Overlapping holding periods
- Strategy:
  - Sort stock based on past returns (past J months)
  - Construct 10 ew portfolio: losers and winner are the extreme deciles
  - Long winners and short losers
  - Hold this position for K months
  - Monthly rebalancing
  - Skip one week between formation and holding period

Table 1

		Panel A				Panel B			
J		$K=$ 3	6	9	12	$K=$ 3	6	9	12
3	Sell	0.0108	0.0091	0.0092	0.0087	0.0083	0.0079	0.0084	0.0083
		(2.16)	(1.87)	(1.92)	(1.87)	(1.67)	(1.64)	(1.77)	(1.79)
3	Buy	0.0140	0.0149	0.0152	.0156	0.0156	0.0158	0.0158	0.0160
		(3.57)	(3.78)	(3.83)	(3.89)	(3.95)	(3.98)	(3.96)	(3.98)
3	Buy-sell	0.0032	0.0058	0.0061	0.0069	0.0073	0.0078	0.0074	0.0077
		(1.10)	(2.29)	(2.69)	(3.53)	(2.61)	(3.16)	(3.36)	(4.00)
6	Sell	0.0087	0.0079	0.0072	0.0080	0.0066	0.0068	0.0067	0.0076
		(1.67)	(1.56)	(1.48)	(1.66)	(1.28)	(1.35)	(1.38)	(1.58)
6	Buy	0.0171	0.0174	0.0174	0.0166	0.0179	0.0178	0.0175	0.0166
		(4.28)	(4.33)	(4.31)	(4.13)	(4.47)	(4.41)	(4.32)	(4.13)
6	Buy-sell	0.0084	0.0095	0.0102	0.0086	0.0114	0.0110	0.0108	0.0090
		(2.44)	(3.07)	(3.76)	(3.36)	(3.37)	(3.61)	(4.01)	(3.54)
9	Sell	0.0077	0.0065	0.0071	0.0082	0.0058	0.0058	0.0066	0.0078
		(1.47)	(1.29)	(1.43)	(1.66)	(1.13)	(1.15)	(1.34)	(1.59)
9	Buy	0.0186	0.0186	0.0176	0.0164	0.0193	0.0188	0.0176	0.0164
		(4.56)	(4.53)	(4.30)	(4.03)	(4.72)	(4.56)	(4.30)	(4.04)
9	Buy-sell	0.0109	0.0121	0.0105	0.0082	0.0135	0.0130	0.0109	0.0085
		(3.03)	(3.78)	(3.47)	(2.89)	(3.85)	(4.09)	(3.67)	(3.04)
12	Sell	0.0060	0.0065	0.0075	0.0087	0.0048	0.0058	0.0070	0.0085
		(1.17)	(1.29)	(1.48)	(1.74)	(0.93)	(1.15)	(1.40)	(1.71)
12	Buy	0.0192	0.0179	0.0168	0.0155	0.0196	0.0179	0.0167	0.0154
		(4.63)	(4.36)	(4.10)	(3.81)	(4.73)	(4.36)	(4.09)	(3.79)
12	Buy-sell	0.0131	0.0114	0.0093	0.0068	0.0149	0.0121	0.0096	0.0069
		(3.74)	(3.40)	(2.95)	(2.25)	(4.28)	(3.65)	(3.09)	(2.31)

Size and beta

- Focus on 6-month/6-month strategy
- Post-ranking betas
- Average market capitalization

- Why do we care about these stats?

Table 2

	Beta	Average Market Capitalization
P1	1.36	208.24
P2	1.19	480.07
P3	1.14	545.31
P4	1.11	618.85
P5	1.09	692.89
P6	1.08	702.51
P7	1.09	738.09
P8	1.12	758.87
P9	1.17	680.18
P10	1.28	495.13
P10–P1	−0.08	—

Driven by size of beta?

- Test whether strategies work in subsample
- Subsample by size: small, medium, large mkt caps
- Subsample by mkt beta: small, medium, large beta

- Is this a double sort?
- Can this subsample analysis help to disentangle from other explanations? Why?

Table 3

Panel A: Average Monthly Returns

	All	S1	S2	S3	β_1	β_2	β_3
P1	0.0079	0.0083	0.0047	0.0082	0.0129	0.0097	0.0052
	(1.56)	(1.35)	(0.99)	(2.22)	(2.92)	(2.01)	(0.95)
P2	0.0112	0.0117	0.0102	0.0098	0.0140	0.0128	0.0086
	(2.78)	(2.29)	(2.54)	(3.08)	(4.38)	(3.37)	(1.83)
P3	0.0125	0.0152	0.0125	0.0105	0.0132	0.0133	0.0102
	(3.40)	(3.23)	(3.34)	(3.53)	(4.59)	(3.77)	(2.28)
P4	0.0124	0.0163	0.0130	0.0105	0.0134	0.0128	0.0110
	(3.59)	(3.59)	(3.58)	(3.66)	(5.02)	(3.82)	(2.50)
P5	0.0128	0.0164	0.0134	0.0109	0.0135	0.0135	0.0121
	(3.87)	(3.74)	(3.83)	(3.85)	(5.14)	(4.15)	(2.86)
P6	0.0134	0.0174	0.0146	0.0102	0.0135	0.0142	0.0122
	(4.14)	(4.08)	(4.22)	(3.66)	(5.23)	(4.38)	(2.92)
P7	0.0136	0.0175	0.0143	0.0109	0.0136	0.0142	0.0126
	(4.19)	(4.13)	(4.12)	(3.90)	(5.09)	(4.43)	(3.01)
P8	0.0143	0.0174	0.0148	0.0111	0.0143	0.0146	0.0132
	(4.30)	(4.11)	(4.16)	(3.86)	(5.12)	(4.44)	(3.15)
P9	0.0153	0.0183	0.0154	0.0126	0.0165	0.0156	0.0141
	(4.36)	(4.28)	(4.11)	(4.17)	(5.34)	(4.56)	(3.28)
P10	0.0174	0.0182	0.0173	0.0157	0.0191	0.0176	0.0160
	(4.33)	(3.99)	(4.11)	(4.41)	(5.17)	(4.53)	(3.50)
P10–P1	0.0095	0.0099	0.0126	0.0075	0.0062	0.0079	0.0108
	(3.07)	(2.77)	(4.57)	(3.03)	(2.05)	(2.64)	(3.35)
F-Statistics[a]	2.83	2.65	4.51	4.38	2.51	1.99	1.69
p-Value	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.04)	(0.09)

Subperiod Analysis

- Seasonal effects?
- Does the strategy work for January data as well?

- 5-year subperiods?

Table 4

	All	S1	S2	S3
Jan.	−0.0686	−0.0797	−0.0347	−0.0161
	(−3.52)	(−3.36)	(−2.14)	(−1.28)
Feb.	0.0063	0.0089	0.0149	0.0099
	(0.85)	(0.81)	(2.44)	(1.35)
Mar.	0.0105	0.0196	0.0103	0.0108
	(1.37)	(2.08)	(1.49)	(1.49)
Apr.	0.0333	0.0323	0.0368	0.0215
	(7.39)	(5.35)	(7.29)	(4.91)
May	0.0102	0.0046	0.0091	0.0079
	(1.32)	(0.56)	(1.18)	(1.19)
June	0.0238	0.0237	0.0231	0.0185
	(3.86)	(3.50)	(3.23)	(2.59)
July	0.0075	0.0112	0.0084	0.0035
	(0.96)	(1.44)	(0.96)	(0.41)
Aug.	0.0027	0.0079	−0.0011	−0.0058
	(0.35)	(0.97)	(−0.14)	(−0.71)
Sept.	0.0116	0.0126	0.0137	0.0053
	(1.10)	(1.20)	(1.27)	(0.60)
Oct.	0.0137	0.0160	0.0151	0.0025
	(1.30)	(1.40)	(1.44)	(0.22)
Nov.	0.0372	0.0352	0.0331	0.0248
	(5.31)	(5.01)	(4.12)	(2.78)
Dec.	0.0264	0.0265	0.0224	0.0070
	(2.61)	(2.13)	(2.86)	(0.99)
Feb.–Dec.	0.0166	0.0181	0.0169	0.0096
	(6.67)	(6.47)	(6.83)	(4.00)
F-Statistics[a]	7.90	7.14	4.11	1.81
p-Value	(0.00)	(0.00)	(0.00)	(0.51)
F-Statistics[b]	2.04	1.23	1.91	1.28
p-Value	(0.03)	(0.27)	(0.04)	(0.24)

Table 6

Sample	Months	65–69	70–74	75–79	80–84	85–89
	All	0.0123	0.0109	−0.0044	0.0127	0.0162
		(1.94)	(1.23)	(−0.51)	(2.67)	(3.42)
All	Jan.	−0.0524	−0.1070	−0.1017	−0.0253	−0.0569
		(−1.28)	(−2.54)	(−1.31)	(−1.38)	(−2.76)
	Feb.–Dec.	0.0182	0.0217	0.0044	0.0161	0.0229
		(3.36)	(2.88)	(0.78)	(3.44)	(6.09)
	All	0.0082	0.0128	−0.0064	0.0153	0.0197
		(1.14)	(1.63)	(−0.58)	(2.61)	(2.89)
S1	Jan.	−0.0838	−0.0853	−0.1107	−0.0124	−0.1064
		(−1.60)	(−2.29)	(−1.09)	(−0.62)	(−4.45)
	Feb.–Dec.	0.0165	0.0217	0.0031	0.0179	0.0311
		(3.19)	(3.18)	(0.41)	(2.94)	(6.59)
	All	0.0177	0.0115	0.0018	0.0172	0.0146
		(3.08)	(1.57)	(0.24)	(3.38)	(3.40)
S2	Jan.	−0.0264	−0.0465	−0.0795	−0.0100	−0.0112
		(−1.05)	(−1.81)	(−1.16)	(−0.46)	(−0.48)
	Feb.–Dec.	0.0217	0.0168	0.0092	0.0197	0.0170
		(3.86)	(2.29)	(1.87)	(3.83)	(4.08)
	All	0.0129	0.0115	0.0018	0.0076	0.0035
		(2.71)	(1.62)	(0.35)	(1.41)	(0.73)
S3	Jan.	−0.0073	−0.0154	−0.0335	−0.0094	−0.0147
		(−0.32)	(−0.48)	(−0.77)	(−0.33)	(−0.78)
	Feb.–Dec.	0.0148	0.0139	0.0050	0.0092	0.0052
		(3.08)	(1.95)	(1.21)	(1.70)	(1.04)

Takeaway

- Paper documents momentum anomaly:
  - Strategy in the paper is different from today's standard
  - Recent paper (mostly) don't use overlapping holding periods
- Techniques:
  - Overlaping holding periods
  - Example of how to use sequential double sort
  - Subperiod analysis: e.g. by month or 5-year windows

Momentum and Autocorrelation in Stock Returns

Lewellen (2002, RFS)

"Momentum if one of the strongest and most puzzling asset pricing anomalies" (Lewellen, 2002)

Why is it so puzzling?

- Strong violation of the efficient market hypothesis
- Rational risk-based explanation
  - Risk would have to go up after sequence of good returns
- One behavioral explanation:
  - Underreaction to firm-specific news

Momentum and Autocorrelation

- Momentum: role of BM, Size, and industry
  - "Momentum is robust and pervasive"‘
- Size and BM exhibit momentum

  $\Longrightarrow$ momentum cannot be firm- or industry-specific
- Stock covary "too strongly"with each other
- Excess covariance as an explanation for momentum?

Momentum and Autocorrelation

- Is momentum the same as autocorrelation?
- Intuitive explanations for momentum:
  - Autocorrelation in stock returns
  - lead-lag: negative correlation between return of a stocks and lagged returns of other stocks (cross-serial correlation)
  - Cross-sectional dispersion in expected returns
- Evidence for lead-lag: industry, BM, and size are negatively cross-serially correlated
- This restricts theories for momentum:
  - Behavioral: underreaction to portfolio-specific news and overreaction to macro news
  - Excess covariance

Momentum in Stock Returns

Data

- NYSE, AMEX, Nasdaq
- Common shares
- Form: industry, size, BM, and double sorted size-BM portfolios
- Monthly returns for
  - 15 industry portfolios (based on SIC codes)
  - 5, 10, or 15 size and BM portfolios
  - 9, 16, or 25 size-BM double sorted portfolios
- To use accounting data (Book): require min of 3 years of data
- NYSE breakpoints

Table 1: summary stats

Industry portfolios				Size portfolios				Size-B/M portfolios[a]			
Portfolio	Average return	Std. dev.	Average no. of firms	Portfolio	Average return	Std. dev.	Average no. of firms	Portfolio	Average return	Std. dev.	Average no. of firms
Natural resources	0.99	5.44	195	Small	1.48	6.78	1,557	Small: Low	1.11	7.22	474
Construction	1.00	5.08	287	2	1.29	5.83	387	2	1.17	6.10	353
Food, tobacco	1.13	4.11	120	3	1.27	5.59	286	3	1.33	5.62	393
Construction products	1.10	5.09	215	4	1.27	5.33	241	High	1.48	6.00	770
Logging, paper	1.20	5.33	65	5	1.26	5.12	210	2: Low	1.22	6.58	170
Chemicals	1.12	4.53	171	6	1.21	4.97	181	2	1.05	5.42	130
Petroleum	1.26	4.89	36	7	1.20	4.81	167	3	1.36	4.80	127
Machinery	1.20	5.29	215	8	1.23	4.62	155	High	1.59	5.64	94
Electrical equipment	1.22	5.33	370	9	1.15	4.37	145	3: Low	1.04	5.69	134
Transport equipment	1.13	5.23	97	Large	1.06	3.97	139	2	1.02	4.90	102
Shipping	1.02	5.58	101					3	1.28	4.77	84
Utilities, telecom.	1.00	3.46	203					High	1.47	5.48	48
Trade	1.14	4.91	340					Large: Low	1.06	4.70	127
Financial	1.18	4.69	601					2	0.92	4.26	81
Services, other	1.39	6.08	457					3	1.11	4.19	63
								High	1.35	5.02	30

Each month from January 1941 through December 1999, 15 industry and 10 size portfolios are formed from all NYSE, AMEX, and Nasdaq stocks classified as ordinary common equity on CRSP. Size-B/M portfolios are formed from the subset of stocks with Compustat data, from May 1963 through December 1999. The industry portfolios are based on two-digit SIC codes; they typically, but not always, consist of firms in consecutive SIC codes. The size breakpoints are determined by NYSE deciles and the size-B/M breakpoints are determined by NYSE quartiles (using independent size and B/M sorts). The table reports the average return, standard deviation, and average number of firms for each portfolio. Returns are value weighted and measured in percent.

[a] Statistics for May 1963–December 1999.

Momentum Strategy

Slightly different momentum strategy:

- Weights proportional to their market-adjusted returns:

$$w_{i,t} = \frac{1}{N}(r^k_{i,t-1} - r^k_{m,t-1})$$

- Portfolio invest in all assets
- Easier to apply to other portfolios (size, BM, industry)
- Use $k = 12$ months
- Different holding periods

Table 2: Momentum Profits

Assets		Month after formation 1	3	5	7	9	11	13	15	17
Individual stocks										
	Average return	**0.500**	**0.800**	**0.451**	0.098	−0.133	**−0.333**	**−0.534**	**−0.484**	**−0.508**
	t-statistic	3.08	5.03	3.06	0.72	−1.02	−2.61	−4.14	−3.84	−4.51
15 industry portfolios										
VW	Average return	**0.741**	**0.497**	**0.382**	**0.327**	**0.185**	0.023	−0.093	**−0.198**	−0.138
	t-statistic	6.62	4.39	3.43	3.07	1.71	0.22	−0.91	−2.00	−1.43
EW	Average return	**1.005**	**0.626**	**0.409**	**0.249**	0.077	−0.109	**−0.276**	**−0.328**	**−0.291**
	t-statistic	8.76	5.47	3.68	2.34	0.70	−1.01	−2.66	−3.30	−3.01
5 size portfolios										
VW	Average return	**0.509**	**0.341**	**0.462**	**0.446**	**0.296**	**0.212**	**0.236**	**0.310**	**0.288**
	t-statistic	4.65	2.95	4.08	4.06	2.59	1.88	2.18	2.85	2.64
EW	Average return	**0.597**	**0.404**	**0.525**	**0.472**	**0.303**	**0.241**	**0.273**	**0.324**	**0.299**
	t-statistic	4.77	3.05	4.03	3.74	2.33	1.85	2.26	2.63	2.40
15 size portfolios										
VW	Average return	**0.505**	**0.393**	**0.422**	**0.405**	**0.297**	**0.193**	**0.217**	**0.274**	**0.209**
	t-statistic	4.47	3.21	3.66	3.82	2.66	1.65	2.09	2.76	2.05
EW	Average return	**0.635**	**0.499**	**0.537**	**0.512**	**0.403**	**0.266**	**0.275**	**0.335**	**0.278**
	t-statistic	4.60	3.35	3.81	3.94	3.22	2.03	2.29	2.79	2.38

Table 2: Momentum Profits

5 B/M portfolios[a]										
VW	Average return	**0.419**	**0.456**	**0.397**	**0.347**	**0.268**	**0.263**	0.070	0.156	0.168
	t-statistic	3.22	3.40	3.07	2.73	2.08	2.12	0.60	1.24	1.36
EW	Average return	**0.822**	**0.684**	**0.604**	**0.626**	**0.569**	**0.465**	**0.247**	**0.313**	**0.424**
	t-statistic	6.49	5.36	4.63	4.82	4.30	3.66	1.91	2.44	3.37
10 B/M portfolios[a]										
VW	Average return	**0.434**	**0.382**	**0.330**	**0.272**	0.184	**0.223**	0.076	0.165	0.154
	t-statistic	3.54	2.98	2.64	2.16	1.43	1.76	0.68	1.38	1.31
EW	Average return	**0.925**	**0.765**	**0.673**	**0.692**	**0.622**	**0.517**	**0.286**	**0.370**	**0.471**
	t-statistic	7.08	5.71	5.09	5.18	4.54	4.10	2.34	2.92	3.88
9 size-B/M portfolios[a]										
VW	Average return	**0.807**	**0.570**	**0.446**	**0.529**	**0.432**	0.215	0.059	0.159	0.186
	t-statistic	5.47	3.81	3.02	3.65	3.00	1.55	0.41	1.10	1.31
EW	Average return	**0.977**	**0.694**	**0.587**	**0.687**	**0.638**	**0.413**	0.238	**0.319**	**0.350**
	t-statistic	6.33	4.56	3.98	4.81	4.57	2.87	1.60	2.18	2.39
25 size-B/M portfolios[a]										
VW	Average return	**0.799**	**0.542**	**0.381**	**0.438**	**0.357**	0.150	−0.024	0.047	0.100
	t-statistic	5.60	3.84	2.86	3.29	2.74	1.17	−0.18	0.37	0.77
EW	Average return	**0.923**	**0.626**	**0.501**	**0.573**	**0.492**	**0.275**	0.081	0.155	0.215
	t-statistic	6.22	4.34	3.69	4.28	3.78	2.06	0.59	1.16	1.59

The table reports profits for momentum strategies based on past 12-month returns. The strategies use either individual stocks or portfolios sorted by industry, size, and book-to-market (equal- or value-weighted, as indicated in the table). The strategies invest $w_{it} = (1/N)(r_{i,t-1} - r_{m,t-1})$ in asset i, where $r_{i,t-1} - r_{m,t-1}$ is the asset's lagged return in excess of the equal-weighted index; the weights are rescaled to have \$1 long and \$1 short. The tests use all NYSE, AMEX, and Nasdaq stocks with the necessary return and accounting data. Returns are measured in percent. Bold denotes average returns greater than 1.645 standard errors from zero.

[a] Statistics for May 1963–December 1999.

Table 3: Benchmark-adjusted Momentum Profits

Assets		Month after formation 1	3	5	7	9	11	13	15	17
Individual stocks—industry-adjusted returns										
	Average return	**0.317**	**0.694**	**0.374**	0.069	−0.127	**−0.273**	**−0.438**	**−0.379**	**−0.419**
	t-statistic	2.18	4.90	2.86	0.57	−1.10	−2.41	−3.78	−3.34	−4.10
Individual stocks—size-adjusted returns										
	Average return	**0.406**	**0.737**	**0.391**	0.055	−0.152	**−0.349**	**−0.533**	**−0.489**	**−0.501**
	t-statistic	2.86	5.48	3.12	0.49	−1.42	−3.40	−5.23	−4.85	−5.47
Individual stocks—size and B/M-adjusted returns[a]										
	Average return	**0.537**	**0.810**	**0.456**	0.177	−0.018	**−0.258**	**−0.475**	**−0.409**	**−0.434**
	t-statistic	3.51	5.70	3.46	1.48	−0.16	−2.29	−4.25	−3.60	−4.09
15 industry portfolios—size-adjusted returns										
VW	Average return	**0.660**	**0.443**	**0.331**	**0.274**	0.154	0.003	−0.103	**−0.210**	−0.146
	t-statistic	6.37	4.22	3.20	2.75	1.53	0.03	−1.08	−2.27	−1.63
EW	Average return	**0.900**	**0.553**	**0.344**	**0.197**	0.042	−0.136	**−0.278**	**−0.327**	**−0.281**
	t-statistic	8.51	5.28	3.35	1.99	0.42	−1.37	−2.93	−3.59	−3.19
15 industry portfolios—size and B/M-adjusted returns[a]										
VW	Average return	**0.567**	**0.396**	**0.304**	**0.382**	**0.212**	0.060	−0.055	−0.169	−0.125
	t-statistic	4.31	2.94	2.28	3.00	1.67	0.50	−0.46	−1.44	−1.10
EW	Average return	**0.848**	**0.534**	**0.366**	**0.321**	0.189	0.001	−0.185	**−0.258**	**−0.208**
	t-statistic	6.55	4.27	3.00	2.70	1.54	0.01	−1.59	−2.28	−1.84

Table 3: Benchmark-adjusted Momentum Profits

5 size portfolios—industry-adjusted returns										
VW	Average return	**0.453**	**0.304**	**0.406**	**0.390**	**0.279**	**0.197**	**0.212**	**0.277**	**0.247**
	t-statistic	4.72	3.02	4.10	4.06	2.80	2.00	2.27	2.95	2.60
EW	Average return	**0.477**	**0.322**	**0.435**	**0.408**	**0.280**	**0.221**	**0.245**	**0.301**	**0.266**
	t-statistic	4.43	2.85	3.91	3.76	2.51	1.97	2.37	2.82	2.47
15 size portfolios—industry-adjusted returns										
VW	Average return	**0.454**	**0.363**	**0.386**	**0.382**	**0.293**	**0.200**	**0.218**	**0.265**	**0.197**
	t-statistic	4.38	3.23	3.66	3.94	2.87	1.86	2.33	2.95	2.15
EW	Average return	**0.517**	**0.415**	**0.456**	**0.453**	**0.368**	**0.253**	**0.262**	**0.318**	**0.257**
	t-statistic	4.37	3.26	3.75	4.00	3.37	2.23	2.53	3.03	2.55
9 size-B/M portfolios—industry-adjusted returns[a]										
VW	Average return	**0.712**	**0.495**	**0.391**	**0.434**	**0.386**	**0.217**	0.094	**0.198**	**0.223**
	t-statistic	6.25	4.29	3.41	3.85	3.42	1.93	0.83	1.77	2.03
EW	Average return	**0.798**	**0.598**	**0.528**	**0.604**	**0.581**	**0.419**	**0.315**	**0.397**	**0.407**
	t-statistic	6.72	5.17	4.70	5.48	5.31	3.69	2.67	3.46	3.52
25 size-B/M portfolios—industry-adjusted returns[a]										
VW	Average return	**0.711**	**0.486**	**0.351**	**0.374**	**0.320**	0.151	0.028	0.105	0.151
	t-statistic	6.41	4.42	3.31	3.54	3.08	1.43	0.27	1.02	1.47
EW	Average return	**0.780**	**0.557**	**0.482**	**0.561**	**0.505**	**0.349**	**0.250**	**0.328**	**0.343**
	t-statistic	6.71	4.89	4.38	5.15	4.66	3.12	2.19	2.97	3.08

The table reports benchmark-adjusted profits for momentum strategies based on past 12-month returns. The strategies are the same as those in Table 2 (using identical weights). For individual stocks, benchmark returns are determined by the stock's industry, size, or size-B/M grouping (the size grouping is based on NYSE deciles and the size-B/M grouping is based on NYSE quintiles). The benchmark for industry portfolios is determined by the size and B/M characteristics of firms in the industry. The benchmark for size and size-B/M portfolios is determined by the industrial mix of firms in the portfolio. The tests use all NYSE, AMEX, and Nasdaq stocks with the necessary return and accounting data. Returns are measured in percent. Bold denotes average returns greater than 1.645 standard errors from zero.

[a] Statistics for May 1963–December 1999.

Momentum is a pervasive feature of stocks returns

- Hold in individual stocks
- Hold separately in: size, BM, industry, and size-BM portfolios
- These are diversified portfolios!

Autocovariance

Matrix of autocovariance:

$$\Delta_k \equiv Cov(r_t^{12}, r_{t+k})$$

- Autocorrelation of returns
- Cross-serial correlation of returns

- How do these autocorrelations relate to momentum?

Table 4: Auto- and cross-serial correlations

- Negative autocorrelations
- Negative cross-serial correlations

		Size portfolios						B/M portfolios[a]				
		$R_{Small,t}$	$R_{2,t}$	$R_{3,t}$	$R_{4,t}$	$R_{Big,t}$		$R_{Low,t}$	$R_{2,t}$	$R_{3,t}$	$R_{4,t}$	$R_{High,t}$
Past returns	$R_{Small,t-k}$	−0.02	−0.03	−0.03	**−0.05**	**−0.05**	$R_{Low,t-k}$	−0.04	**−0.07**	−0.05	**−0.08**	**−0.08**
	$R_{2,t-k}$	−0.04	−0.04	−0.04	**−0.05**	**−0.05**	$R_{2,t-k}$	−0.03	−0.04	−0.02	−0.05	−0.06
	$R_{3,t-k}$	**−0.05**	**−0.05**	**−0.05**	**−0.06**	**−0.05**	$R_{3,t-k}$	−0.04	−0.04	−0.02	−0.05	−0.06
	$R_{4,t-k}$	**−0.07**	**−0.06**	**−0.06**	**−0.07**	**−0.05**	$R_{4,t-k}$	−0.05	−0.03	−0.01	−0.03	−0.04
	$R_{Big,t-k}$	**−0.10**	**−0.08**	**−0.07**	**−0.07**	−0.04	$R_{High,t-k}$	**−0.06**	−0.04	−0.02	−0.04	−0.04

		Industry portfolios														
		$R_{1,t}$	$R_{2,t}$	$R_{3,t}$	$R_{4,t}$	$R_{5,t}$	$R_{6,t}$	$R_{7,t}$	$R_{8,t}$	$R_{9,t}$	$R_{10,t}$	$R_{11,t}$	$R_{12,t}$	$R_{13,t}$	$R_{14,t}$	$R_{15,t}$
Past returns	$R_{1,t-k}$	**−0.05**	**−0.06**	**−0.05**	**−0.07**	**−0.06**	**−0.06**	**−0.06**	**−0.08**	**−0.08**	**−0.08**	**−0.06**	**−0.07**	**−0.07**	**−0.05**	**−0.06**
	$R_{2,t-k}$	−0.04	**−0.05**	**−0.05**	**−0.07**	**−0.05**	**−0.06**	−0.02	**−0.05**	**−0.06**	**−0.06**	**−0.07**	−0.03	**−0.07**	**−0.05**	**−0.07**
	$R_{3,t-k}$	**−0.05**	−0.04	−0.01	**−0.05**	−0.03	−0.01	−0.01	**−0.05**	**−0.05**	−0.04	**−0.06**	−0.01	−0.03	−0.04	**−0.07**
	$R_{4,t-k}$	−0.03	**−0.05**	−0.03	−0.04	−0.03	**−0.06**	−0.01	−0.03	**−0.05**	**−0.05**	**−0.07**	−0.02	**−0.05**	−0.04	−0.04
	$R_{5,t-k}$	−0.03	−0.04	**−0.06**	**−0.08**	−0.04	**−0.06**	−0.01	**−0.06**	**−0.08**	**−0.05**	**−0.08**	−0.05	**−0.08**	**−0.06**	**−0.09**
	$R_{6,t-k}$	−0.04	−0.03	**−0.06**	**−0.07**	−0.03	−0.03	0.00	−0.03	−0.03	**−0.06**	**−0.06**	−0.01	**−0.06**	**−0.06**	**−0.07**
	$R_{7,t-k}$	**−0.05**	**−0.05**	**−0.06**	**−0.08**	**−0.06**	**−0.05**	**−0.05**	**−0.06**	**−0.06**	**−0.07**	**−0.05**	−0.04	**−0.07**	**−0.06**	**−0.07**
	$R_{8,t-k}$	−0.04	**−0.06**	**−0.06**	**−0.07**	−0.04	**−0.07**	−0.02	−0.02	−0.05	**−0.07**	**−0.08**	−0.02	**−0.06**	−0.04	−0.04
	$R_{9,t-k}$	−0.03	−0.02	−0.03	**−0.05**	−0.01	−0.03	−0.01	0.00	−0.02	−0.04	**−0.06**	−0.01	**−0.05**	−0.03	−0.02
	$R_{10,t-k}$	−0.01	−0.03	−0.04	**−0.05**	−0.02	−0.03	0.01	−0.01	−0.03	−0.04	−0.04	−0.01	**−0.07**	−0.03	**−0.05**
	$R_{11,t-k}$	−0.03	**−0.05**	−0.03	**−0.05**	−0.04	−0.04	−0.02	−0.02	−0.03	**−0.05**	**−0.07**	−0.02	**−0.05**	**−0.05**	−0.04
	$R_{12,t-k}$	**−0.05**	−0.03	−0.04	−0.04	−0.02	−0.03	−0.03	−0.01	−0.02	−0.03	**−0.06**	0.00	−0.04	**−0.07**	−0.04
	$R_{13,t-k}$	**−0.05**	**−0.05**	**−0.05**	**−0.06**	−0.03	**−0.05**	−0.02	−0.03	−0.04	**−0.05**	**−0.07**	−0.02	**−0.06**	**−0.06**	**−0.07**
	$R_{14,t-k}$	**−0.05**	−0.05	**−0.05**	**−0.07**	−0.02	−0.03	−0.02	−0.03	−0.04	−0.04	**−0.07**	−0.02	**−0.05**	**−0.05**	**−0.06**
	$R_{15,t-k}$	−0.03	−0.04	−0.04	−0.04	−0.01	**−0.05**	−0.01	−0.02	−0.04	**−0.05**	**−0.07**	−0.03	−0.04	−0.03	−0.03

The table reports autocorrelations (diagonals) and cross-serial correlations (off diagonals) for value-weighted industry, size, and B/M portfolios. The industries appear in the same order as in Table 1. Autocorrelations equal the correlation between a portfolio's monthly return and its past 12-month return. Cross-serial correlations equal the correlation between a portfolio's monthly return and the past 12-month returns on other assets. The table reports the average correlation for lags of 1–18 months; the correlations are estimated individually for each lag and then averaged. The portfolio used as the predictive variable (12-month returns) changes as you move down the columns, and the portfolio being predicted changes as you move across the rows. Bold denotes estimates that are significant at the 5% level based on bootstrap simulations.

[a] Statistics for May 1963–December 1999.

Table 4: Auto- and cross-serial correlations

- Negative autocorrelations
- Negative cross-serial correlations

		Size portfolios						B/M portfolios[a]				
		$R_{Small,t}$	$R_{2,t}$	$R_{3,t}$	$R_{4,t}$	$R_{Big,t}$		$R_{Low,t}$	$R_{2,t}$	$R_{3,t}$	$R_{4,t}$	$R_{High,t}$
Past returns	$R_{Small,t-k}$	−0.02	−0.03	−0.03	**−0.05**	**−0.05**	$R_{Low,t-k}$	−0.04	**−0.07**	−0.05	**−0.08**	**−0.08**
	$R_{2,t-k}$	−0.04	−0.04	−0.04	**−0.05**	**−0.05**	$R_{2,t-k}$	−0.03	−0.04	−0.02	−0.05	−0.06
	$R_{3,t-k}$	**−0.05**	**−0.05**	**−0.05**	**−0.06**	**−0.05**	$R_{3,t-k}$	−0.04	−0.04	−0.02	−0.05	−0.06
	$R_{4,t-k}$	**−0.07**	**−0.06**	**−0.06**	**−0.07**	**−0.05**	$R_{4,t-k}$	−0.05	−0.03	−0.01	−0.03	−0.04
	$R_{Big,t-k}$	**−0.10**	**−0.08**	**−0.07**	**−0.07**	−0.04	$R_{High,t-k}$	**−0.06**	−0.04	−0.02	−0.04	−0.04

		Industry portfolios														
		$R_{1,t}$	$R_{2,t}$	$R_{3,t}$	$R_{4,t}$	$R_{5,t}$	$R_{6,t}$	$R_{7,t}$	$R_{8,t}$	$R_{9,t}$	$R_{10,t}$	$R_{11,t}$	$R_{12,t}$	$R_{13,t}$	$R_{14,t}$	$R_{15,t}$
Past returns	$R_{1,t-k}$	**−0.05**	**−0.06**	**−0.05**	**−0.07**	**−0.06**	**−0.06**	**−0.06**	**−0.08**	**−0.08**	**−0.08**	**−0.06**	**−0.07**	**−0.07**	**−0.05**	**−0.06**
	$R_{2,t-k}$	−0.04	**−0.05**	**−0.05**	**−0.07**	**−0.05**	**−0.06**	−0.02	**−0.05**	**−0.06**	**−0.06**	**−0.07**	−0.03	**−0.07**	**−0.05**	**−0.07**
	$R_{3,t-k}$	**−0.05**	−0.04	−0.01	**−0.05**	−0.03	−0.01	−0.01	**−0.05**	**−0.05**	−0.04	**−0.06**	−0.01	−0.03	−0.04	**−0.07**
	$R_{4,t-k}$	−0.03	**−0.05**	−0.03	−0.04	−0.03	**−0.06**	−0.01	−0.03	**−0.05**	**−0.05**	**−0.07**	−0.02	**−0.05**	−0.04	−0.04
	$R_{5,t-k}$	−0.03	−0.04	**−0.06**	**−0.08**	−0.04	**−0.06**	−0.01	**−0.06**	**−0.08**	**−0.05**	**−0.08**	−0.05	**−0.08**	**−0.06**	**−0.09**
	$R_{6,t-k}$	−0.04	−0.03	**−0.06**	**−0.07**	−0.03	−0.03	0.00	−0.03	−0.03	**−0.06**	**−0.06**	−0.01	**−0.06**	**−0.06**	**−0.07**
	$R_{7,t-k}$	**−0.05**	**−0.05**	**−0.06**	**−0.08**	**−0.06**	**−0.05**	**−0.05**	**−0.06**	**−0.06**	**−0.07**	**−0.05**	−0.04	**−0.07**	**−0.06**	**−0.07**
	$R_{8,t-k}$	−0.04	**−0.06**	**−0.06**	**−0.07**	−0.04	**−0.07**	−0.02	−0.02	−0.05	**−0.07**	**−0.08**	−0.02	**−0.06**	−0.04	−0.04
	$R_{9,t-k}$	−0.03	−0.02	−0.03	**−0.05**	−0.01	−0.03	−0.01	0.00	−0.02	−0.04	**−0.06**	−0.01	**−0.05**	−0.03	−0.02
	$R_{10,t-k}$	−0.01	−0.03	−0.04	**−0.05**	−0.02	−0.03	0.01	−0.01	−0.03	−0.04	−0.04	−0.01	**−0.07**	−0.03	**−0.05**
	$R_{11,t-k}$	−0.03	**−0.05**	−0.03	**−0.05**	−0.04	−0.04	−0.02	−0.02	−0.03	**−0.05**	**−0.07**	−0.02	**−0.05**	**−0.05**	−0.04
	$R_{12,t-k}$	**−0.05**	−0.03	−0.04	−0.04	−0.02	−0.03	−0.03	−0.01	−0.02	−0.03	**−0.06**	0.00	−0.04	**−0.07**	−0.04
	$R_{13,t-k}$	**−0.05**	**−0.05**	**−0.05**	**−0.06**	−0.03	**−0.05**	−0.02	−0.03	−0.04	**−0.05**	**−0.07**	−0.02	**−0.06**	**−0.06**	**−0.07**
	$R_{14,t-k}$	**−0.05**	−0.05	**−0.05**	**−0.07**	−0.02	−0.03	−0.02	−0.03	−0.04	−0.04	**−0.07**	−0.02	**−0.05**	**−0.05**	**−0.06**
	$R_{15,t-k}$	−0.03	−0.04	−0.04	−0.04	−0.01	**−0.05**	−0.01	−0.02	−0.04	**−0.05**	**−0.07**	−0.03	−0.04	−0.03	−0.03

The table reports autocorrelations (diagonals) and cross-serial correlations (off diagonals) for value-weighted industry, size, and B/M portfolios. The industries appear in the same order as in Table 1. Autocorrelations equal the correlation between a portfolio's monthly return and its past 12-month return. Cross-serial correlations equal the correlation between a portfolio's monthly return and the past 12-month returns on other assets. The table reports the average correlation for lags of 1–18 months; the correlations are estimated individually for each lag and then averaged. The portfolio used as the predictive variable (12-month returns) changes as you move down the columns, and the portfolio being predicted changes as you move across the rows. Bold denotes estimates that are significant at the 5% level based on bootstrap simulations.

[a] Statistics for May 1963–December 1999.

Auto- and cross-serial correlations

- Previous relied on average correlation with lags from 1 to 18 months
- Correlations could be varying across lags
- Regress: portfolio returns on it own past returns

Table 5: Autocorrelations

Portfolio	Forecast horizon (months) 1	3	5	7	9	11	13	15	17
Size portfolios									
Small	**.016**	−.002	−.003	−.004	−.006	−.007	−.010	−.006	−.006
2	.007	−.010	−.008	−.009	−.013	**−.014**	**−.015**	−.007	−.008
3	.000	**−.016**	−.012	−.013	**−.016**	**−.018**	**−.016**	−.007	−.008
4	−.007	**−.020**	**−.017**	**−.020**	**−.022**	**−.023**	**−.020**	−.011	−.010
Big	.000	−.006	−.007	−.010	−.015	**−.018**	**−.019**	−.011	−.008
Average	.003	−.011	−.009	−.011	**−.014**	**−.016**	**−.016**	−.008	−.008
Wald test (χ^2)	**27.0**	**20.1**	**11.0**	**13.7**	**10.2**	**9.7**	5.3	3.8	2.0
Industry portfolios									
Natural resources	−.002	−.012	−.008	−.007	−.008	**−.018**	**−.019**	**−.020**	**−.018**
Construction	−.004	−.011	−.006	−.009	**−.016**	**−.022**	**−.019**	−.011	−.011
Food, tobacco	.014	.008	.005	.003	−.005	−.006	−.014	−.012	−.009
Construction products	.013	−.005	−.005	−.009	−.014	**−.016**	**−.020**	−.012	−.009
Logging, paper	−.003	−.007	−.002	−.008	−.014	−.015	−.014	−.011	−.014
Chemicals	.004	−.001	.001	−.004	−.012	−.012	**−.017**	−.014	**−.016**
Petroleum	−.001	−.003	−.008	−.009	−.014	**−.019**	**−.018**	**−.020**	−.015
Machinery	.003	−.010	−.006	−.003	−.010	−.014	−.009	.006	.003
Electrical equipment	.002	−.007	−.006	−.005	−.008	−.012	−.013	−.007	−.007
Transport equipment	.007	−.004	−.004	−.005	−.011	**−.019**	**−.017**	−.011	−.011
Shipping	−.002	−.015	**−.015**	**−.019**	**−.024**	**−.028**	**−.024**	−.013	−.008
Utilities, telecom.	.011	.006	−.002	−.011	−.009	−.012	−.011	−.003	.003
Trade	.007	−.011	−.012	**−.015**	−.012	**−.018**	**−.026**	**−.018**	**−.015**
Financial	.001	−.013	−.010	**−.015**	**−.015**	**−.017**	**−.019**	−.011	−.012
Services, other	.011	−.004	−.007	−.006	−.003	−.006	**−.013**	−.008	−.004
Average	.004	−.006	−.006	−.008	**−.012**	**−.016**	**−.017**	**−.011**	−.009
Wald test (χ^2)	13.2	16.1	10.0	14.3	11.5	14.3	14.9	17.5	15.0

Table 5: Autocorrelations

Size-B/M portfolios[a]										
Small	Low	.008	−.011	−.007	−.001	−.008	−.013	**−.020**	−.009	−.005
	2	.005	−.011	−.002	.001	−.008	−.012	−.019	−.009	−.011
	High	.008	−.010	−.001	.000	−.006	−.008	−.016	−.008	−.013
Medium	Low	−.007	**−.022**	−.012	−.007	−.011	−.020	**−.022**	−.010	−.005
	2	−.006	−.016	−.004	−.006	−.009	−.014	−.016	−.003	−.005
	High	−.008	−.023	−.010	−.011	−.012	−.012	−.020	−.005	−.011
Large	Low	−.003	−.006	−.005	−.002	−.004	−.012	−.021	−.016	−.007
	2	−.008	−.006	.000	−.005	−.006	−.012	−.012	.002	.002
	High	−.006	−.019	−.007	−.010	−.012	−.018	−.019	.000	−.004
Average		−.002	−.014	−.005	−.005	−.008	−.013	**−.018**	−.006	−.007
Wald test (χ^2)		11.7	12.5	6.0	5.1	2.6	4.9	6.6	4.8	5.0

The table reports, for lags of 1–18 months, the OLS slope coefficient when a portfolio's monthly return is regressed on its own past 12-month return. The table shows estimates for value-weighted industry, size, and size-B/M portfolios, described more fully in Table 1. Bold denotes estimates that are greater than 1.645 standard errors from zero or Wald statistics that are significant at the 10% level.

[a] Statistics for May 1963–December 1999.

- Persistence in returns at odds with empirical evidence
- Cross-serial correlation tightly related to momentum
- Table 6 shows profit decomposition: profits come from cross-serial correlation

Using Fama and French three-factor model

- Verify momentum in the Fama and French Factor
  - What to expect?
- Use the Fama and French model Residuals
- We know Fama and French three-factor model explains size and BM portfolios but not industry portfolios

Table 8: Using Fama and French three-factor model

	Month after formation								
Assets	1	3	5	7	9	11	13	15	17
FF factors									
Average return	**0.609**	**0.372**	**0.368**	**0.373**	0.264	0.085	−0.054	−0.009	0.177
t-statistic	3.68	2.22	2.21	2.37	1.61	0.54	−0.34	−0.06	1.14
15 industry portfolios—FF residuals									
Average return	**0.590**	**0.434**	**0.304**	**0.200**	0.119	−0.038	−0.079	**−0.203**	−0.144
t-statistic	5.81	4.16	2.94	1.99	1.19	−0.40	−0.83	−2.19	−1.59
5 size portfolios—FF residuals									
Average return	**0.114**	**0.102**	**0.090**	0.071	0.043	0.026	−0.008	0.010	0.002
t-statistic	2.58	2.23	1.99	1.60	1.03	0.62	−0.19	0.24	0.05
5 B/M portfolios—FF residuals[a]									
Average return	0.084	0.059	0.092	0.061	0.052	0.036	−0.074	−0.101	−0.101
t-statistic	1.01	0.72	1.17	0.77	0.65	0.46	−0.97	−1.28	−1.31
9 size-B/M portfolios—FF residuals[a]									
Average return	**0.142**	0.037	0.033	0.015	0.028	−0.016	−0.078	−0.015	0.030
t-statistic	2.19	0.60	0.56	0.25	0.47	−0.28	−1.40	−0.29	0.54
25 size-B/M portfolios—FF residuals[a]									
Average return	**0.146**	0.066	0.037	−0.003	−0.011	−0.075	**−0.140**	**−0.091**	−0.068
t-statistic	2.30	1.08	0.64	−0.04	−0.19	−1.39	−2.56	−1.79	−1.29

The table reports profits for momentum strategies based on past 12-month returns. The first row reports a strategy using the Fama and French (1993) factors. The remaining rows use the three-factor model to adjust returns during both the formation and postformation period. To isolate time-series patterns in the residuals, the intercepts in the preliminary three-factor regressions are permitted to be nonzero. The momentum strategy invests in assets in proportion to their abnormal returns, scaled so the weights on both sides of the trade sum to \$1. Returns are measured in percent. Bold denotes average returns greater than 1.645 standard errors from zero.

[a] Statistics for May 1963–December 1999.

Takeaway

- Momentum in well-diversified portfolios:
  - Size, BM, industry, and size-BM portfolios
- Autocorrelations: negative
- Cross-serial correlations: negative
- Stocks covary "too strongly"

Value and Momentum Everywhere

Asness, Moskowitz, and Pedersen (2013, JF)

Value and Momentum

- Value: stocks with high BM ratio outperform those with low BM ratio
- Momentum: winners outperform losers

- Value and momentum are studied separately
- Focus on equity (stocks)

Value and Momentum Everywhere

- Global Phenomenon
- Across different market and asset classes

- Negative correlation between momentum and value
- Comovement across asset classes for both value and momentum

Value and Momentum Everywhere

Data

- Assets
  1. Individual stocks: US
  2. Individual stocks: UK
  3. Individual stocks: Continental Europe
  4. Individual stocks: Japan
  5. Global Equity Indices: 18 different markets
  6. 10 different currencies
  7. Global bonds: 10 countries
  8. 27 Commodity Futures
- US stocks: CRSP common equity with a recent book value, at least 12 months of returns. Excludes: penny stocks (price less than \$1). Focus liquid stocks top half of remaining universe based on market cap (top 17% of total universe).

Value and Momentum Everywhere

Momentum

- Cumulative returns from $t-12$ to t.

Value: cheap vs. expensive

- Stocks: book to price
- Country equity indices: aggregate book to price
- Commodities: book to price,
  - book: average commodity spot price 4.5 to 5.5 years ago
- Currencies: book to price
  - book: average exchange rate 4.5 to 5.5 years ago adjusted for PPP
- Bonds: real bond yield, i.e. yield minus expected inflation

Value and Momentum Everywhere

Within each asset class

- Value and momentum portfolios: terciles
- Long-short portfolios with weights:

$$w_{it}^S = c_t(\text{rank}(S_{it}) - \Sigma_i \text{rank}(S_{it})/N)$$

where c_t keeps leverage constant (same long and short legs)

- Portfolios:

$$r_t^S = \Sigma_i w_{it}^S r_{it}, \quad \text{where } S \in (\text{value, momentum})$$

and

$$r_t^{COMBO} = 0.5 r_t^{VALUE} + 0.5 r_t^{MOM}$$

Table 1: Performance of Value and Momentum

Panel A: Individual Stock Portfolios

		Value Portfolios					Momentum Portfolios					50/50 Combination	
		P1	P2	P3	P3–P1	Factor	P1	P2	P3	P3–P1	Factor	P3–P1	Factor
U.S. stocks	Mean	9.5%	10.6%	13.2%	3.7%	3.9%	8.8%	9.7%	14.2%	5.4%	7.7%	4.6%	5.8%
01/1972 to	(*t*-stat)	(3.31)	(4.33)	(5.19)	(1.83)	(1.66)	(2.96)	(4.14)	(4.82)	(2.08)	(2.84)	(3.98)	(5.40)
07/2011	Stdev	17.9%	15.4%	15.9%	12.8%	14.8%	18.6%	14.8%	18.5%	16.4%	17.0%	7.2%	6.8%
	Sharpe	0.53	0.69	0.83	0.29	0.26	0.47	0.66	0.77	0.33	0.45	0.63	0.86
	Alpha	− 1.7%	0.8%	3.6%	5.3%	5.8%	− 2.3%	0.2%	3.7%	6.0%	8.7%	5.7%	7.2%
	(*t*-stat)	(− 1.59)	(1.02)	(3.17)	(2.66)	(2.49)	(− 1.68)	(0.29)	(2.34)	(2.30)	(3.22)	(5.05)	(7.06)
									Correlation (Val, Mom) =			− 0.53	− 0.65

Similar result for other countries and asset classes

Table 2: Correlations

Table II

Correlation of Value and Momentum Strategies across Markets and Asset Classes

Reported are the average correlations among all value and momentum strategies across markets and asset classes. Panel A reports the correlations of the average return series, where we first compute the average return series for a group (e.g., all individual stock value strategies across all markets and all nonstock value strategies across all nonstock asset classes) and then compute the correlation between the two average return series. The diagonal elements in Panel A are computed as the average correlation between each market's return series and the average of all other return series in other markets, excluding the market itself. For example, we compute the correlation between U.S. stock value returns and the average returns to value strategies across stocks in the United Kingdom, Europe, and Japan. We then do the same for U.K. value returns with the average of value returns across the United States, Europe, and Japan, and repeat this for Europe value and Japan value strategies as well. We then take the average of these correlations and report them as the first diagonal element of Panel A. Correlations are computed from quarterly returns to mitigate the influence of nonsynchronous trading across markets. Panel B breaks down the correlations of the individual stock value and momentum strategies series with each of the nonstock value and momentum strategies. An *F*-test for the joint significance of the individual correlations within each group is performed, where * indicates the correlations are significantly different from zero at the 5% significance level.

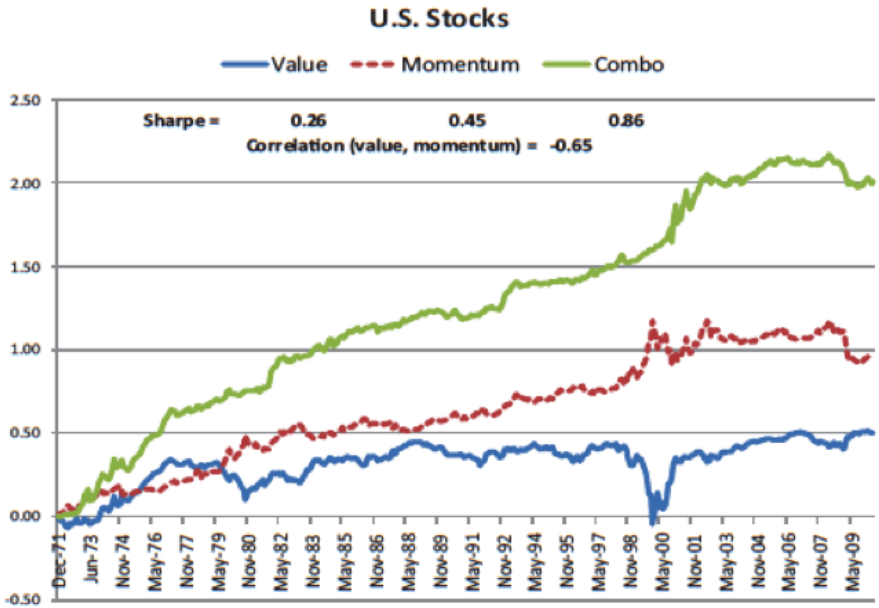
Panel A: Correlation of Average Return Series

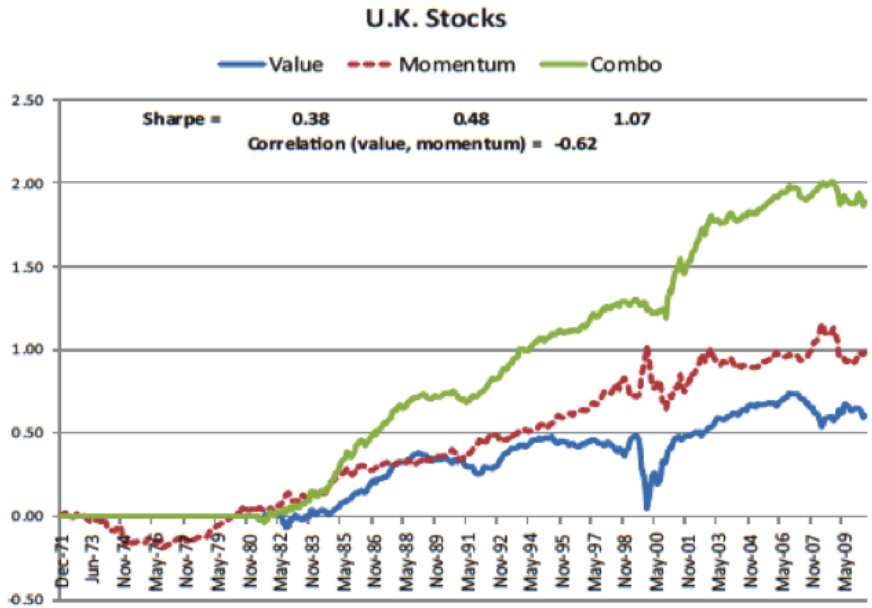
	Stock Value	Nonstock Value	Stock Momentum	Nonstock Momentum
Stock value	0.68*	0.15*	−0.53*	−0.26*
Nonstock value		0.07	−0.16*	−0.13*
Stock momentum			0.65*	0.37*
Nonstock momentum				0.21*

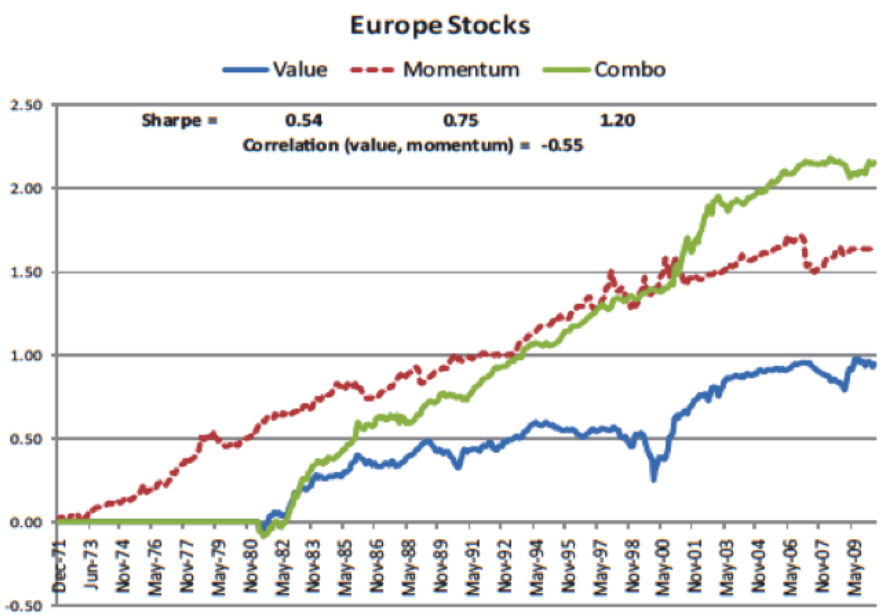
Panel B: Correlation of Average Stock Series with Each Nonstock Series

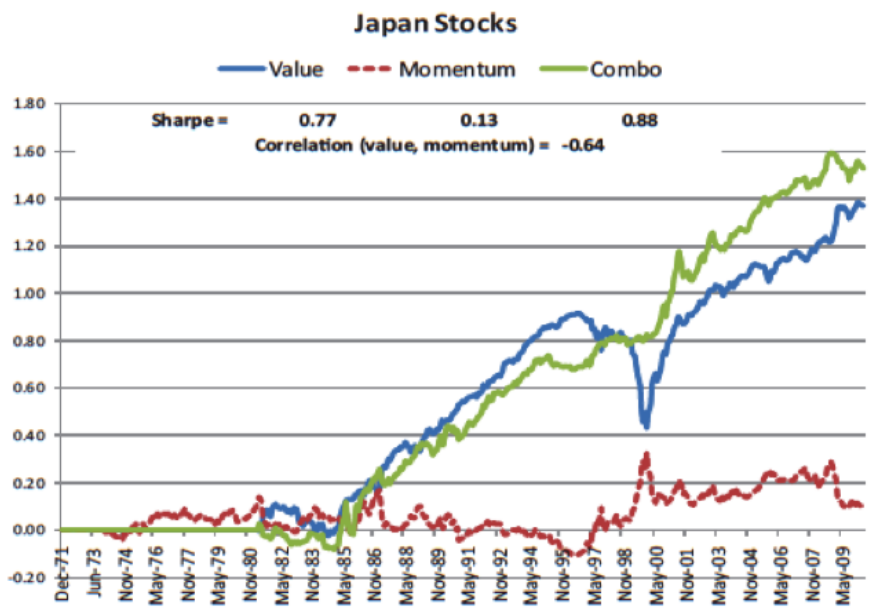
	Country Index Value	Currency Value	Fixed Income Value	Commodity Value	Country Index Momentum	Currency Momentum	Fixed Income Momentum	Commodity Momentum
Global Stock value	0.27*	0.13*	−0.03	0.01	−0.28*	−0.20*	−0.01	−0.17*
Global Stock momentum	−0.19*	−0.12*	−0.05	−0.06	0.40*	0.28*	0.09	0.20*

Figure 2: cumulative returns









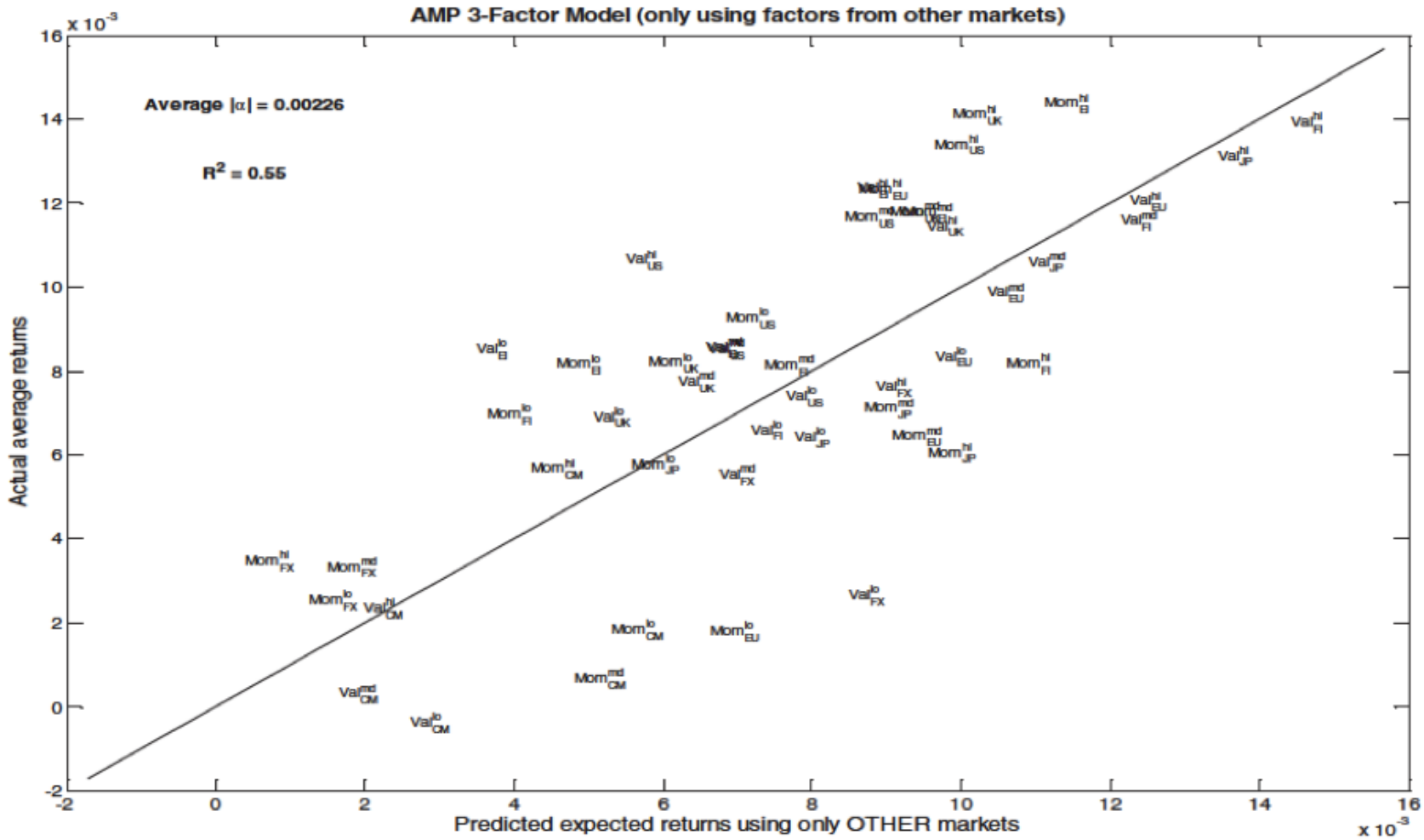
Comovement and Asset Pricing Test

- Can we explain value and momentum in one market using value and momentum from other markets?
- We can test:

$$R^p_{i,t} - r_{f,t} = \alpha^p_i + \beta^p_i MKT_t + v^p_i \sum_{j \neq i} w_j VAL_{j,t} + m^p_i \sum_{j \neq i} w_j MOM_{j,t} + \varepsilon^p_{i,t}$$

- More evidence that value and momentum comove in different markets
- Test assets: 48 portfolios of value and momentum within each asset class

Comovement and Asset Pricing Test



Takeaway

- Value and momentum in different markets and asset classes
- Negative correlation between value and momentum
- Value-momentum combo works better: large Sharpe ratio
- Value and momentum covary across asset classes

Momentum Crashes

Daniel and Moskowitz (2016, JFE)

Momentum

- Momentum strategies deliver high Sharpe ratios (so far...)
- It's everywhere: different assets classes, countries, industries
- Exhibit significant negative skewness
  - April 2009 return was -45.52%, the second worst since 1932
  - There is an HBS case about it
  - Monthly momentum return skewness is -4.7, while the market is -0.57
- Maximum monthly momentum return in our sample: 26.1%
- The 5 worst are -74%, -61%, -49%, -46%, and -44%

Portfolio Construction

- CRSP share codes 10 and 11
- NYSE, AMAX, Nasdaq
- Valid share price and number of shares on the formation date
- At least 8 month of past return data
- Rank stock based on their cumulative returns from $t-12$ to $t-1$
- Skip one month as formation period
- Sort stocks into deciles

Table 1

Momentum portfolio characteristics, 1927:01–2013:03.

This table presents characteristics of the monthly momentum decile portfolio excess returns over the 87-year full sample period from 1927:01 through 2013:03. The decile 1 portfolio—the loser portfolio—contains the 10% of stocks with the worst losses, and decile 10—the winner portfolio—contains the 10% of the stocks with the largest gains. WML is the zero-investment winner-minus-loser portfolio which is long the Decile 1 and short the Decile 10 portfolio. The mean excess return, standard deviation, and alpha are in percent, and annualized. SR denotes the annualized Sharpe Ratio. The α, $t(\alpha)$, and β are estimated from a full-period regression of each decile portfolio's excess return on the excess Center for Research in Securities Prices value-weighted index. For all portfolios except WML, sκ(m) denotes the full-period realized skewness of the monthly log returns (not excess) to the portfolios and sκ(d) denotes the full-period realized skewness of the daily log returns. For WML, sκ is the realized skewness of $\log(1+r_{WML}+r_f)$.

Return statistic	Momentum decile portfolios										WML	Market
	1	2	3	4	5	6	7	8	9	10		
$\overline{r-r_f}$	−2.5	2.9	2.9	6.4	7.1	7.1	9.2	10.4	11.3	15.3	17.9	7.7
σ	36.5	30.5	25.9	23.2	21.3	20.2	19.5	19.0	20.3	23.7	30.0	18.8
α	−14.7	−7.8	−6.4	−2.1	−0.9	−0.6	1.8	3.2	3.8	7.5	22.2	0
$t(\alpha)$	(−6.7)	(−4.7)	(−5.3)	(−2.1)	(−1.1)	(−1.0)	(2.8)	(4.5)	(4.3)	(5.1)	(7.3)	(0)
β	1.61	1.41	1.23	1.13	1.05	1.02	0.98	0.95	0.99	1.03	−0.58	1
SR	−0.07	0.09	0.11	0.28	0.33	0.35	0.47	0.54	0.56	0.65	0.60	0.41
sκ(m)	0.09	−0.05	−0.19	0.21	−0.13	−0.30	−0.55	−0.54	−0.76	−0.82	−4.70	−0.57
sκ(d)	0.12	0.29	0.22	0.27	0.10	−0.10	−0.44	−0.66	−0.67	−0.61	−1.18	−0.44

Figure 1

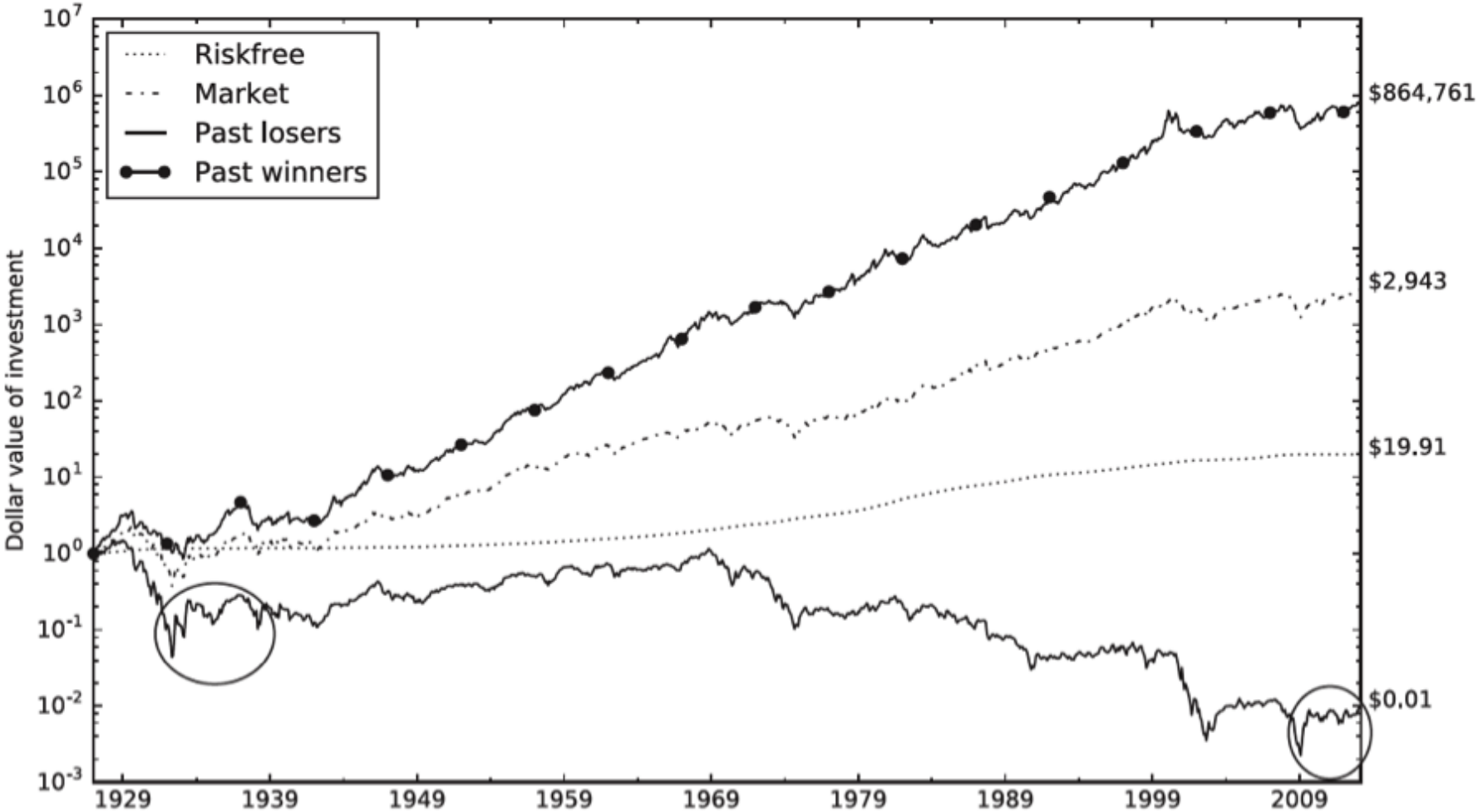


Fig. 1. Winners and losers, 1927–2013. Plotted are the cumulative returns to four assets: (1) the risk-free asset; (2) the Center for Research in Security Prices (CRSP) value-weighted index; (3) the bottom decile "past loser" portfolio and (4) the top decile "past winner" portfolio over the full sample period 1927:01 to 2013:03. To the right of the plot we tabulate the final dollar values for each of the four portfolios, given a $1 investment in January 1927.

Figure 2


Panel A: Cumulative gains from investments, March 09, 2009-March 28, 2013
Riskfree
Market
Past losers
Past winners
Dollar value of investment
1
2
3
4
5
6
2009:07
2010:01
2010:07
2011:01
2011:07
2012:01
2012:07
2013:01

Figure 2

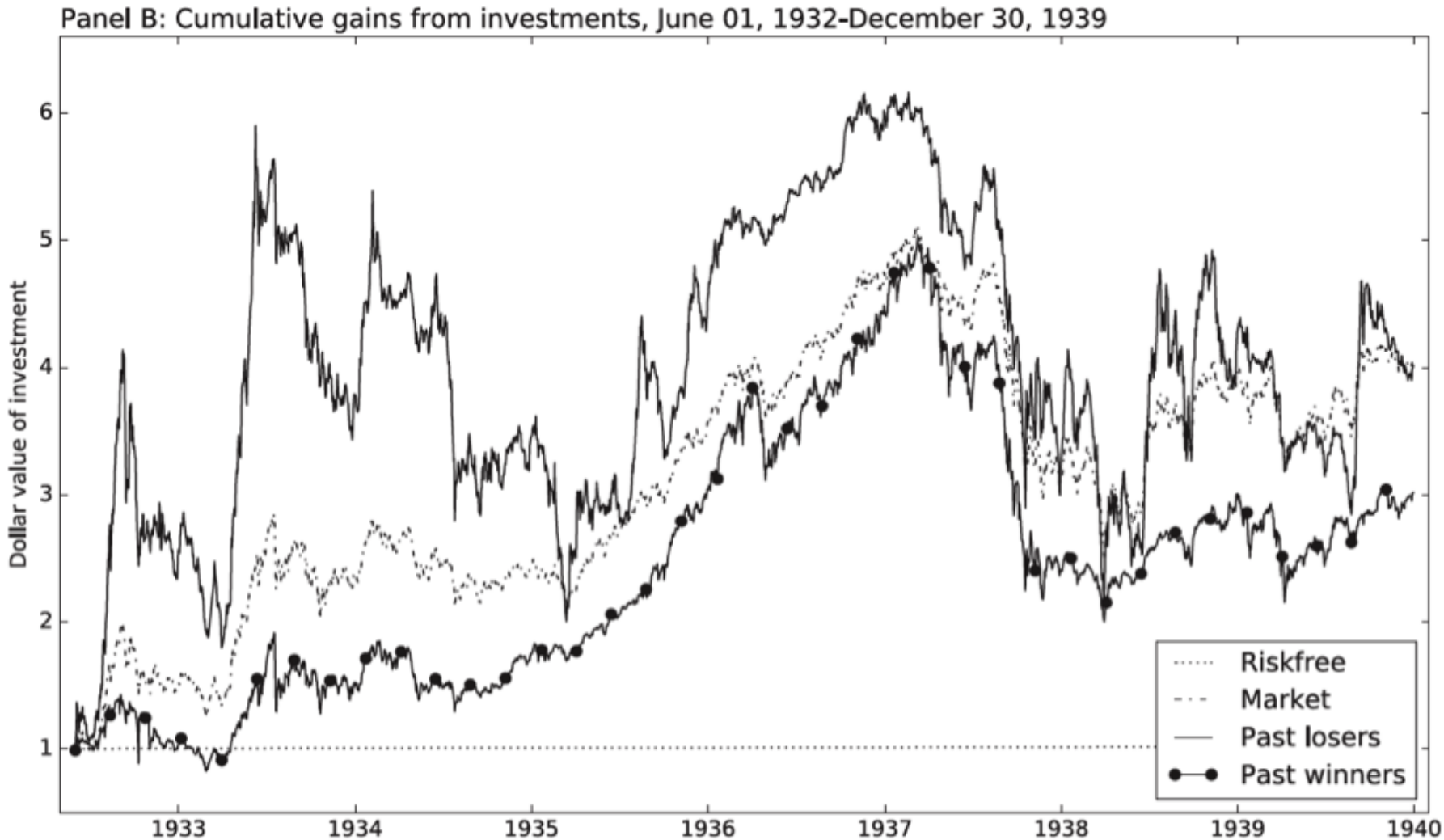

Panel B: Cumulative gains from investments, June 01, 1932-December 30, 1939
Dollar value of investment
1
2
3
4
5
6
1933
1934
1935
1936
1937
1938
1939
1940
Riskfree
Market
Past losers
Past winners

Table 2

This table lists the 15 worst monthly returns to the winner-minus-loser (WML) momentum portfolio over the 1927:01–2013:03 time period. Also tabulated are Mkt-2y, the two-year market returns leading up to the portfolio formation date, and Mkt_t, the contemporaneous market return. The dates between July 1932 and September 1939 are marked with an asterisk (*), those between April and August of 2009 with †, and those from January 2001 and November 2002 with ‡. All numbers in the table are in percent.

Rank	Month	WML_t	MKT-2y	Mkt_t
1	1932:08*	−74.36	−67.77	36.49
2	1932:07*	−60.98	−74.91	33.63
3	2001:01‡	−49.19	10.74	3.66
4	2009:04†	−45.52	−40.62	10.20
5	1939:09*	−43.83	−21.46	16.97
6	1933:04*	−43.14	−59.00	38.14
7	2009:03†	−42.28	−44.90	8.97
8	2002:11‡	−37.04	−36.23	6.08
9	1938:06*	−33.36	−27.83	23.72
10	2009:08†	−30.54	−27.33	3.33
11	1931:06*	−29.72	−47.59	13.87
12	1933:05*	−28.90	−37.18	21.42
13	2001:11‡	−25.31	−19.77	7.71
14	2001:10‡	−24.98	−16.77	2.68
15	1974:01	−24.04	−5.67	0.46

Momentum Losses

- Momentum strategy suffers worst performance at turning points following large market declines: market bottomed.
- As of March 2009, many the firms in the Loser portfolio had fallen by 90% or more.
  - Firms like Citigroup, Bank of America, Ford, GM
- Time-varying betas
- Momentum seems to get very negatively exposed to the market when crashes
- Estimate time-varying betas: 126-day rolling window using daily data

Figure 3

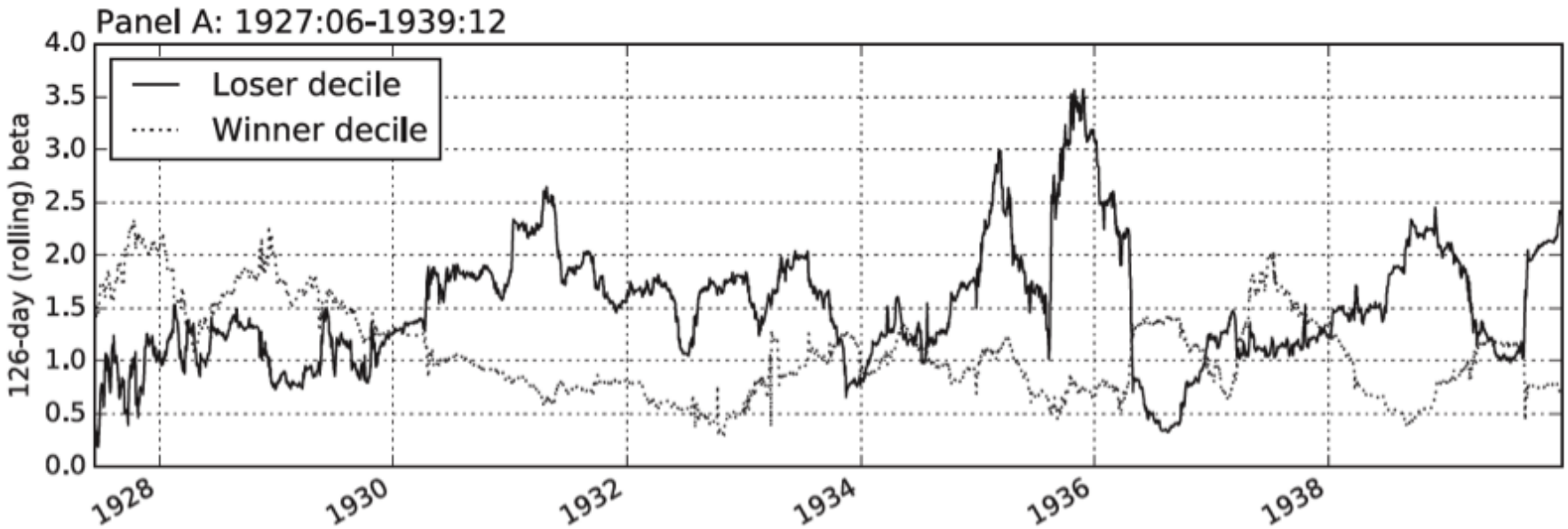

Panel A: 1927:06-1939:12
Loser decile
Winner decile
126-day (rolling) beta
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1928
1930
1932
1934
1936
1938

Figure 3

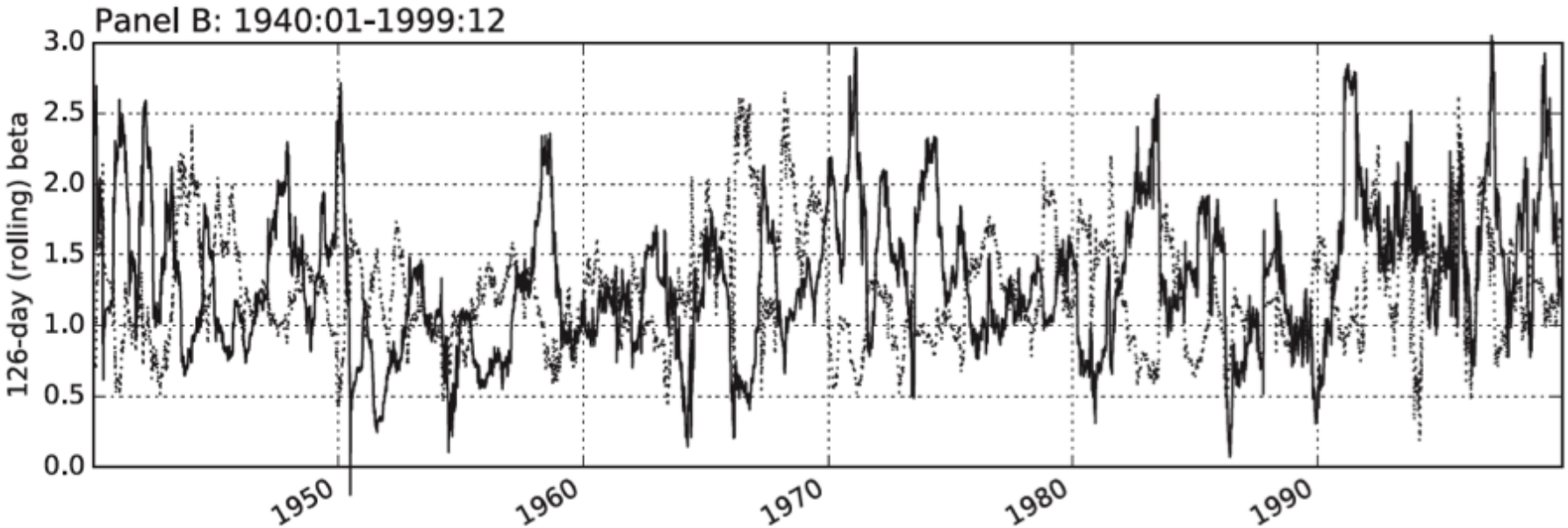
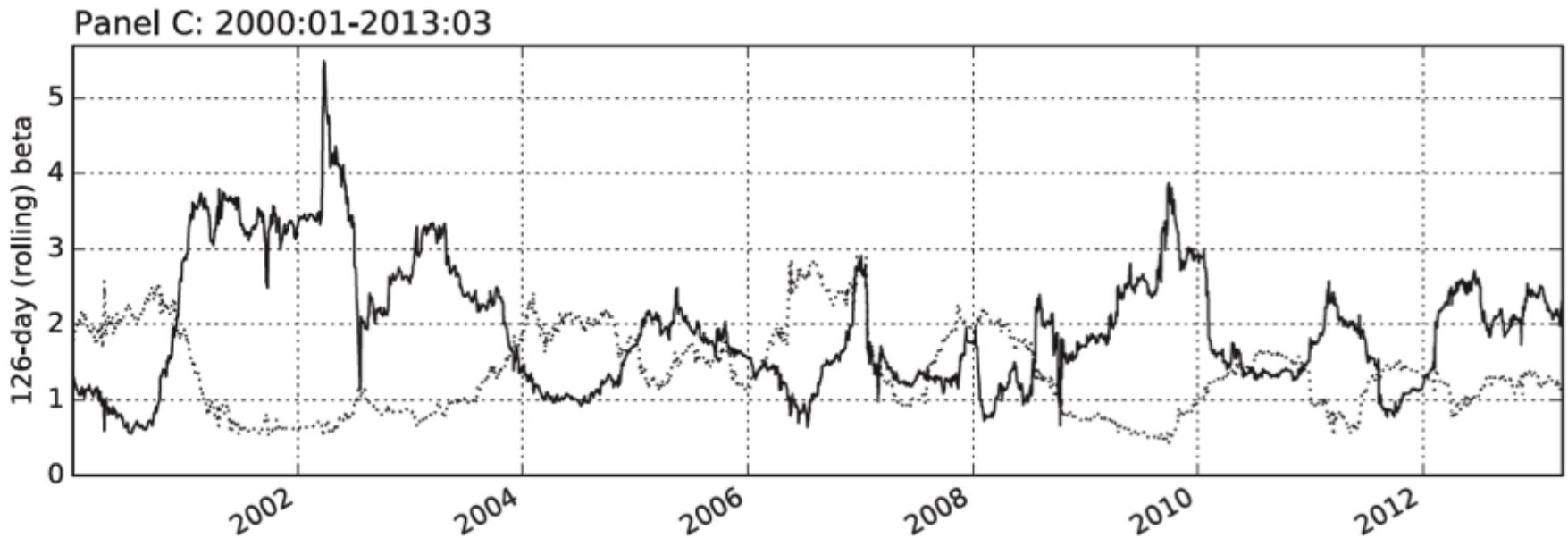

Panel B: 1940:01-1999:12
126-day (rolling) beta
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1950
1960
1970
1980
1990

Figure 3


Panel C: 2000:01-2013:03
126-day (rolling) beta
0
1
2
3
4
5
2002
2004
2006
2008
2010
2012

Option-like behavior

Estimate:

$$\tilde{R}_{\mathrm{WML},t} = (\alpha_0 + \alpha_B \cdot I_{B,t-1}) + (\beta_0 + I_{B,t-1}(\beta_B + \tilde{I}_{U,t}\beta_{B,U}))\tilde{R}_{m,t} + \tilde{\epsilon}_t$$

where

- I_B bear market dummy (past 2 years)
- I_U contemporaneous up market dummy

Table 3

This table presents the results of estimating four specifications of a monthly time-series regressions run over the period 1927:01 to 2013:03. In all cases the dependent variable is the return on the WML portfolio. The independent variables are a constant; an indicator for bear markets, $I_{B,t-1}$, which equals one if the cumulative past two-year return on the market is negative; the excess market return, $R^e_{m,t}$; and a contemporaneous up-market indicator, $I_{U,t}$, which equals one if $R^e_{m,t} > 0$. The coefficients $\hat{\alpha}_0$ and $\hat{\alpha}_B$ are multiplied by 100 (i.e., are in percent per month).

Coefficient	Variable	Estimated coefficients (t-statistics)			
		(1)	(2)	(3)	(4)
$\hat{\alpha}_0$	1	1.852	1.976	1.976	2.030
		(7.3)	(7.7)	(7.8)	(8.4)
$\hat{\alpha}_B$	$I_{B,t-1}$		−2.040	0.583	
			(−3.4)	(0.7)	
$\hat{\beta}_0$	$\tilde{R}^e_{m,t}$	−0.576	−0.032	−0.032	−0.034
		(−12.5)	(−0.5)	(−0.6)	(−0.6)
$\hat{\beta}_B$	$I_{B,t-1}\cdot\tilde{R}^e_{m,t}$		−1.131	−0.661	−0.708
			(−13.4)	(−5.0)	(−6.1)
$\hat{\beta}_{B,U}$	$I_{B,t-1}\cdot I_{U,t}\cdot\tilde{R}^e_{m,t}$			−0.815	−0.727
				(−4.5)	(−5.6)
R^2_{adj}		0.130	0.269	0.283	0.283

Can we forecast momentum returns?

- Use volatility to forecast returns:

$$\tilde{R}_{\mathrm{WML},t} = \gamma_0 + \gamma_{\mathrm{B,t-1}} \cdot \mathrm{I}_{\mathrm{B,t-1}} + \gamma_{\sigma_m^2} \cdot \hat{\sigma}^2_{m,t-1} + \gamma_{int} \cdot \mathrm{I}_{\mathrm{B}} \cdot \hat{\sigma}^2_{m,t-1} + \tilde{\epsilon}_t,$$

- Idea: forecast crashes to avoid them!
- Construct a dynamic strategy such that:
  - Exposure to momentum (crashes) is low when volatility is high
  - Exposure to momentum (crashes) is high when expected return is high

Takeaway

- Momentum is very different in normal times versus crashes
- In panic states, past losers have a high premium
- As market conditions improve, losers experience strong gains and momentum crashes happen
- The expected gains from the loser portfolio are related to both past market losses, and lagged market volatility.