Breaking Bad: Parameter Uncertainty Caused by Structural Breaks in Stocks

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Uncertainty

- Estimating parameters for portfolio optimization is notoriously difficult (Michaud, 1989; DeMiguel et al., 2009, FAJ, RFS)
- Existence of breaks further complicates estimation procedure and gives rise to uncertainty (Ang and Timmermann, 2012; Smith and Timmermann, 2021, ARFE, RFS)
- Agents prefer risk ("probabilized") over uncertainty ("non probabilized")(Knight, 1921; Ellsberg, 1961)
- Investors are ambiguity averse (Garlappi et al., 2007, RFS)

Uncertainty in Financial Markets: Consequences

- Trading happens less frequently and there are larger no-trade intervals (Dow and Werlang, 1992, Econometrica)
- Limited stock market participation under uncertainty (Easley and O'Hara, 2009, RFS)
- Risk premia increase with (amount of traders avers to) uncertainty (Guidolin and Rinaldi, 2010)
- Larger levels of uncertainty decrease allocation to risky assets (Uppal and Wang, 2003; Garlappi et al., 2007; Stöckl, 2020, RFS, JF)
- In periods of high uncertainty, investors avoid unfamiliar assets (Boyle et al., 2012, MS)

Research Gap

Parameter Uncertainty

The role of stock-specific uncertainty and some of its drivers are not yet clearly understood:

- What type of uncertainty (on a stock level) is important for investors?
- How to measure (proxy for) uncertainty in stocks?
- What is the impact of uncertainty on individual stocks?

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We argue that:

- $\Rightarrow$ Agents avoid uncertain stocks until uncertainty is resolved (here: parameter uncertainty).
- $\Rightarrow$ Parameter uncertainty is difficult to measure. Suggested proxy: Stock age since last time series break (aka Break Age)
- $\Rightarrow$ We check its validity by testing whether break age offers higher CARs relative to firm age

Research Hypotheses

Parameter Uncertainty

Why break age?

- Break points co-occur with earnings releases and stock-related news (dividend payments, stock-splits and buyback announcements) (Lleo et al., 2020)
- Time series breaks occur frequently and impair predictive relationships (Dangl and Halling, 2012; Smith and Timmermann, 2021, RFS, JFE)
- Regime shifts are difficult to verify, regimes may be unknown, even advanced prediction models cannot exploit the induced uncertainty (Ang and Timmermann, 2012; Stöckl, 2020)

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We test the following research hypotheses

1. Directly after (detecting) a break in the time series, stock offer higher expected returns that diminish with the resolution of uncertainty
2. This phenomenon is more pronounced for smaller stocks as they are less researched by analysts

Data & Break Point Detection Models

- Monthly delisting-adjusted stock returns from CRSP as of 1925
  (33'460 PERMNO, 4.4 m PERMNO-DATE obs)
- Abnormal returns calculated using Fama-French-Carhart-Factors
  (CAPM, FF3, FFC4 based on 12-month rolling regressions)

$$AR_{i,t} = R_{i,t} - \beta_{m,i,t}R_{m,t} - \beta_{smb,i,t}R_{smb,t} - \beta_{hml,i,t}R_{hml,t} - \beta_{mom,i,t}R_{mom,t}$$

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- R-package *cpm* allows online break detection for multiple different methods
  - Student: Gaussian (change in mean)
  - Bartlett: Gaussian (change in variance)
  - GLR: Gaussian (change in mean and/or variance)
  - Mann-Whitney: Non-Gaussian (change in location)
  - Mood: Non-Gaussian (change in scale)
  - Lepage: Non-Gaussian (general changes)
  - Kolmogorov-Smirnov: Non-Gaussian (general changes)
  - Cramer-von-Mises: Non-Gaussian (general changes)

Cumulative Abnormal Returns

- We depict average (equally/value-weighted) **C**umulative **A**bnormal **R**eturns for each month after break detection against a benchmark of IPO returns

$$AR_t = \sum_{i=1}^{N} w_{i,t} AR_{i,t}$$

$$CAR_t = \prod_{k=0}^{t} \left(1 + \left(AR_t^{BP} - AR_t^{IPO}\right)\right) - 1$$

Statistics

Breakpoint Statistics CPM

	% of stocks with BPs	Median no of BPs per stock	Median time to detect BP	Median time between BPs
Mann-Whitney	30.28	2.00	33.00	32.00
Mood	53.32	2.00	36.00	33.00
Student	57.80	2.00	34.00	32.00
Bartlett	73.02	3.00	24.00	20.00
GLR	68.30	3.00	27.00	21.00

Table: Break-point detection statistics depicting percentage of stocks with detected break-points, the median number of break-points per stock, the median break-point detection time as well as the median time between break-points.

Results

Break Age and CAR

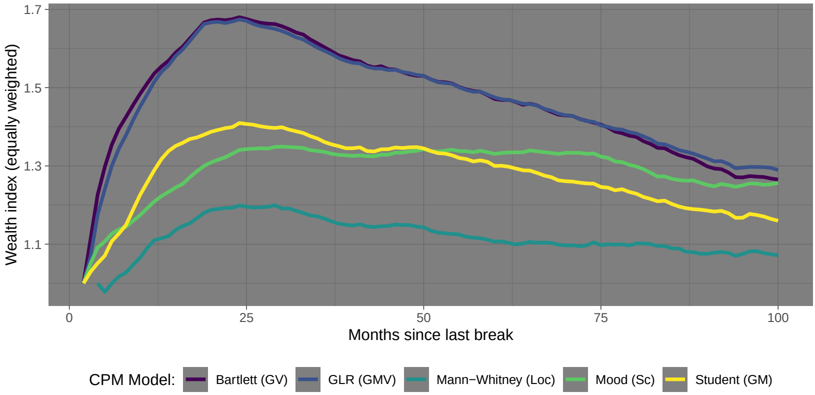


Figure: Cumulative abnormal benchmarked returns (vs. IPOs), equally weighted, full sample, only breakpoints (break date >1)

▸ Value-weighted results

Results

Break Age and CAR

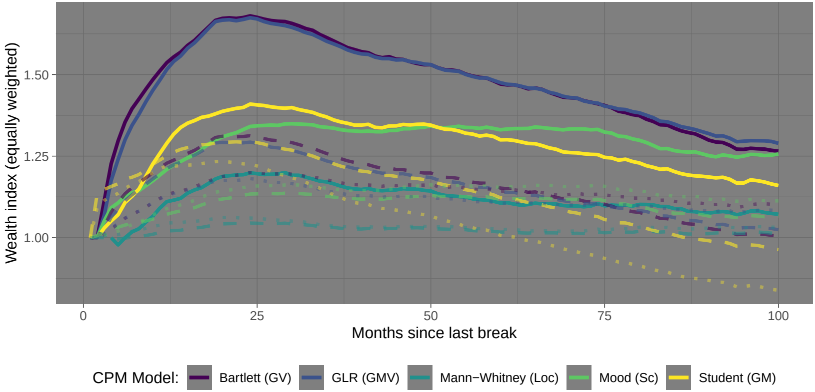


Figure: Cumulative abnormal benchmarked returns (vs. IPOs), equally weighted, full sample (solid line: only breakpoints, dashed line: including IPOs, dotted line: including breakpoints as of break date)

Value-weighted results

Results

Break Age and CAR (Sample starting in 1980:01)

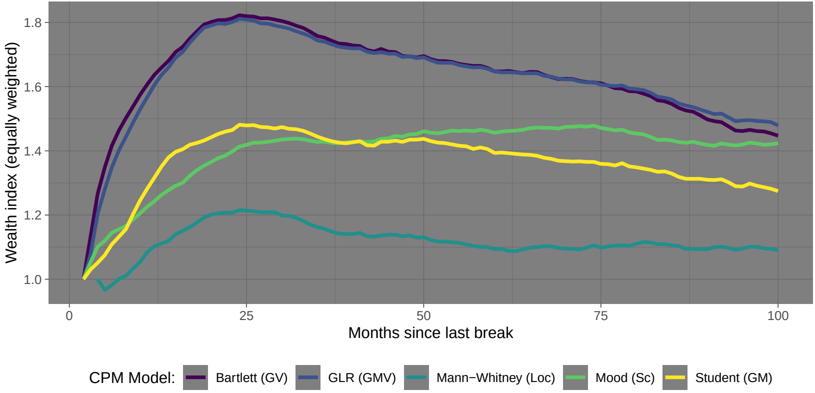
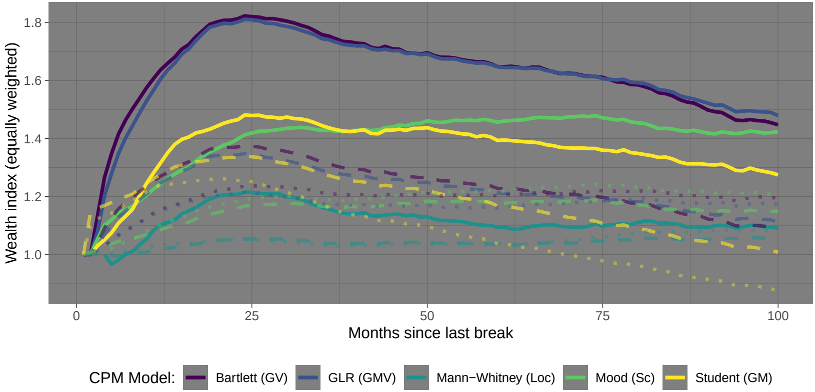


Figure: Cumulative abnormal benchmarked returns (vs. IPOs), equally weighted, short sample, only breakpoints (break date >1)

Value-weighted results

Results

Break Age and CAR (Sample starting in 1980:01)



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Conclusion

- There is a substantial premium for assets with recent breaks in their time series
- This premium is strongest (among the implemented models) for breaks in the variance and mean-variance relationship
- The premium is driven by smaller stocks (as they are potentially less covered by analysts)

Open questions

- What about other break point detection models (i.e. for detecting breakpoints in regression coefficients)
- What is a more suitable benchmark than IPO stocks
- Distinguish between market wide and stock specific breaks
- Apply CAR over various size quantiles
- Verify relationship by studying trading volume

Thank you for your attention.

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Break Age and CAR

Value weighted (long sample)

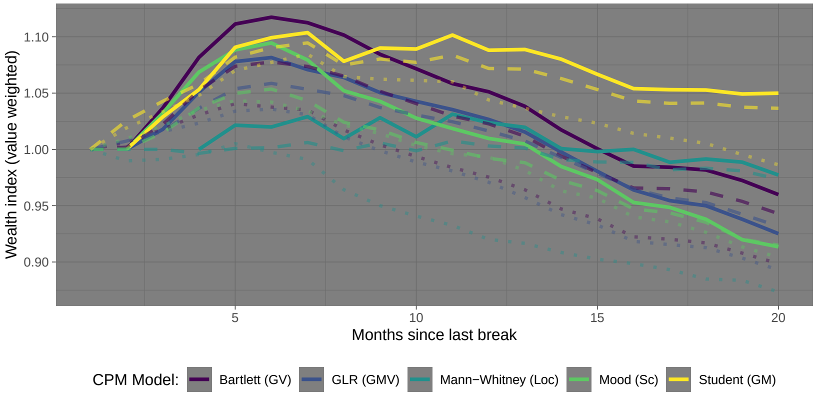

Figure: Cumulative abnormal benchmarked returns, value weighted, full sample (solid line: only breakpoints, dashed line: including IPOs, dotted line: including breakpoints as of break date)

Back to main results

Break Age and CAR

Value weighted (short sample)

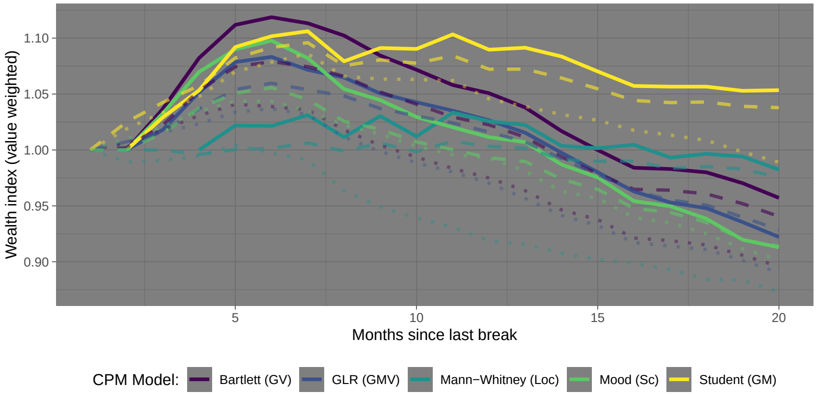

Figure: Cumulative abnormal benchmarked returns, value weighted, short sample (solid line: only breakpoints, dashed line: including IPOs, dotted line: including breakpoints as of break date)

Back to main results