Review:
Isolating Momentum Crashes

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Reviewer: Sungguk Cha

MINDs Lab BRAIN
25th Algorithmic Trading Research Club
2021.11.27.

TL;DR

1. Momentum strategies are awesome,

but **possible drawdown is fearful**.

2. This paper introduces crash indicator strategy (CI)

which **predicts momentum crashes**.

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1. Introduction

Momentum strategy (Jegadeesh and Titman (1993)) is awesome.

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(b) systematic risk managing *(DYN, Daniel and Moskowitz (2016))*

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Sometimes, momentum crashes with dramatic drawdown.

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(a) momentum-specific risk managing *(CVOL, Barroso and Santa-Clara(2015))*

momentum volatility

(b) systematic risk managing *(DYN, Daniel and Moskowitz (2016))*

expected return, conditional variance, time-invariant scaling parameter, ...

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- it shows *ex-ante* crash indicator based on systematic risk measures largely separates momentum crashes from momentum bull markets.
- it performs **predictive regressions** with crash indicators to show **explanatory power**.

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It introduces crash indicator strategy (**CI**).

Three contributions of this literature.

- it shows *ex-ante* crash indicator based on systematic risk measures largely separates momentum crashes from momentum bull markets.
- it performs predictive regressions with crash indicators to show explanatory power.
- it proposes **an implementable trading strategy**.

Preliminary

A I Estimation of Momentum Beta

At the beginning of each month, beta is estimated by a simple rolling regression of the 126 preceding daily momentum returns on the CAPM:

$$r_{MOM,t} - r_{f,t} = \alpha + \beta_{MOM} \cdot (r_{Mkt,t} - r_{f,t}) + \epsilon_t, \tag{7}$$

where $r_{MOM,t}$ and $r_{Mkt,t}$ denote daily momentum and market returns. $r_{f,t}$ is the daily risk-free rate and ϵ_t are residuals at time t.

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Momentum return

Market return

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momentum beta is correlation between them.

where $r_{MOM,t}$ and $r_{Mkt,t}$ denote daily momentum and market returns. $r_{f,t}$ is the daily risk-free rate and ϵ_t are residuals at time t.

Preliminary

A II Estimation of Momentum Volatility

Following Barroso and Santa-Clara (2015), at the beginning of month t, volatility is estimated by the realized volatility of the previous 126 daily momentum returns:

$$\sigma_{MOM,t} = \sqrt{12}\sqrt{21\sum_{j=0}^{125} r^2_{MOM,d_{t-1-j}}/126}, \tag{8}$$

where $\sigma_{MOM,t}$ states the annualized momentum volatility in month t and $r^2_{MOM,d_{t-1-j}}$ denotes the daily squared momentum return at day $t-1-j$.

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momentum volatility is a variance of momentum returns

where $\sigma_{MOM,t}$ states the annualized momentum volatility in month t and $r^2_{MOM,d_{t-1-j}}$ denotes the daily squared momentum return at day $t-1-j$.

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We classify the 10% best (worst) performing stocks and re-balance portolios on a monthly basis.

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We determine momentum returns based on daily and monthly return-sorted decile portfolios provided by Kenneth French.

We classify the 10% best (worst) performing stocks and re-balance portolios on a monthly basis.

Monthly (daily) data cover the period from January 1927 (Oct. 1926) to May 2020.

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We experimented on international momentum portfolios provided by AQR Capital

Management.

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We experimented on international momentum portfolios provided by AQR Capital

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To perform robustness checks, we further use a Global-Ex-USA and regional portfolios

(Europe, North America, and Pacific), covering Jan. 1987 ~ May 2020.

2. Momentum in US Equity Markets

2.2 Momentum Crashes

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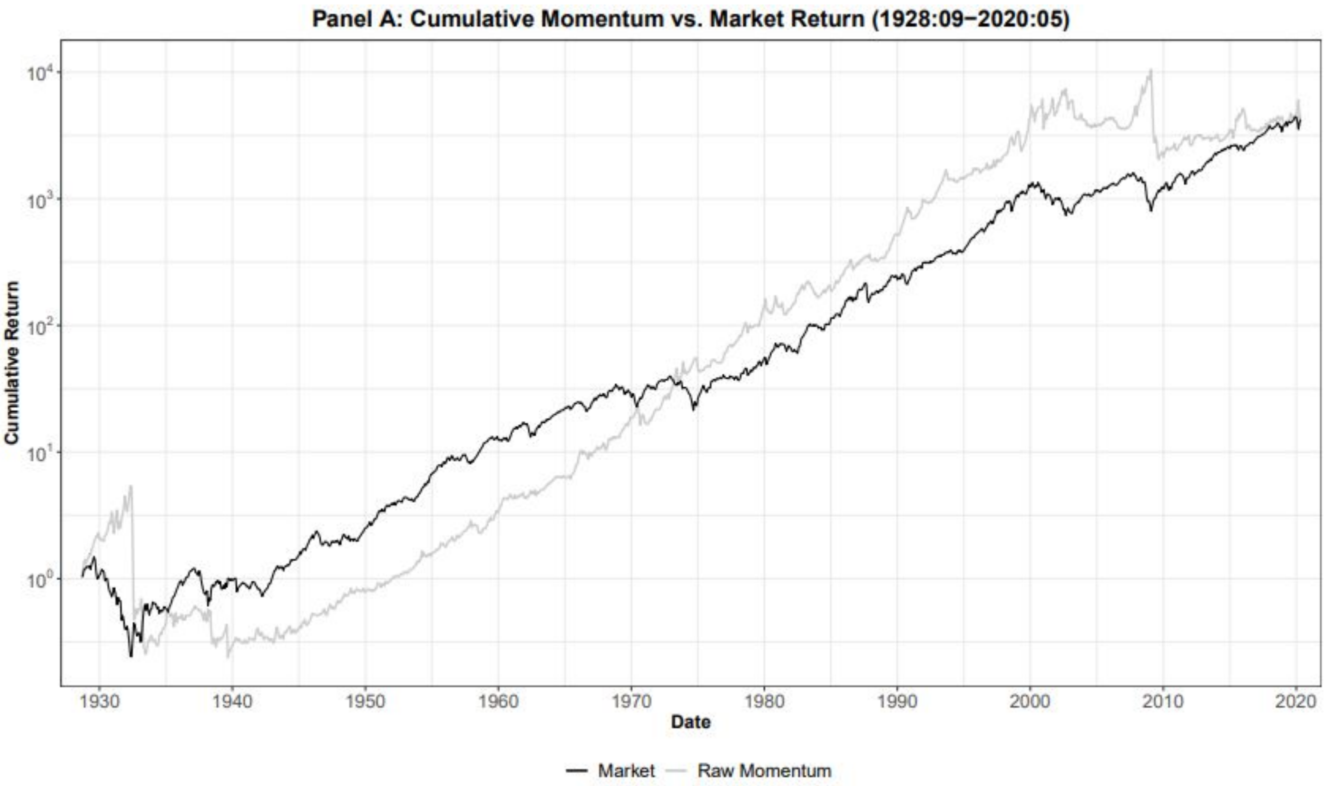

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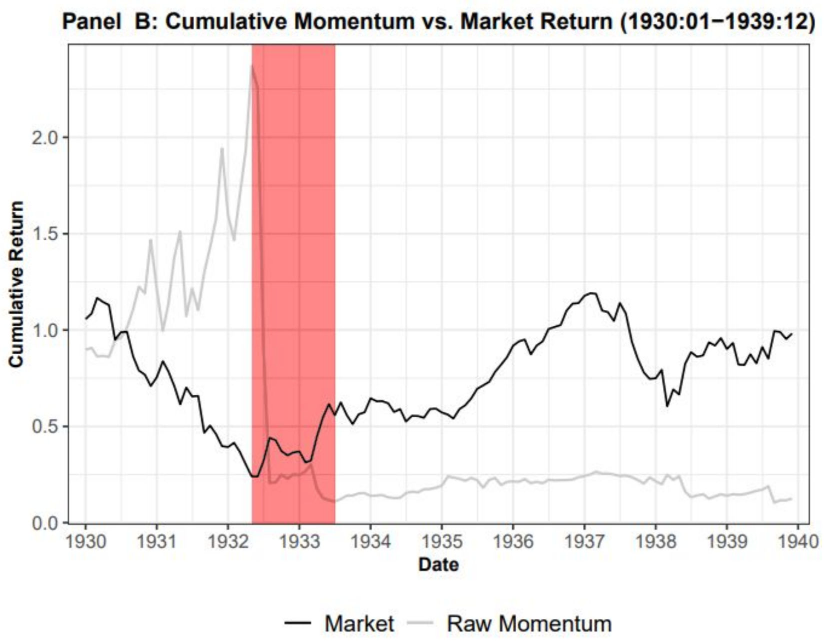

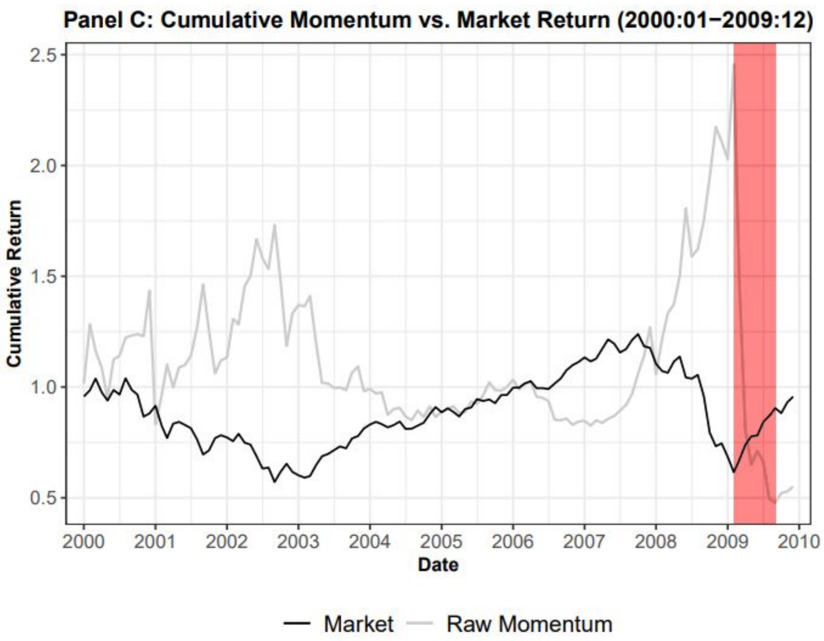

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3 Predicting Momentum Crashes

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3.1 Time-varying Risk of Momentum

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Crash indicator = Market rebound indicator * momentum beta

This subsection introduces

1. Market rebound,

2. momentum beta,

3. and crash indicator.

3 Predicting Momentum Crashes
3.1 Time-varying Risk of Momentum

Cooper et al. (2004) find a **positive correlation** of **momentum returns** and the **market state**.

3 Predicting Momentum Crashes
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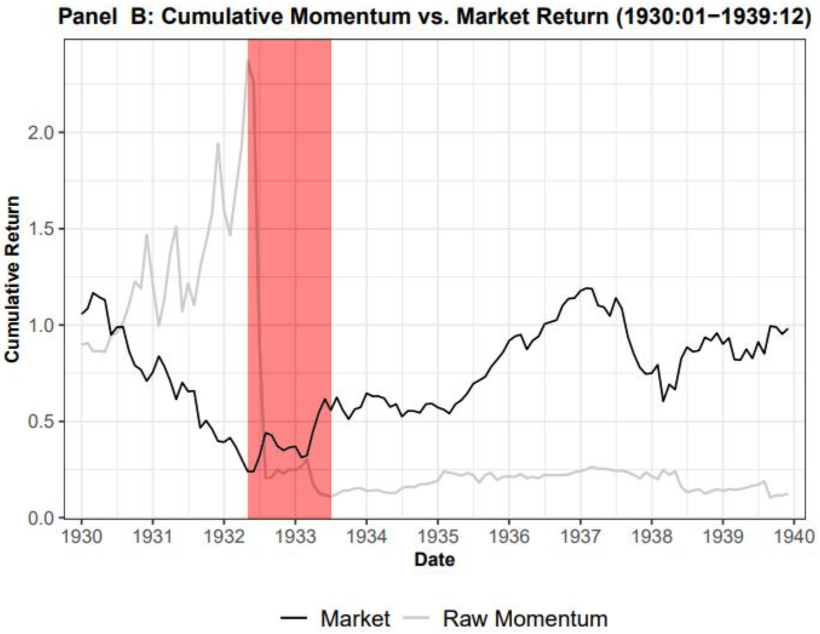
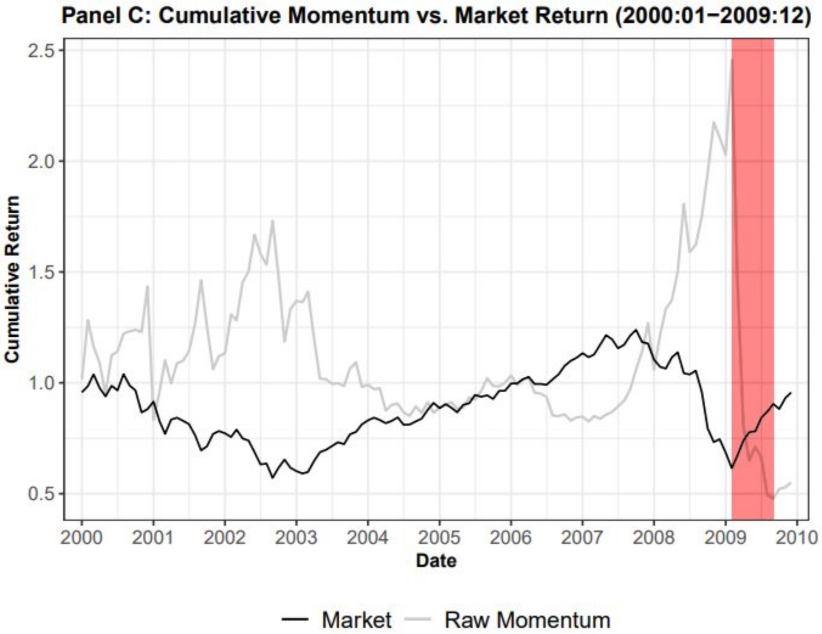
Cooper et al. (2004) find a positive correlation of momentum returns and the market state.

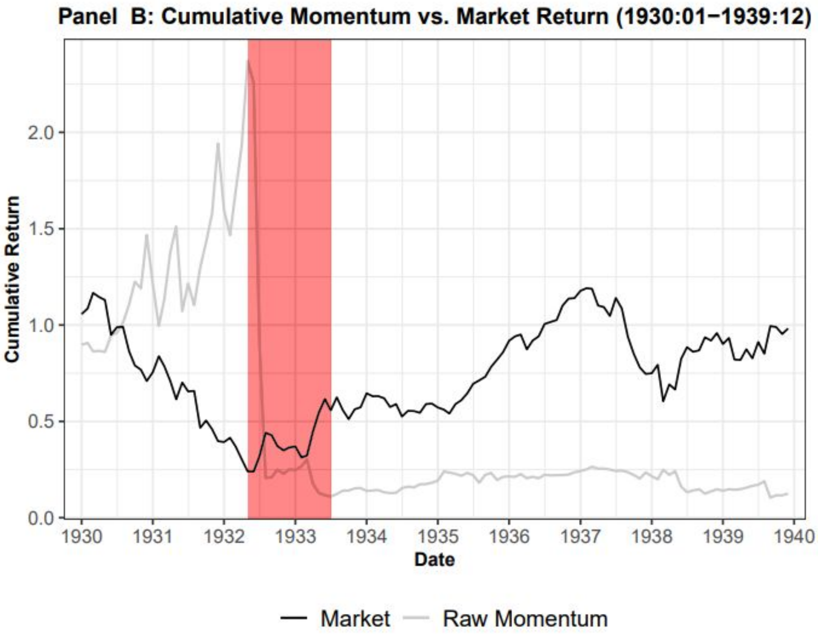
Daniel and Moskowitz (2016) show that crash periods display positive 1-month returns.

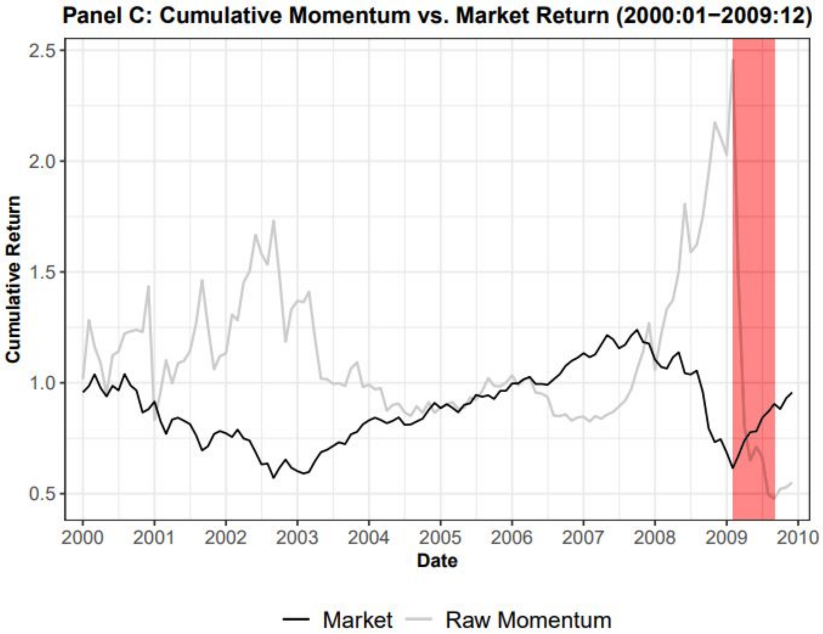




3 Predicting Momentum Crashes
3.1 Time-varying Risk of Momentum

I.e., before momentum crash, we can find ‘**market rebound.**’





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Grundy and martin (2001) find a time-varying market beta of momentum returns.

Bull market winners hold **high beta** stocks, while **bear** market winners hold **low beta** stocks.

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Further, they propose **a dynamically hedged portfolio** that adjust momentum returns and size risks.

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However, their momentum return calculation **requires future data**, which is **not tradable**.

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Bull market winners hold high beta stocks, while bear market winners hold low beta stocks.

Further, they propose a dynamically hedged portfolio that adjust momentum returns and size risks.

However, their momentum return calculation requires future data, which is not tradable.

Moreover, *Daniel and Moskowitz (2016)* show **ex-ante hedging does not improve performance**.

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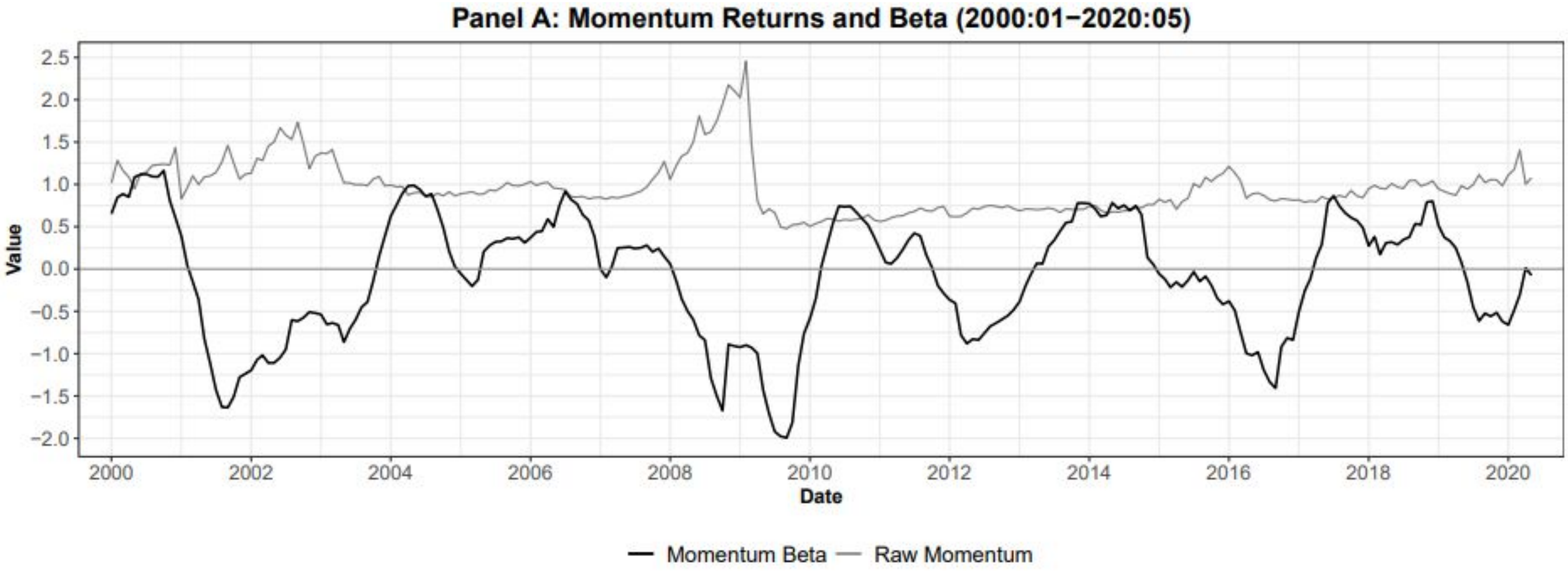

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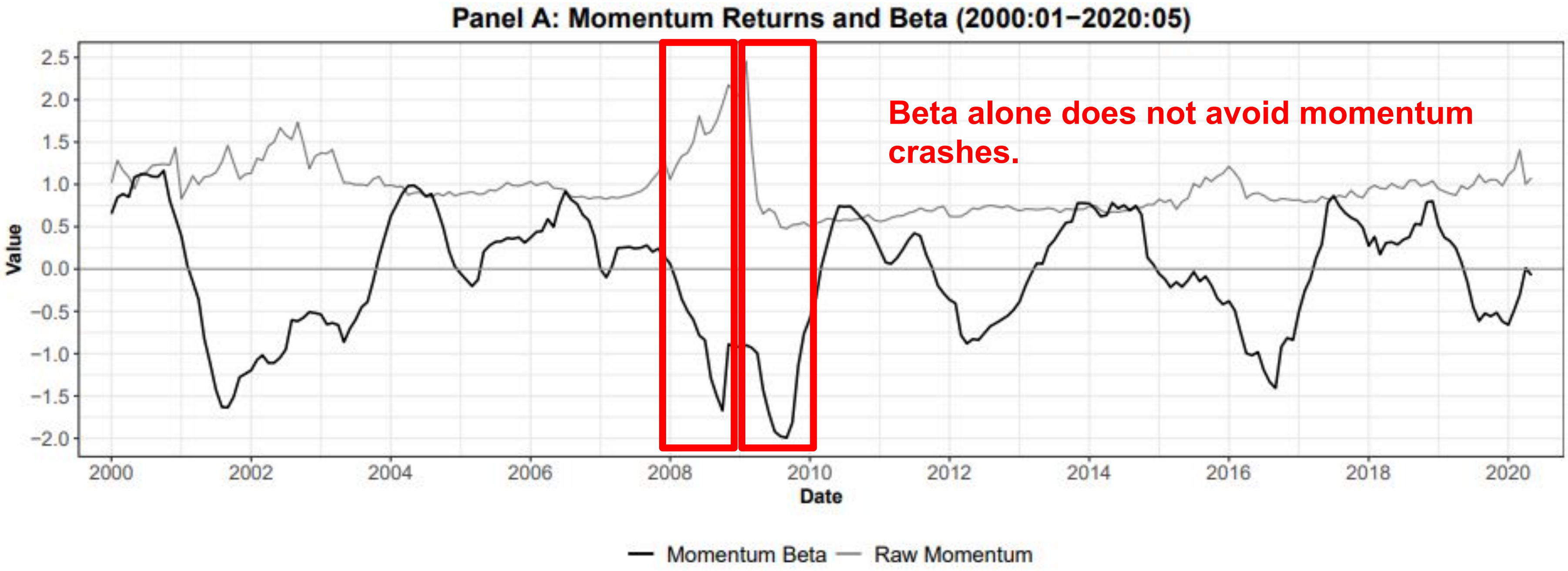

Beta alone does not avoid momentum crashes.

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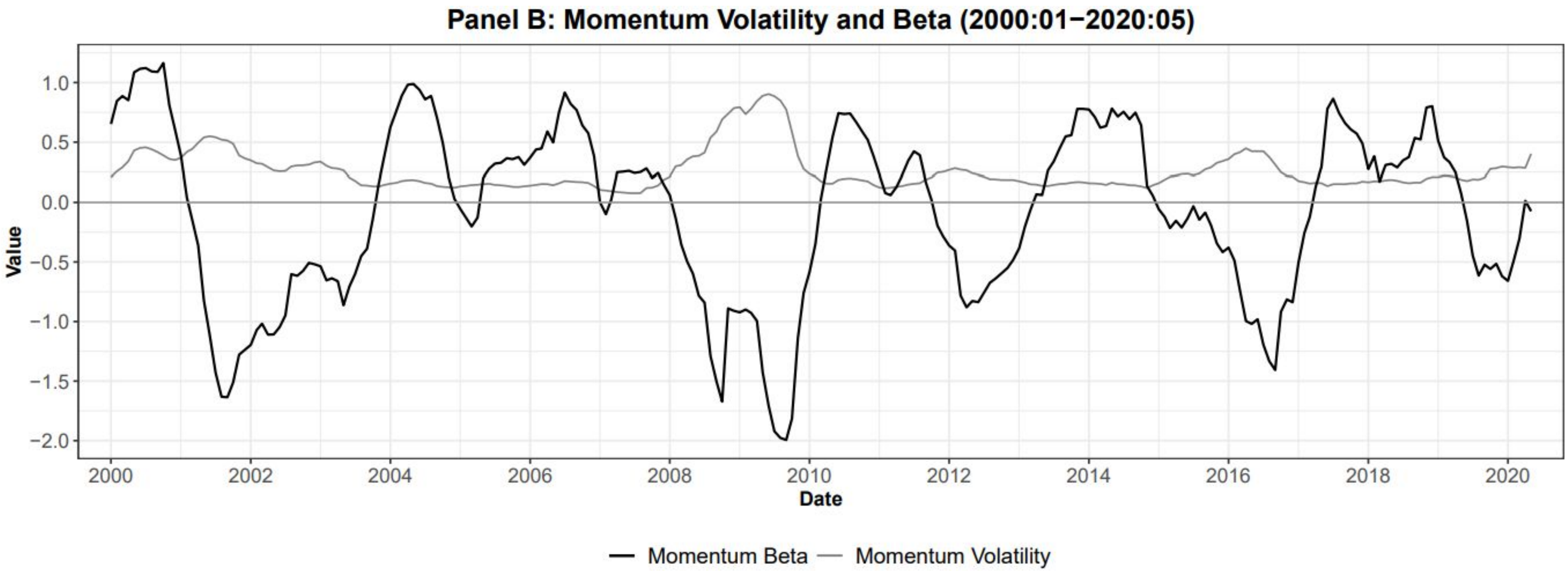

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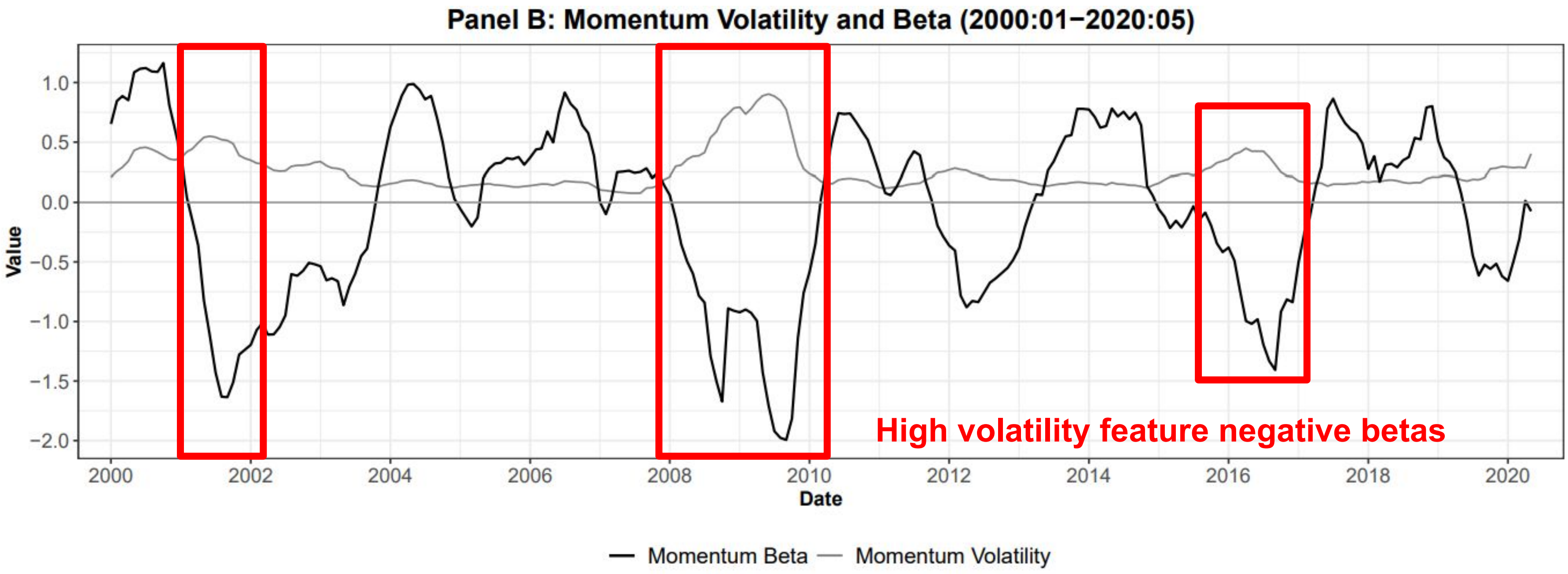

Table 1: Worst Momentum Returns and Corresponding Risk Measures

Rank	Date	Momentum	Systematic Risk			Specific Risk
			$Market_{1M}$	$Market_{2Y}$	β_{MOM}	σ_{MOM}
1	1932 – 08	−77.0%	37.6%	−67.6%	−0.84	0.51
2	1932 – 07	−60.2%	33.9%	−74.8%	−0.79	0.44
3	2009 – 04	−45.6%	10.2%	−40.6%	−1.00	0.84
4	1939 – 09	−45.2%	16.9%	−21.6%	−0.08	0.22
5	2001 – 01	−42.0%	3.9%	10.7%	0.39	0.37
6	1933 – 04	−41.9%	39.0%	−59.0%	−0.11	0.43
7	2009 – 03	−39.8%	9.0%	−44.9%	−0.93	0.78
8	1938 – 06	−33.2%	24.0%	−27.7%	−1.29	0.44
9	1931 – 06	−29.0%	14.2%	−47.6%	−1.05	0.35
10	2020 – 04	−28.7%	13.6%	−0.8%	0.01	0.28
11	1933 – 05	−26.9%	21.6%	−36.7%	−0.13	0.38
12	2009 – 08	−25.4%	3.4%	−27.2%	−1.98	0.85
13	2002 – 11	−20.1%	6.0%	−36.2%	−0.51	0.31
14	2016 – 04	−19.8%	0.9%	10.9%	−1.00	0.45
15	1975 – 01	−19.7%	14.0%	−41.8%	−0.40	0.17

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Most (13 out of 15) are in **bear market**.

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Similarly, **13 out of 15 exhibit a negative beta**.

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Similarly, 13 out of 15 exhibit a negative beta.

Most show **high momentum volatility**.

3 Predicting Momentum Crashes

3.2 Isolation of Crash Periods

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3.2 Isolation of Crash Periods

1. A bear market indicator, $I_{B,t-1}$, based on Daniel and Moskowitz (2016), which equals one if the two-year market return preceding the start of month t ($Market_{2Y,t-1}$) is negative and zero otherwise.

$$I_{B,t-1} = \begin{cases} 1 & \text{if } Market_{2Y,t-1} < 0, \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

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3 Predicting Momentum Crashes

3.2 Isolation of Crash Periods

2. Rebound indicator *(Daniel and Moskowitz, 2016)*

$$I_{R,\tau} = \begin{cases} 1 & \text{if } Market_{2Y,t-1} < 0 \ \& \ Market_{1M,\tau} > 0, \\ 0 & \text{otherwise} \end{cases}$$

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3 Predicting Momentum Crashes
3.2 Isolation of Crash Periods

3. Proposing crash indicator

$$I_{C,\tau} = \begin{cases} 1 & \text{if } Market_{2Y,t-1} < 0 \ \& \ Market_{1M,\tau} > 0 \ \& \ \beta_{MOM,t-1} < 0, \\ 0 & \text{otherwise} \end{cases}$$

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Indicator performance comparison from Sep. 1928 to May 2020.

Table 2: Comparison of Mean Returns

Indicator (I_j)	$I_j = 0$	$I_j = 1$	Diff.	t-value	Implementation
$I_{B,t-1}$	1.59%	−1.04%	−2.63%	−2.49**	ex-ante
$I_{R,t-1}$	1.47%	−2.38%	−3.84%	−2.53**	ex-ante
$I_{C,t-1}$	1.49%	−3.63%	−5.12%	−2.83***	ex-ante
$I_{R,t}$	1.95%	−6.66%	−8.61%	−5.65***	ex-post
$I_{C,t}$	1.94%	−8.47%	−10.40%	−5.94***	ex-post

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$I_{R,t}$	1.95%	−6.66%	−8.61%	−5.65***	ex-post
$I_{C,t}$	1.94%	−8.47%	−10.40%	−5.94***	ex-post

Crash indicator outperforms *Daniel and Moskowitz (2016)*.

Indicator performance comparison from Sep. 1928 to May 2020.

Table 2: Comparison of Mean Returns

Indicator (I_j)	$I_j = 0$	$I_j = 1$	Diff.	t-value	Implementation
$I_{B,t-1}$	1.59%	−1.04%	−2.63%	−2.49**	ex-ante
$I_{R,t-1}$	1.47%	−2.38%	−3.84%	−2.53**	ex-ante
$I_{C,t-1}$	1.49%	−3.63%	−5.12%	−2.83***	ex-ante
$I_{R,t}$	1.95%	−6.66%	−8.61%	−5.65***	ex-post
$I_{C,t}$	1.94%	−8.47%	−10.40%	−5.94***	ex-post

Crash indicator outperforms *Daniel and Moskowitz (2016)*.
ex-ante implementation means it is practically implementable.

3 Predicting Momentum Crashes
3.2 Isolation of Crash Periods

To investigate momentum predictability, they employed predictive **regressions** of monthly momentum returns.

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3 Predicting Momentum Crashes
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Indicator

Momentum volatility

Fama and French (1993) risk factors

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Table 3: Predictive Regressions

	Model								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$I_{B,t-1}$	-0.026^{***}								
	(-4.18)								
$I_{R,t-1}$		-0.038^{***}							
		(-4.47)							
$I_{C,t-1}$			-0.051^{***}						
			(-5.43)						
$\sigma_{MOM,t-1}$				-0.078^{***}					
				(-4.14)					
$I_{B,t-1} \cdot \sigma_{MOM,t-1}$					-0.083^{***}				
					(-5.06)				
$I_{R,t-1} \cdot \sigma_{MOM,t-1}$						-0.123^{***}		-0.103^{***}	
						(-5.63)		(-4.47)	
$I_{C,t-1} \cdot \sigma_{MOM,t-1}$							-0.144^{***}		-0.125^{***}
							(-6.30)		(-5.23)
FF3 included?	No	No	No	No	No	No	No	Yes	Yes
$Adj.R^2$	0.016	0.018	0.026	0.014	0.022	0.027	0.034	0.040	0.046

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1. Significance increases

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2. **combination** of market risk and momentum-specific risk **improves** crash predictability.

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3. CI continues to show the highest predictive power.

Contents

4 Risk-Managed Momentum

4 Risk-Managed Momentum

4.1 Risk Management Strategies

4 Risk-Managed Momentum

4.1 Risk Management Strategies

Constant volatility scaling strategy (CVOL) *(Barroso and Santa-Clara 2015)*

$$r_{MOM_t^{CVOL}} = \underbrace{\frac{\sigma_{target}}{\hat{\sigma}_{MOM,t-1}}}_{\widehat{=} w_{t-1}^{CVOL}} r_{MOM,t}$$

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4 Risk-Managed Momentum
4.1 Risk Management Strategies

Constant volatility scaling strategy (CVOL) *(Barroso and Santa-Clara 2015)*

Target volatility (12%)

$$r_{MOM_t^{CVOL}} = \underbrace{\frac{\sigma_{target}}{\hat{\sigma}_{MOM,t-1}}}_{\widehat{=} w_{t-1}^{CVOL}} r_{MOM,t}$$

Empirical volatility

4 Risk-Managed Momentum
4.1 Risk Management Strategies

Constant volatility scaling strategy (CVOL) *(Barroso and Santa-Clara 2015)*

Target volatility (12%)

$$r_{MOM_t^{CVOL}} = \underbrace{\frac{\sigma_{target}}{\hat{\sigma}_{MOM,t-1}}}_{\widehat{=} w_{t-1}^{CVOL}} r_{MOM,t}$$

Empirical volatility

It increases momentum returns and reduces volatility.

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4 Risk-Managed Momentum
4.1 Risk Management Strategies

Daniel and Moskowitz (2016) focuses on systematic market risk and scales momentum exposure dynamically (DYN).

$$r_{MOM_t^{DYN}} = \underbrace{\left(\frac{1}{2\lambda}\right)\frac{\hat{\mu}_{t-1}}{\hat{\sigma}^2_{t-1}}}_{\widehat{=} w_{t-1}^{DYN}} r_{MOM,t}$$

4 Risk-Managed Momentum
4.1 Risk Management Strategies

Daniel and Moskowitz (2016) focuses on systematic market risk and scales momentum exposure dynamically (DYN).
It maximizes the Sharpe ratio of Markowitz' (1952) portfolio optimization

$$r_{MOM_t^{DYN}} = \underbrace{(\frac{1}{2\lambda})\frac{\hat{\mu}_{t-1}}{\hat{\sigma}^2_{t-1}}}_{\widehat{=} w^{DYN}_{t-1}} r_{MOM,t}$$

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4 Risk-Managed Momentum
4.1 Risk Management Strategies

$$r_{MOM_t^{CVOL}} = \underbrace{\frac{\sigma_{target}}{\hat{\sigma}_{MOM,t-1}}}_{\widehat{=} w_{t-1}^{CVOL}} r_{MOM,t}$$

$$r_{MOM_t^{DYN}} = \underbrace{\left(\frac{1}{2\lambda}\right)\frac{\hat{\mu}_{t-1}}{\hat{\sigma}_{t-1}^2}}_{\widehat{=} w_{t-1}^{DYN}} r_{MOM,t}$$

$$r_{MOM_t^{CI}} = \underbrace{\frac{\sigma_{target}^2}{\hat{\sigma}_{t-1}^2} \cdot (-1)^{I_{C,t-1}}}_{\widehat{=} w_{t-1}^{CI}} r_{MOM,t}$$

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4 Risk-Managed Momentum

4.2 Risk Managed Performance

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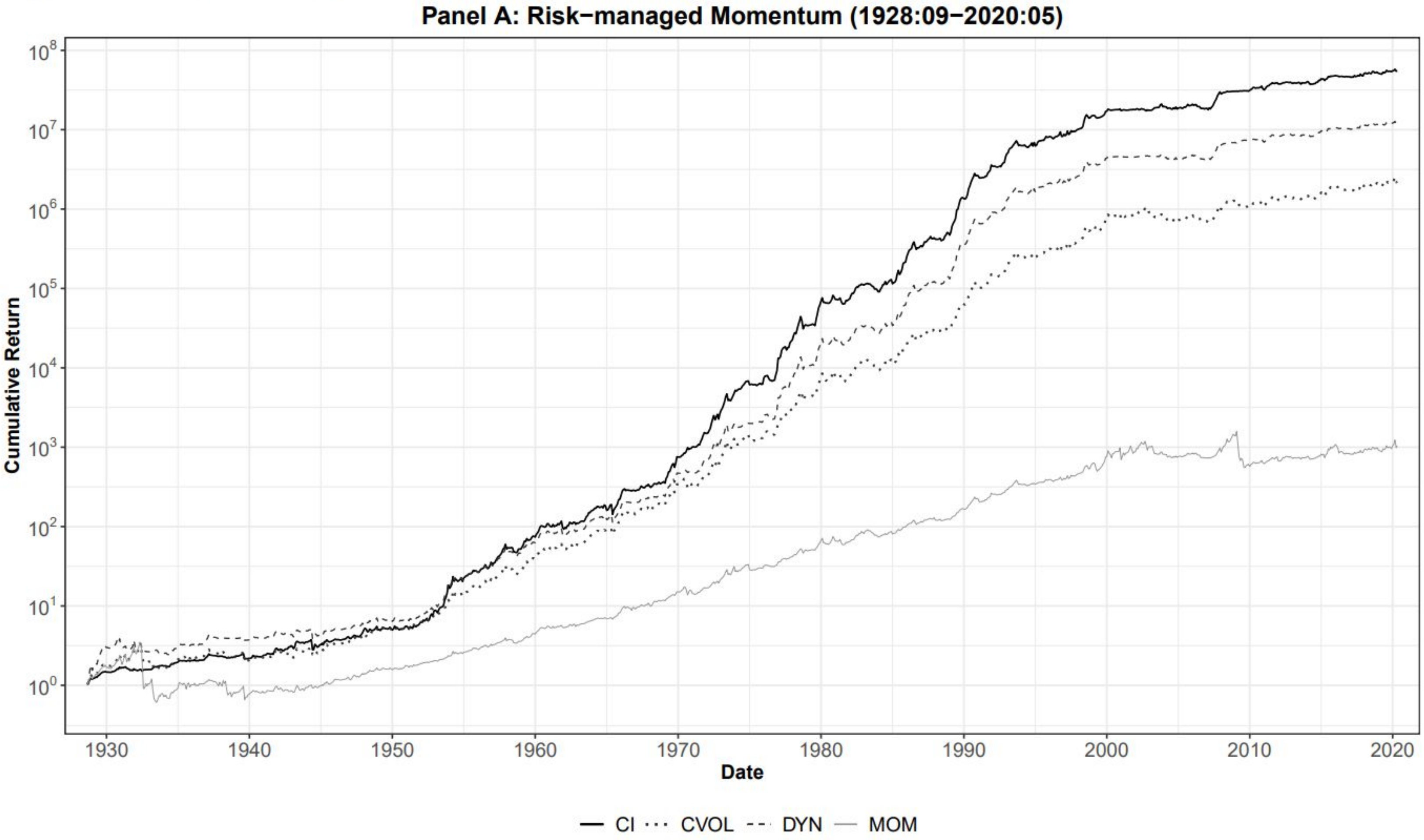
Figure 6: Risk-Managed Performance: Cumulative Returns



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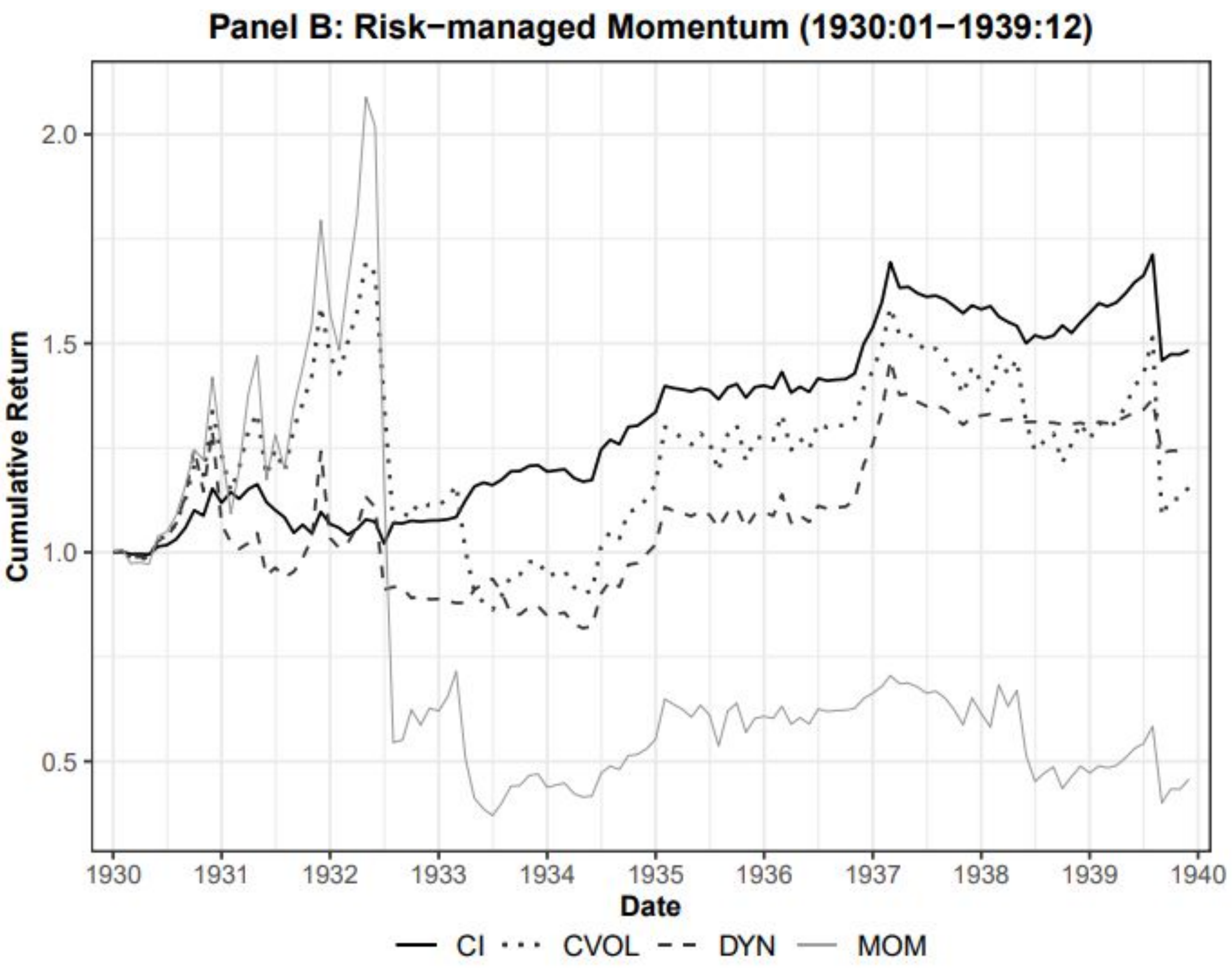

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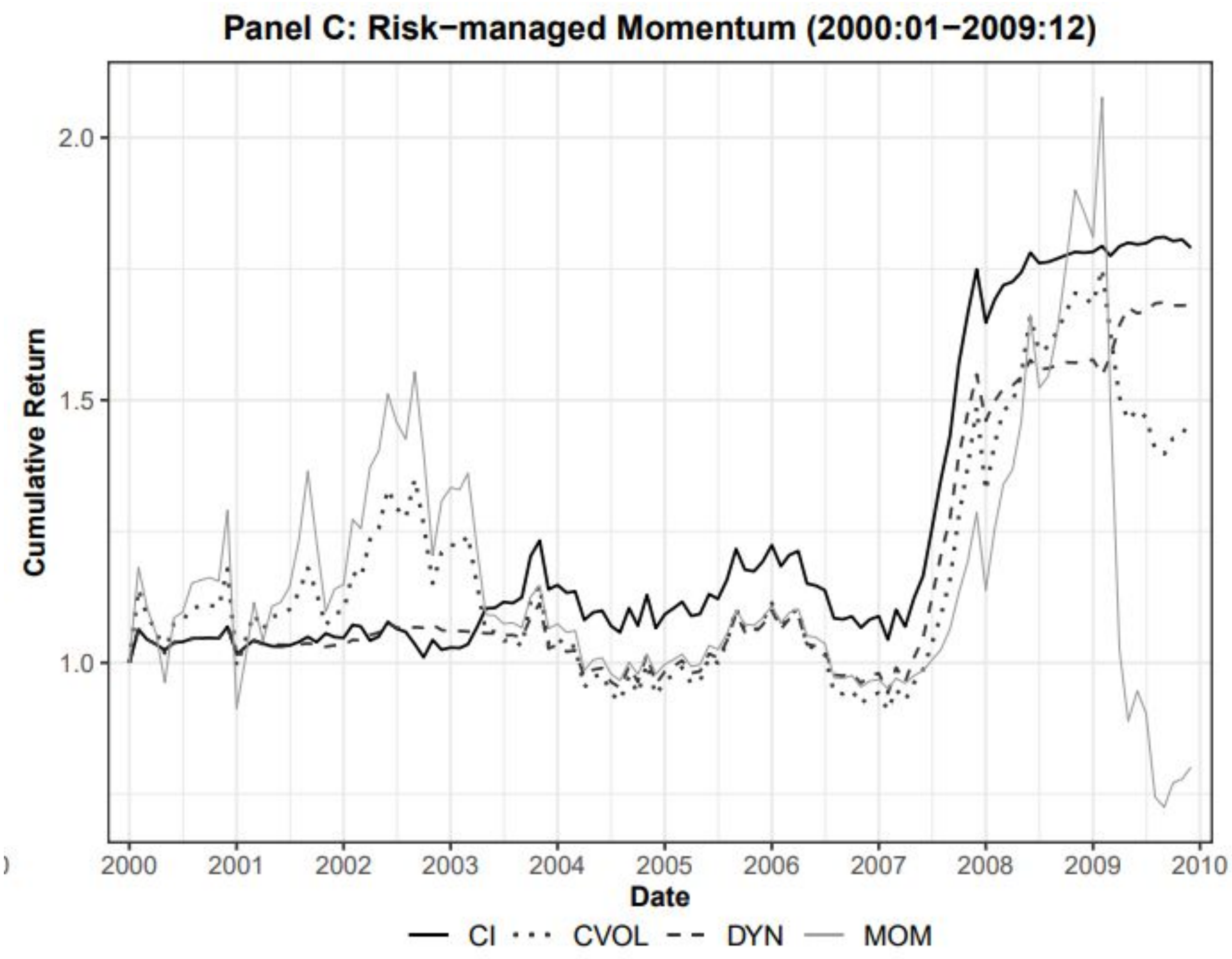

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Table 5: Risk-Managed Performance: Descriptive Statistics

Statistic	Full Period			
	MOM_{raw}	CVOL	DYN	CI
Mean	13.81%	17.85%	19.62%	21.33%
Median	17.64%	18.80%	10.73%	12.46%
Minimum	−77.02%	−28.26%	−24.62%	−25.39%
Maximum	26.16%	24.99%	42.18%	44.18%
Volatility	27.32%	19.00%	19.00%	19.00%
Sharpe Ratio	0.51	0.94	1.03	1.12
Skew	−2.27	−0.32	0.85	0.75
Kurtosis	16.58	2.02	6.47	6.07

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Robustness Check

pass

Conclusion

Crashes particularly occur in rebounding bear markets.

(negative market-beta and high momentum volatility)

We show that a crash indicator and its predictive power.

Based on this finding, we propose an implementable trading strategy that outperforms existing risk-management strategies.