Momentum Turning Points

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TS Momentum Attempts to Exploit Trend, Struggles Around Breaks

Time-series (TS) momentum strategies are based on two premises:

1. Expected returns vary over time
2. Sign persistence: Expected return positive (neg.) now $\Rightarrow$ likely remain positive (neg.)

TS momentum strategies attempt to exploit such variation, if it exists

- Take long (short) positions in uptrend (downtrend) phases

Momentum turning points

- Unless trend is perennial in one direction, trends break down
- TS momentum strategies rely on realized returns, which reflect mixture of trend and noise
- At/after turning points, TS momentum prone to place bad bets

Nature of Turning Points Difficulty Depends on Speed

The speed of the momentum signal balances the tension between

- Reacting quickly
- Reducing higher-frequency noise

Slow: Relatively long lookback window—e.g., 12 months—reduces influence of noise but *slow* reaction to turning point (Type II error)

Fast: Relatively short lookback window–e.g., 1 month—*fast* reaction to turning point but more influenced by noise (Type I error)

Main research question:

- Can we react more effectively to momentum turning points?

TS Momentum Strategy Weights

Simple Speeds:

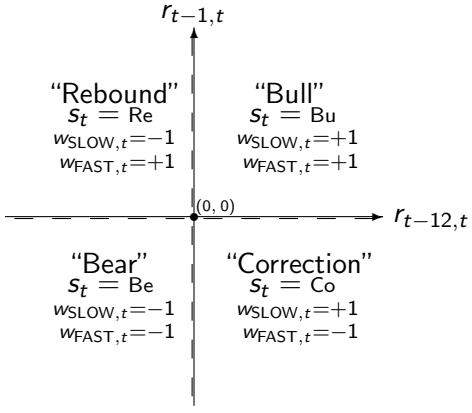
- SLOW: 12-month trailing return—standard horizon: $w_{\text{SLOW},t} = \begin{cases} +1 & \text{if } r_{t-12,t} \geq 0, \\ -1 & \text{if } r_{t-12,t} < 0. \end{cases}$
- FAST: 1-month trailing return: $w_{\text{FAST},t} := \begin{cases} +1 & \text{if } r_{t-1,t} \geq 0, \\ -1 & \text{if } r_{t-1,t} < 0. \end{cases}$

Intermediate Speeds:

- Speed parameter $a \in [0, 1]$: $w_t(a) = (1 - a)w_{\text{SLOW},t} + a\, w_{\text{FAST},t} \quad \in [-1, +1]$
- MED ("medium", $a = \frac{1}{2}$): $w_{\text{MED},t} = w_t\left(\frac{1}{2}\right) = \frac{1}{2}w_{\text{SLOW},t} + \frac{1}{2}w_{\text{FAST},t} \quad \in \{-1, 0, +1\}$

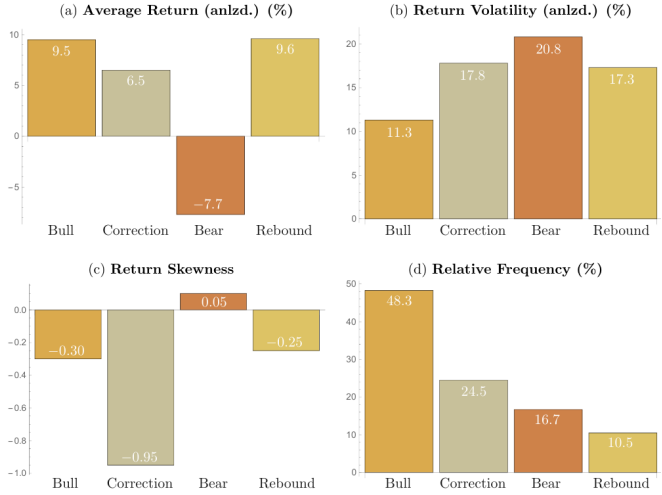
SLOW × FAST Generates Market Cycles

- Intersect SLOW (12-month) with FAST (1-month) ⇒ 4 observable *market cycles*



- Strategies of *all* speeds dictated *ex-ante* by these four phases

U.S. Stock Market Cycles: *Predictive* Return Properties



U.S. value-weighted returns, Kenneth French Data Library, 1969-01 to 2018-12

- Bull states followed by high avg. return & low volatility
- Bear states followed by neg. avg. return & high volatility
- Correction states followed by lower avg. returns, increased volatility, & severe downside outcomes—possibly lead up to Bear.
- Rebound states followed by avg. returns & skewness similar to Bull, but higher volatility—possibly lead up to Bull state.
- Turning points (Corrections + Rebounds) occur 35% of time

▸ Economic Linkages

Performance of Market and Momentum of Various Speeds

		Market	$a = 0$ SLOW MOM12	$a = \frac{1}{4}$	$a = \frac{1}{2}$ MED	$a = \frac{3}{4}$	$a = 1$ FAST MOM1
Part 1	Average (%) (anlzd.)	5.91	6.46	6.17	5.88	5.59	5.30
	Volatility (%) (anlzd.)	15.64	15.62	12.72	11.60	12.74	15.66
	Sharpe Ratio (anlzd.)	0.38	0.41	0.48	0.51	0.44	0.34
Part 2	Skewness	−0.55	−0.43	−0.13	0.02	0.03	0.15
	Max. Drawdown (%)	−54.36	−43.43	−37.96	−34.43	−34.07	−44.53
	Avg./|Max. DD|	0.11	0.14	0.16	0.17	0.17	0.12
Part 3	Average Position	1.00	0.46	0.39	0.32	0.25	0.18
	Market Beta	1.00	0.15	0.05	−0.04	−0.13	−0.23
	Alpha (%) (anlzd.)	0.00	5.58	5.85	6.12	6.39	6.66
	Alpha *t*-statistic	—	2.54	3.24	3.71	3.57	3.07

U.S. value-weighted excess returns, Kenneth French Data Library, 1969-01 to 2018-12

Part 1: Sharpe Ratio Performance by Speed

	Market	$a=0$ SLOW MOM12	$a=\frac{1}{4}$	$a=\frac{1}{2}$ MED	$a=\frac{3}{4}$	$a=1$ FAST MOM1
Average (%) (anlzd.)	5.91	6.46	6.17	5.88	5.59	5.30
Variance (%) (anlzd.)	2.45	2.44	1.62	1.35	1.62	2.45
Volatility (%) (anlzd.)	15.64	15.62	12.72	11.60	12.74	15.66
Sharpe Ratio (anlzd.)	0.38	0.41	0.48	0.51	0.44	0.34

U.S. value-weighted excess returns, Kenneth French Data Library, 1969-01 to 2018-12

- Reducing exposure following Correction/Rebound improves Sharpe ratio:

$$\textbf{Sharpe}[w_t(a) \cdot r_{t+1}] \approx ((1-a)\,\textbf{Sharpe}[w_{\text{SLOW},t} \cdot r_{t+1}] + a\,\textbf{Sharpe}[w_{\text{FAST},t} \cdot r_{t+1}])\, D(a)$$

$$\text{Disagreement Multiplier:} \quad D(a) := \sqrt{\frac{\mathbf{E}[r_{t+1}^2]}{\mathbf{E}[r_{t+1}^2|^{\text{Bu}}_{\text{Be}}]\mathbf{P}[^{\text{Bu}}_{\text{Be}}] + (2a-1)^2\mathbf{E}[r_{t+1}^2|^{\text{Co}}_{\text{Re}}]\mathbf{P}[^{\text{Co}}_{\text{Re}}]}} > 1.$$

Part 2a: Cycle-Conditional Market Return Extremes

Cond. Market *Monthly* Return Percentiles (%)	Bull	Bear	Correction	Rebound
MIN	−9.55	−17.23	−23.24	−10.35
P01	−7.85	−12.79	−14.62	−10.16
P05	−4.64	−10.10	−7.14	−8.41
P10	−3.37	−8.06	−5.64	−5.51
P25	−1.51	−4.83	−2.08	−2.44
P50	1.05	−0.89	1.07	1.15
P75	3.07	3.98	3.82	4.59
P90	4.68	6.82	5.84	7.24
P95	6.13	7.99	7.15	7.98
P99	7.21	13.68	11.79	10.61
MAX	9.59	16.10	12.47	11.30

U.S. value-weighted excess returns, Kenneth French Data Library, 1969-01 to 2018-12

- Corrections introduce extreme outcomes and volatility, despite most outcomes being positive
- 5 of 10 worst months in last 50 years were after Correction phases
- 4 of 10 best months in last 50 years were after Correction phases

▸ More Details

Part 2b: Downside Performance by Speed

	Market	$a = 0$ SLOW MOM12	$a = \frac{1}{4}$	$a = \frac{1}{2}$ MED	$a = \frac{3}{4}$	$a = 1$ FAST MOM1
Skewness	−0.55	−0.43	−0.13	0.02	0.03	0.15
Max. Drawdown (%)	−54.36	−43.43	−37.96	−34.43	−34.07	−44.53
Avg./|Max. DD|	0.11	0.14	0.16	0.17	0.17	0.12

U.S. value-weighted excess returns, Kenneth French Data Library, 1969-01 to 2018-12

- MED's skewness, in general, is scaled/shifted relative to SLOW/FAST:

$$\begin{aligned}\textbf{Skew}[w_t(\tfrac{1}{2}) \cdot r_{t+1}] \approx \frac{1}{2}(\textbf{Skew}[w_{\text{SLOW},t} \cdot r_{t+1}] + \textbf{Skew}[w_{\text{FAST},t} \cdot r_{t+1}]) \left[D(\tfrac{1}{2})\right]^3 \\ + 3\,\textbf{Sharpe}[w_t(\tfrac{1}{2}) \cdot r_{t+1}] \left(\left[D(\tfrac{1}{2})\right]^2 - 1\right)\end{aligned}$$

Part 3a: Market Timing and Volatility Timing

Widely-used decomposition of expected returns:

$$\mathbf{E}[w_t(a) \cdot r_{t+1}] = \underbrace{\mathbf{Cov}[w_t(a), r_{t+1}]}_{\text{"market timing"}} + \underbrace{\mathbf{E}[w_t(a)]}_{\text{"static"}} \mathbf{E}[r_{t+1}],$$

New decomposition of covariance between strategy returns and market:

$$\mathbf{Cov}[w_t(a) \cdot r_{t+1}, r_{t+1}] = \mathbf{E}[w_t(a)]\mathbf{Var}[r_{t+1}] + \mathbf{Cov}[w_t(a), r_{t+1}]\mathbf{E}[r_{t+1}] + \mathbf{Cov}[w_t(a), (r_{t+1} - \mathbf{E}[r_{t+1}])^2].$$

New market beta and alpha decompositions:

Overlooked

$$\mathbf{Beta}[w_t(a) \cdot r_{t+1}] = \underbrace{\mathbf{E}[w_t(a)]}_{\text{"static"}} + \underbrace{\mathbf{Cov}[w_t(a), r_{t+1}] \frac{\mathbf{E}[r_{t+1}]}{\mathbf{Var}[r_{t+1}]}}_{\text{"market timing"}} + \underbrace{\frac{\mathbf{Cov}[w_t(a), (r_{t+1} - \mathbf{E}[r_{t+1}])^2]}{\mathbf{Var}[r_{t+1}]}}_{\text{"volatility timing"}}$$

$$\mathbf{Alpha}[w_t(a) \cdot r_{t+1}] = \underbrace{\mathbf{Cov}[w_t(a), r_{t+1}] \left(1 - \frac{(\mathbf{E}[r_{t+1}])^2}{\mathbf{Var}[r_{t+1}]}\right)}_{\text{"market timing"}} + \underbrace{\left\{ - \frac{\mathbf{Cov}[w_t(a), (r_{t+1} - \mathbf{E}[r_{t+1}])^2]}{\mathbf{Var}[r_{t+1}]} \mathbf{E}[r_{t+1}] \right\}}_{\text{"volatility timing"}}$$

Part 3b: Beta and Alpha Decompositions

Market Beta and Alpha	$a = 0$ SLOW MOM12	$a = \frac{1}{4}$	$a = \frac{1}{2}$ MED	$a = \frac{3}{4}$	$a = 1$ FAST MOM1
Beta	0.15	0.05	−0.04	−0.13	−0.23
Alpha (%) (anlzd.)	5.58	5.85	6.12	6.39	6.66
Alpha *t*-stat.	2.54	3.24	3.71	3.57	3.07
Beta Components					
Static	0.457	0.387	0.317	0.247	0.177
Market Timing	0.008	0.008	0.008	0.008	0.009
Volatility Timing	−0.315	−0.339	−0.364	−0.389	−0.414
Alpha Components (%) (anlzd.)					
Market Timing	3.72	3.84	3.96	4.09	4.21
Volatility Timing	1.86	2.00	2.15	2.30	2.44

U.S. value-weighted excess returns, Kenneth French Data Library, 1969-01 to 2018-12

▸ 15 yrs

Dynamic Speed Selection

Dynamic speed strategy weight:

$$w_t(a_{s(t)}) = (1 - a_{s(t)})w_{\text{SLOW},t} + a_{s(t)}w_{\text{FAST},t}.$$

Consider choosing state-conditional speeds $a_{s(t)}$ to apply after every occurrence of state $s(t)$ to maximize steady-state Sharpe Ratio:

$$\max_{a_{s(t)}:s(t)\in\{\text{Bu,Co,Be,Re}\}} \textbf{Sharpe}[w_t(a_{s(t)}) \cdot r_{t+1}].$$

Solution:

$$a_{\text{Bu}} \in [0,1], \quad (w_{\text{SLOW},t} = w_{\text{FAST},t} = 1, \text{ so any } a \text{ results in } +1)$$

$$a_{\text{Be}} \in [0,1], \quad (w_{\text{SLOW},t} = w_{\text{FAST},t} = -1, \text{ so any } a \text{ results in } -1)$$

$$a_{\text{Co}} = \frac{1}{2}\left(1 - \frac{\mathbf{E}[r_{t+1}^2|{}^{\text{Bu}}_{\text{Be}}]\mathbf{P}\,[{}^{\text{Bu}}_{\text{Be}}]}{\mathbf{E}[r_{t+1}|\text{Bu}]\mathbf{P}[\text{Bu}] - \mathbf{E}[r_{t+1}|\text{Be}]\mathbf{P}[\text{Be}]} \frac{\mathbf{E}[r_{t+1}|\text{Co}]}{\mathbf{E}[r_{t+1}^2|\text{Co}]}\right),$$

$$a_{\text{Re}} = \frac{1}{2}\left(1 + \frac{\mathbf{E}[r_{t+1}^2|{}^{\text{Bu}}_{\text{Be}}]\mathbf{P}\,[{}^{\text{Bu}}_{\text{Be}}]}{\mathbf{E}[r_{t+1}|\text{Bu}]\mathbf{P}[\text{Bu}] - \mathbf{E}[r_{t+1}|\text{Be}]\mathbf{P}[\text{Be}]} \frac{\mathbf{E}[r_{t+1}|\text{Re}]}{\mathbf{E}[r_{t+1}^2|\text{Re}]}\right).$$

DYN Strategy Performance Over the Last 50 Years

DYN Strategy Estimation Window			Evaluation					
			Evaluation Window			Sharpe Ratio (anlzd.)		
From (yr-mo)	To (yr-mo)	Length (yrs)	From (yr-mo)	To (yr-mo)	Length (yrs)	DYN ($\widehat{a}_{\text{Co}}, \widehat{a}_{\text{Re}}$)	"Oracle" OPT	Efficiency DYN/OPT
1926-07	1968-12	42.5	1969-01	2018-12	50.0	0.524 (0.00, 0.58)	0.570	0.920
1926-07	1973-12	47.5	1974-01	2018-12	45.0	0.547 (0.07, 0.59)	0.572	0.956
1926-07	1978-12	52.5	1979-01	2018-12	40.0	0.611 (0.08, 0.65)	0.626	0.977
1926-07	1983-12	57.5	1984-01	2018-12	35.0	0.614 (0.22, 0.67)	0.623	0.985
1926-07	1988-12	62.5	1989-01	2018-12	30.0	0.688 (0.26, 0.69)	0.721	0.954
1926-07	1993-12	67.5	1994-01	2018-12	25.0	0.675 (0.11, 0.71)	0.684	0.988
1926-07	1998-12	72.5	1999-01	2018-12	20.0	0.564 (0.17, 0.69)	0.579	0.975
1926-07	2003-12	77.5	2004-01	2018-12	15.0	0.611 (0.16, 0.69)	0.621	0.984

DYN: ex-ante estimated investable strategy; OPT: ex-post estimated "oracle" of best possible speed pair
U.S. value-weighted excess returns, Kenneth French Data Library

Dynamic vs. Static Speed Performance Per Unit Risk

50-Year Evaluation Window, 1969-01 to 2018-12

	$a = 0.00$ SLOW	0.25	0.50 MED	0.75	1.00 FAST	$\widehat{a}_{Co} = 0.00$ $\widehat{a}_{Re} = 0.58$ DYN
Sharpe Ratio (anlzd.)	0.41	0.48	0.51	0.44	0.34	0.52
Efficiency (/OPT)	0.73	0.85	0.89	0.77	0.59	0.92
Avg. (anlzd.)/|Max. DD|	0.15	0.16	0.17	0.16	0.12	0.23

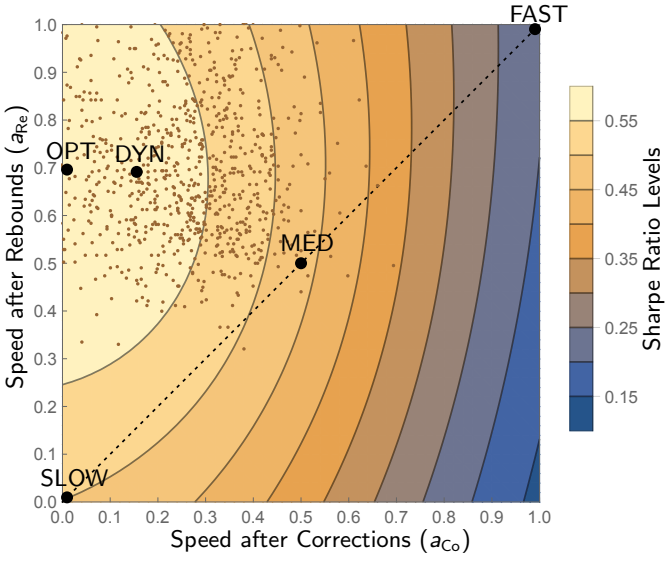
15-Year Evaluation Window, 2004-01 to 2018-12

	$a = 0.00$ SLOW	0.25	0.50 MED	0.75	1.00 FAST	$\widehat{a}_{Co} = 0.16$ $\widehat{a}_{Re} = 0.69$ DYN
Sharpe Ratio (anlzd.)	0.55	0.57	0.51	0.36	0.21	0.61
Efficiency (/OPT)	0.88	0.91	0.81	0.58	0.34	0.98
Avg. (anlzd.)/|Max. DD|	0.22	0.26	0.23	0.14	0.08	0.28

U.S. value-weighted excess returns, Kenneth French Data Library

▸ Detail 15 yr

Sharpe Ratios For All Dynamic Speed Pairs—Last 15 Years



- Brown dots correspond to DYN estimated ex-ante from 1,000 block bootstrap historical samples
- Static-speed strategies are on the diagonal
- DYN almost always does better than static speeds
- Upper-left corner relatively efficient: slow after Corrections, fast after Rebounds

Performance in International Equity Markets—Last 15 Years

	Sharpe Ratio (anlzd.)							
Country	$a = 0.00$ SLOW MOM12	0.25	0.50 MED	0.75	1.00 FAST MOM1	$a_{Co} = \widehat{a}_{Co}$ $a_{Re} = \widehat{a}_{Re}$ DYN (a_{Co}, a_{Re})		$a_{Co} = 0.00$ $a_{Re} = 0.81$ DYN
AU	0.367	0.417	0.420	0.350	0.258	0.526	(0.00, 1.00)	0.528
CA	0.299	0.417	0.517	0.551	0.527	0.650	(0.56, 1.00)	0.601
DE	0.458	0.474	0.429	0.316	0.198	0.542	(0.00, 0.66)	0.544
ES	0.165	0.154	0.120	0.067	0.020	0.238	(0.16, 0.86)	0.256
FR	0.421	0.487	0.492	0.390	0.269	0.642	(0.28, 0.81)	0.649
IT	0.329	0.303	0.236	0.140	0.050	0.329	(0.00, 0.00)	0.418
JP	0.529	0.599	0.618	0.559	0.462	0.554	(0.00, 0.20)	0.547
NL	0.394	0.343	0.195	0.000	−0.131	0.419	(0.00, 0.81)	0.420
SE	0.613	0.700	0.687	0.510	0.322	0.820	(0.12, 0.59)	0.803
UK	0.301	0.211	0.052	−0.115	−0.224	0.475	(0.00, 1.00)	0.472
US	0.589	0.618	0.565	0.419	0.264	0.669	(0.07, 0.57)	0.659

Datastream 1980-2018, Exceeds all static speeds ; Below best static speed

▸ Drawdowns

Conclusion

- Intermediate static speeds strategies: many advantages over SLOW and FAST
  - Higher Sharpe ratios, less severe drawdowns, more positive (less negative) skewness, higher significance of alphas, stronger predictability of all moments of future returns
  - Market cycles (bull, correction, bear, and rebound) useful for explaining phenomena
  - New understanding of Sharpe ratios and skewness
- Volatility timing plays important (overlooked) role:
  - We provide formal decomposition of what drives beta and alpha
  - Momentum weights are strong negative predictors of return volatility
  - Betas are lower than static tilts might imply
- Dynamic speed strategies
  - Can dynamically time optimal speed blends
  - Slow down after Corrections, speed up after Rebounds
- Insights apply to international equity markets

Appendix

Market Cycle Patterns

Takeaway from U.S. stock market: Slow down after Corrections; speed up after Rebounds

- Cycle patterns reinforce this takeaway

Unconditional Frequency (%)			
Bull	Correction	Bear	Rebound
48.3	24.3	16.8	10.5

Monthly Transition Probability (%)						
	Bull	Correction	Bear	Rebound	Up	Down
Bull	62.8	34.8	2.1	0.3	63.3	36.7
Correction	61.2	29.9	8.8	0.0	61.2	38.8
Bear	9.0	0.0	55.0	36.0	45.0	55.0
Rebound	14.3	1.6	42.9	41.3	55.6	44.4

U.S. value-weighted excess returns, Kenneth French Data Library, 1969-01 to 2018-12

▸ More Stats

- Corrections tend to revert to Bulls—FAST takes short position, which is a bad bet
- Market likely to go up after Rebounds—FAST takes long position, which is a good bet

Does this takeaway apply in international markets?

MOM6 vs. MED

	MOM6	$a = 0$ SLOW MOM12	$a = \frac{1}{4}$	$a = \frac{1}{2}$ MED	$a = \frac{3}{4}$	$a = 1$ FAST MOM1
Average (%) (anlzd.)	4.75	6.46	6.17	5.88	5.59	5.30
Volatility (%) (anlzd.)	15.67	15.62	12.72	11.60	12.74	15.66
Sharpe Ratio (anlzd.)	0.30	0.41	0.48	0.51	0.44	0.34
Skewness	−0.61	−0.43	−0.13	0.02	0.03	0.15
Max. Drawdown (%)	−64.56	−43.43	−37.96	−34.43	−34.07	−44.53
Avg. (anlzd.)/|Max. DD|	0.07	0.14	0.16	0.17	0.17	0.12
Average Position	0.33	0.46	0.39	0.32	0.25	0.18
Market Beta	−0.01	0.15	0.05	−0.04	−0.13	−0.23
Alpha (%) (anlzd.)	4.79	5.58	5.85	6.12	6.39	6.66
Alpha *t*-statistic	2.15	2.54	3.24	3.71	3.57	3.07

Sample: 1969-01 to 2018-12

- MOM6 is relatively slow-moving: 5 of 6 (83%) months overlap in consecutive month signals
- MOM6 does not lever down at/after turning points

Economic Linkages: Macro Innovations by Cycle (t-Stats)

Economy (Surprises)					
Phase	Production	Consumption	Employment	Sales	MP Shock
Bull	1.53	2.25	2.30	2.63	0.41
Correction	1.46	−0.29	1.06	−0.13	1.72
Bear	−3.15	−3.24	−4.06	−3.73	0.58
Rebound	−1.41	−0.23	−1.30	−0.65	−3.96

Risk (Surprises)					
Phase	NFCI*	PS Liquidity	TED*	Noise*	Vol Spread
Bull	1.72	4.63	1.67	1.53	3.80
Correction	−1.21	−1.67	−1.67	−0.52	−1.02
Bear	−3.41	−6.22	−3.03	−4.29	−4.19
Rebound	2.32	0.43	2.00	2.15	−0.86

Surveys (Surprises)					
Phase	News Uncertainty*	Consumer Sentiment	PMI	SPF Recession*	SPF Corporate Profits
Bull	2.09	1.64	3.48	2.30	1.80
Correction	0.06	−0.10	−0.77	−1.21	−0.61
Bear	−4.04	−3.30	−3.21	−3.00	−2.83
Rebound	−0.28	0.09	−2.39	0.84	0.76

▸ Data ▸ Back to Market Cycles Example

Economic Linkages: Data

The macro series all ends on March 2019 unless specified otherwise. The starting dates vary and are subject to availability from the original sources.

From the FRED database of the St. Louis Federal Reserve:

- Chicago Fed National Activity Index: Personal Consumption and Housing
- Chicago Fed National Activity Index: Production and Income
- Chicago Fed National Activity Index: Sales, Orders and Inventories
- Chicago Fed National Activity Index: Employment, Unemployment and Hours
- Chicago Fed National Financial Conditions Index
- Effective Federal Funds Rate
- TED Spread
- University of Michigan: Consumer Sentiment

From Gertler and Karadi (2015) we obtain:

- Monetary policy shocks (end date: June 2012)

...

Economic Linkages: Data (cont'd...)

From Pastor and Stambaugh (2003):

- Aggregate liquidity measure (end date: December 2018)
- Liquidity innovation measure (end date: December 2018)

Bond illiquidity metric from Hu et al. (2013):

- Noise (end date: December 2016)

High vol/low vol valuation spread from Pflueger et al. (2018):

- PVS indicator (end date: Q2 2016)

From Bloom et al. (2016):

- U.S. News uncertainty

From Bloomberg:

- PMI

From the Survey of Professional Forecasters

- Recession probabilities (QTR1, median response)
- Corporate profits after tax (DCPROF2, % change of median response)

Back to Economic Linkages | Back to Market Cycles Example

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MIN	−9.55	−17.23	−23.24	−10.35
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P10	−3.37	−8.06	−5.64	−5.51
P25	−1.51	−4.83	−2.08	−2.44
P50	1.05	−0.89	1.07	1.15
P75	3.07	3.98	3.82	4.59
P90	4.68	6.82	5.84	7.24
P95	6.13	7.99	7.15	7.98
P99	7.21	13.68	11.79	10.61
MAX	9.59	16.10	12.47	11.30

Sample: 1969-01 to 2018-12

- Corrections introduce extreme outcomes and volatility, despite most outcomes being positive
- 5 of 10 worst months in last 50 years were after Correction phases: −23.24 (1987-10); −16.08 (1998-08); −12.90 (1980-03); −11.91 (1978-10); −10.72 (2000-11)
- 4 of 10 best months in last 50 years were after Correction phases: 12.47 (1987-01); 12.16 (1976-01); 11.35 (2011-10); 10.84 (1991-12)

Performance of Market and Momentum of Various Speeds—Last 15 yrs

	Market	$a = 0$ SLOW MOM12	$a = \frac{1}{4}$	$a = \frac{1}{2}$ MED	$a = \frac{3}{4}$	$a = 1$ FAST MOM1
Average (%) (anlzd.)	7.58	7.60	6.45	5.30	4.15	3.00
Volatility (%) (anlzd.)	13.91	13.91	11.41	10.48	11.50	14.06
Sharpe Ratio (anlzd.)	0.54	0.55	0.57	0.51	0.36	0.21
Skewness	−0.77	0.12	0.27	0.49	0.35	0.00
Max. Drawdown (%)	−51.51	−33.96	−24.67	−23.32	−29.34	−38.36
Avg./|Max. DD|	0.15	0.22	0.26	0.23	0.14	0.08
Average Position	1.00	0.72	0.62	0.52	0.41	0.31
Market Beta	1.00	0.20	0.14	0.08	0.01	−0.05
Alpha (%) (anlzd.)	0.00	6.08	5.40	4.72	4.04	3.37
Alpha t-statistic	—	1.70	1.83	1.73	1.34	0.91

Sample: 2004-01 to 2018-12

50 yrs

Beta and Alpha Decompositions—Last 15 yrs

Market Beta and Alpha	$a = 0$ SLOW MOM12	$a = \frac{1}{4}$	$a = \frac{1}{2}$ MED	$a = \frac{3}{4}$	$a = 1$ FAST MOM1
Beta	0.20	0.14	0.08	0.01	−0.05
Alpha (%) (anlzd.)	6.08	5.40	4.72	4.04	3.37
Alpha *t*-stat.	1.70	1.83	1.73	1.34	0.91
Beta Components					
Static	0.722	0.619	0.517	0.414	0.311
Market Timing	0.007	0.006	0.005	0.003	0.002
Volatility Timing	−0.528	−0.487	−0.445	−0.403	−0.362
Alpha Components (%) (anlzd.)					
Market Timing	2.09	1.72	1.36	0.99	0.63
Volatility Timing	4.00	3.69	3.37	3.06	2.74

Sample: 2004-01 to 2018-12

50 yrs

DYN vs. Static: Performance Summary—Last 15 yrs

	Market	$a = 0$ SLOW MOM12	$a = \frac{1}{4}$	$a = \frac{1}{2}$ MED	$a = \frac{3}{4}$	$a = 1$ FAST MOM1	DYN
Average (%) (anlzd.)	7.58	7.60	6.45	5.30	4.15	3.00	7.20
Volatility (%) (anlzd.)	13.91	13.91	11.41	10.48	11.50	14.06	11.78
Sharpe Ratio (anlzd.)	0.54	0.55	0.57	0.51	0.36	0.21	0.61
Skewness	−0.77	0.12	0.27	0.49	0.35	0.00	0.21
Max. Drawdown (%)	−51.51	−33.96	−24.67	−23.32	−29.34	−38.36	−25.74
Avg./|Max. DD|	0.15	0.22	0.26	0.23	0.14	0.08	0.28
Average Position	1.00	0.72	0.62	0.52	0.41	0.31	0.72
Market Beta	1.00	0.20	0.14	0.08	0.01	−0.05	0.33
Alpha (%) (anlzd.)	0.00	6.08	5.40	4.72	4.04	3.37	4.71
Alpha *t*-statistic	—	1.70	1.83	1.73	1.34	0.91	1.65

Sample: 2004-01 to 2018-12

DYN vs. Static: Beta and Alpha Decompositions—Last 15 yrs

Market Beta and Alpha	$a = 0$ SLOW MOM12	$a = \frac{1}{4}$	$a = \frac{1}{2}$ MED	$a = \frac{3}{4}$	$a = 1$ FAST MOM1	DYN
Beta	0.20	0.14	0.08	0.01	−0.05	0.33
Alpha (%) (anlzd.)	6.08	5.40	4.72	4.04	3.37	4.71
Alpha t-stat.	1.70	1.83	1.73	1.34	0.91	1.65
Beta Components						
Static	0.722	0.619	0.517	0.414	0.311	0.724
Market Timing	0.007	0.006	0.005	0.003	0.002	0.006
Volatility Timing	−0.528	−0.487	−0.445	−0.403	−0.362	−0.400
Alpha Components (%) (anlzd.)						
Market Timing	2.09	1.72	1.36	0.99	0.63	1.69
Volatility Timing	4.00	3.69	3.37	3.06	2.74	3.03

Sample: 2004-01 to 2018-12

▸ ↖ DYN vs. Static

Drawdowns in International Equity Markets—Last 15 Years

	Average Return (anlzd.)/ |Max. DD| (in %)							
Country	$a = 0.00$ SLOW MOM12	0.25	0.50 MED	0.75	1.00 FAST MOM1	$a_{Co} = \widehat{a}_{Co}$ $a_{Re} = \widehat{a}_{Re}$ DYN (a_{Co}, a_{Re})		$a_{Co} = 0.00$ $a_{Re} = 0.81$ DYN
AU	0.099	0.128	0.127	0.092	0.063	0.221	(0.56, 1.00)	0.223
CA	0.107	0.162	0.188	0.214	0.209	0.261	(0.00, 0.66)	0.256
DE	0.160	0.177	0.191	0.169	0.094	0.202	(0.00, 0.66)	0.205
ES	0.047	0.043	0.032	0.019	0.006	0.083	(0.16, 0.86)	0.095
FR	0.126	0.148	0.194	0.137	0.089	0.304	(0.28, 0.81)	0.269
IT	0.094	0.088	0.078	0.042	0.015	0.094	(0.00, 0.00)	0.212
JP	0.224	0.279	0.347	0.305	0.231	0.264	(0.00, 0.20)	0.240
NL	0.138	0.148	0.080	0.000	−0.038	0.167	(0.00, 0.81)	0.168
SE	0.255	0.394	0.360	0.281	0.175	0.491	(0.12, 0.59)	0.442
UK	0.097	0.073	0.018	−0.031	−0.056	0.219	(0.00, 1.00)	0.243
US	0.241	0.279	0.249	0.190	0.118	0.302	(0.07, 0.57)	0.312

Datastream 1980-2018, Exceeds all static speeds ; Below best static speed

Back to Averages

Market Cycle Patterns: More Statistics

Unconditional Frequency (%)				*Average Duration (months)*			
Bull	Correction	Bear	Rebound	Bull	Correction	Bear	Rebound
48.3	24.3	16.8	10.5	2.70	1.43	2.22	1.70

	Monthly Transition Probability (%)						*Conditional on Leaving the State* (%)			
	Bull	Correction	Bear	Rebound	Up	Down	Bull	Correction	Bear	Rebound
Bull	62.8	34.8	2.1	0.3	63.3	36.7	—	94.4	4.7	0.9
Correction	61.2	29.9	8.8	0.0	61.2	38.8	87.4	—	12.6	0.0
Bear	9.0	0.0	55.0	36.0	45.0	55.0	20.0	0.0	—	80.0
Rebound	14.3	1.6	42.9	41.3	55.6	44.4	24.3	2.7	73.0	—

Sample: 1969-01 to 2018-12

- Rebounds twice as likely as Corrections to signal turning point
- Though Rebounds ultimately tend to be false alarms about turning points (down-to-up), they still indicate good bets before transitioning: 41.3% chance of remaining in Rebound, 55.6% success rate

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Predictability: Why Do Intermediate Speeds Have Higher Alpha t-Stats?

$\mathbf{Corr}(w_t(a), f(r_{t+1}))$	$a=0$ SLOW MOM12	$a=\frac{1}{4}$	$a=\frac{1}{2}$ MED	$a=\frac{3}{4}$	$a=1$ FAST MOM1
Return: $f(r_{t+1}) = r_{t+1}$	0.078	0.094	0.100	0.093	0.080
Volatility:					
$f(r_{t+1}) = \lvert r_{t+1} - \mathbf{E}[r_{t+1}]\rvert$	−0.235	−0.279	−0.294	−0.270	−0.230
$f(r_{t+1}) = (r_{t+1} - \mathbf{E}[r_{t+1}])^2$	−0.181	−0.226	−0.251	−0.241	−0.214
Lower Tail:					
$f(r_{t+1}) = r_{t+1}1_{\{r_{t+1} \le 10\text{th pctl.}\}}$	0.184	0.224	0.242	0.227	0.197
Upper Tail:					
$f(r_{t+1}) = r_{t+1}1_{\{r_{t+1} \ge 90\text{th pctl.}\}}$	−0.100	−0.113	−0.114	−0.100	−0.081

Sample: 1969-01 to 2018-12

- Intermediate speeds have stronger predictability than average of SLOW/FAST

$$\mathbf{Corr}[w_t(a), f(r_{t+1})] \approx ((1-a)\mathbf{Corr}[w_{\text{SLOW},t}, f(r_{t+1})] + a\mathbf{Corr}[w_{\text{FAST},t}, f(r_{t+1})])\, D_1(a)$$

$$D_1(a) := \sqrt{\frac{1}{\mathbf{P}^{[\text{Bu}]}_{[\text{Be}]} + (2a-1)^2 \mathbf{P}^{[\text{Co}]}_{[\text{Re}]}}} > 1$$

Predictability & Alpha: DYN vs. static speeds—over last 50 years

$\mathbf{Corr}(w_t(a), f(r_{t+1}))$	$a=0$ SLOW MOM12	$a=\frac{1}{4}$	$a=\frac{1}{2}$ MED	$a=\frac{3}{4}$	$a=1$ FAST MOM1	DYN
Return: $f(r_{t+1}) = r_{t+1}$	0.078	0.094	0.100	0.093	0.080	0.104
Volatility:						
$f(r_{t+1}) = \lvert r_{t+1} - \mathbf{E}[r_{t+1}]\rvert$	−0.235	−0.279	−0.294	−0.270	−0.230	−0.244
$f(r_{t+1}) = (r_{t+1} - \mathbf{E}[r_{t+1}])^2$	−0.181	−0.226	−0.251	−0.241	−0.214	−0.197
Lower Tail:						
$f(r_{t+1}) = r_{t+1}1_{\{r_{t+1} \leq 10\text{th pctl.}\}}$	0.184	0.224	0.242	0.227	0.197	0.213
Upper Tail:						
$f(r_{t+1}) = r_{t+1}1_{\{r_{t+1} \geq 90\text{th pctl.}\}}$	−0.100	−0.113	−0.114	−0.100	−0.081	−0.086
Alpha T-Stat	2.54	3.24	3.71	3.57	3.07	2.99

- DYN is slightly better at predicting returns and not as bad at giving up high returns (90th pctl.)
- DYN is somewhat worse at predicting volatility and turning lower tail events into positive outcomes