Higher co-moments and asset pricing on London Stock Exchange

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HFAA (Piraeus), 2011

Presentation Outline

- Motivation: Life beyond mean and variance
- Co-moments and asset pricing: Theory
- Co-moments and asset pricing: Evidence from LSE
- Current research and conclusions

Motivation: Failure of the CAPM

- Vast literature documenting the empirical failure of the CAPM
- Long list of "anomalies"/ strategies that generate large pricing errors/ alphas (Fama and French, 2008)
- Two-period model: Important limitation when returns are not i.i.d. (intertemporal premia: Merton's ICAPM)
- Mean-variance model: Important limitation when asset returns are not symmetric and preferences are not quadratic (higher co-moments premia)

There is life beyond mean and variance

- Asset returns exhibit negative skewness and excess kurtosis (e.g. financial distress, bankruptcy, bond defaults)
- In the presence of stochastically time-varying risk factors unconditional returns' distributions are non-normal (e.g. stochastic volatility model of Heston, 1992)
- Utility theory accommodates preferences over skewness and kurtosis
- Prudence (Kimball, 1990): Expect $U^{(3)} > 0$
- Temperance (Eeckhoudt et al., 1996): Expect $U^{(4)} < 0$
- Related: First-order risk aversion (Segal and Spivak, 1990) and Loss Aversion (Kahnemann and Tversky, 1979)

Ample evidence for preferences over skewness and kurtosis

- Investors dislike negative skewness and excess kurtosis in payoff distributions
- Examples: Expensive insurance products, overpriced out-of-the-money puts, capital-guarantee products
- Modern risk management: Value-at-risk and portfolio insurance
- Investors like positive skewness in payoff distributions
- Examples: Participation in unfair games with positively skewed payoffs (jackpots in lotteries and premium bonds)

Prior literature

- Preferences over higher moments in asset pricing: Kraus and Litzenberger (1976) and Scott and Horvath (1980)
- Empirical evidence for pricing of coskewness/ cokurtosis risk: Harvey and Siddique (2000), Dittmar (2002) for US, only Hung, Shackleton and Xu (2004) for the UK
- Higher co-moments models for performance evaluation: Moreno and Rodriguez (2009) for US and Kostakis (2009) for UK
- Limitations of the higher co-moments model: Dittmar (2002), Post et al. (2008), Poti and Wang (2010)

This study

- Examine whether coskewness and cokurtosis risks are priced on LSE
- Show that standard asset pricing theory predicts an extra premium is required for shares exhibiting negative coskewness and positive cokurtosis with the market portfolio
- Estimate CSK and CKT for a large cross section of LSE-listed shares on a monthly basis
- Use CSK and CKT as sorting criteria to construct decile portfolios
- Examine their post-ranking returns and perform standard asset pricing tests

Asset pricing theory

Starting from the central asset pricing equation, $p_t = E(m_{t+1}x_{t+1})$, the premium for any financial asset is given by:

$$E_t(r_{t+1}) - r_t^f = -(1 + r_t^f)Cov(m_{t+1}, r_{t+1})$$

Common choice for SDF: $m_{t+1} = \frac{U^{'}(W_{t+1})}{U^{'}(W_t)}$

Taking a 1st order Taylor series expansion of $U^{'}(W_{t+1})$ around W_t, the SDF becomes linear in market returns:

$$m_{t+1} = 1 + \tilde{b}r_{m,t+1}$$

This leads to the CAPM and implies the standard result:

$$E_t(r_{t+1}) - r_t^f = -(1 + r_t^f)\tilde{b}Cov(r_{m,t+1}, r_{t+1})$$

Asset pricing theory

- No reason to truncate the expansion at 1^{st} order. Taking the 3^{rd} order expansion of $U^{'}(W_{t+1})$ around W_t, the SDF becomes:

$$\frac{U'(W_{t+1})}{U'(W_t)} \simeq 1 + \frac{U''(W_t)W_t}{U'(W_t)} r_{m,t+1} + \frac{U^{(3)}(W_t)W_t^2}{2U'(W_t)} r_{m,t+1}^2 + \frac{U^{(4)}(W_t)W_t^3}{6U'(W_t)} r_{m,t+1}^3$$

$$= 1 - \gamma r_{m,t+1} + \tfrac{1}{2}\gamma\eta r_{m,t+1}^2 - \tfrac{1}{6}\gamma\eta\kappa r_{m,t+1}^3$$

- $\eta \equiv -\frac{U^{(3)}(W)W}{U''(W)}$ is Kimball's (1990) measure of relative *prudence*
- $\kappa \equiv -\frac{U^{(4)}(W)W}{U^{(3)}(W)}$ is Eeckhoudt et al. (1996) measure of relative *temperance*.

- We get an SDF which includes the squared and cubic market returns:

$$m_{t+1} = 1 + \tilde{b} r_{m,t+1} + \tilde{c} r_{m,t+1}^2 + \tilde{d} r_{m,t+1}^3$$

Asset pricing theory

This SDF specification implies the following relationship:

$$E_t(r_{t+1}) - r_t^f = -(1 + r_t^f)\tilde{b}Cov(r_{m,t+1}, r_{t+1}) - (1 + r_t^f)\tilde{c}Cov(r_{m,t+1}^2, r_{t+1}) - (1 + r_t^f)\tilde{d}Cov(r_{m,t+1}^3, r_{t+1})$$

Consequently, the risk premium now has three components:

1. Covariance premium (Covariance $\uparrow \Rightarrow$ premium $\uparrow$)
2. Coskewness premium (Coskewness $\uparrow \Rightarrow$ premium $\downarrow$)
3. Cokurtosis premium (Cokurtosis $\uparrow \Rightarrow$ premium $\uparrow$)

Measures of coskewness and cokurtosis

- Measure of standardized coskewness:

$$CSK_t = \frac{E\left[\varepsilon_{i,t}\varepsilon_{m,t}^2\right]}{\sqrt{E\left[\varepsilon_{i,t}^2\right]}E\left[\varepsilon_{m,t}^2\right]}$$

- Measure of standardized cokurtosis:

$$CKT_t = \frac{E\left[\varepsilon_{i,t}\varepsilon_{m,t}^3\right]}{\sqrt{E\left[\varepsilon_{i,t}^2\right]}E\left[\varepsilon_{m,t}^3\right]}$$

where $\varepsilon_{i,t}$ is the residual from the CAPM regression for each asset i

- Advantage vs Huang-Litzenberger (1976): These coskewness and cokurtosis measures are orthogonal to beta risk

Data and methodology

- Utilize all LSE-listed shares during January 1986- December 2008 (clean sample: 3,501 shares)
- Estimate CSK and CKT measures for each share and each month using a window of 60 monthly returns
- Sort shares each month t according to CSK (correspondingly CKT) in ascending order
- Construct decile CSK and CKT portfolios and calculate excess returns
- Datastream Reuters, LSPD for delisting reasons, Market, SMB, HML and MOM factors for UK

Characteristics of coskewness-sorted portfolios

Characteristics of decile Coskewness portfolios (From Negative CSK to Positive CSK)

	P1	P2	P9	P10	P1-P10	*t*-test
Average CSK	-0.41	-0.27	0.16	0.34	-0.75	-61.70
EW returns (% p.a)	3.92	3.41	-1.64	-2.71	6.64	2.24
VW returns (% p.a)	6.81	4.59	-0.16	-2.38	9.20	2.07
MV (£m)	956	685	1006	1628	-671	-14.55
CAPM Beta	0.81	0.90	0.94	1.08	-0.28	-8.60

Characteristics of cokurtosis-sorted portfolios

Characteristics of decile Cokurtosis portfolios (From Negative CKT to Positive CKT)

	P1	P2	P9	P10	P10-P1	*t-stat*
Average CKT	-0.76	-0.43	0.43	0.75	1.52	21.11
EW returns (% p.a)	-4.26	-2.17	2.41	3.36	7.63	3.00
VW returns (% p.a)	-0.58	-0.01	3.29	7.05	7.63	1.87
MV (£m)	1101	771	1056	1381	279	4.17
CAPM Beta	1.08	1.09	0.97	0.80	-0.28	-11.96

Performance of coskewness-sorted portfolios

Alphas of value-weighted Coskewness portfolios

	P1	P2	P9	P10	P1-P10	Chi-sq.
CAPM alpha (% p.a)	4.60	2.13	-2.74	-5.36	9.96	17.44
	(1.54)	(0.71)	(-1.17)	(-2.07)**	(2.67)***	(0.06)
Fama-French alpha	3.88	2.18	-2.83	-5.92	9.81	19.54
	(1.57)	(0.79)	(-1.20)	(-2.41)**	(2.77)***	(0.03)
Carhart alpha	4.37	2.70	-2.49	-3.38	7.74	22.00
	(1.78)*	(1.09)	(-1.20)	(-1.17)	(2.07)**	(0.02)

Performance of cokurtosis-sorted portfolios

Alphas of value-weighted Cokurtosis portfolios

	P1	P2	P9	P10	P10-P1	Chi-sq.
CAPM alpha (% p.a)	-3.55	-3.01	0.62	4.86	8.41	19.34
	(-1.15)	(-1.09)	(0.21)	(2.10)**	(2.10)**	(0.03)
Fama-French alpha	-4.52	-3.14	0.50	4.09	8.61	31.43
	(-1.61)*	(-1.35)	(0.16)	(1.89)**	(2.32)**	(0.00)
Carhart alpha	-2.37	-2.74	0.82	5.19	7.57	36.69
	(-0.78)	(-1.08)	(0.29)	(2.49)**	(1.96)**	(0.00)

Cross-sectional tests

- 2-step Fama-MacBeth tests for the cross-section of CSK (CKT) portfolios using standard market, size, value and momentum factors
- Main finding: Standard common factors cannot price the cross-section of CSK (or CKT) portfolios' returns
- Construct coskewness and cokurtosis zero-cost (spread) risk factors using a 20% cutoff percentage value
- Augment the CAPM with these two risk factors

$$r_i^e = \alpha_i + \beta_{i,m} r_m^e + \beta_{i,S^- - S^+} \left(S^- - S^+\right) + \beta_{i,K^+ - K^-} \left(K^+ - K^-\right) + \varepsilon_i$$

- and use augmented higher co-moments model for asset pricing tests
- Evidence that these risk factors can help explain the cross-section of CSK and CKT portfolios (verification)

Robustness checks and current research

- Equally weighted portfolios
- Different windows of observations for the estimation of CSK and CKT (48 & 72 months)
- Different cutoff percentage values for the construction of the risk factors
- Current research: Utilize the higher co-moments asset pricing model to re-examine the abnormal performance of "anomalies" in the UK
- Preliminary results: Pricing errors are reduced (but not eliminated). Most interesting: Reduction of momentum abnormal profits.

Summary

- Higher co-moments are relatively neglected in empirical asset pricing
- Ample evidence that there is life beyond mean and variance
- Strong theoretical foundations in asset pricing and utility theory vs. purely empirical risk factors
- Negative coskewness risk and positive cokurtosis risk are significantly priced in a large cross-section of LSE-listed shares
- Promising area of research for international financial markets, cost of capital, performance evaluation, anomalies studies