Realized semibetas in the Korean stock market

Heewon Hwang

June 2024

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Introduction

Motivation: Initial interest in **Downside Risk (Downside Deviation)**

- Downside deviation: 특정 수치 (0) 아래로 일어나는 변동성
- “Risk = Standard deviation”으로 가정하는 경우 평균에서 벗어난 모든 움직임이 리스크로 고려됨 → upside 변동성이 큰 것이 패널티로 적용
- “Risk = Downside deviation”으로 가정하는 경우 0 아래로 생기는 변동성을 리스크로 정의하며 실제 투자자에게 유의미한 “Downside Risk” 도출
- 기준치를 조정해 투자자의 리스크 선호도 및 시장 전망 반영 가능 (bull market: higher MAR, bear market: lower MAR)
- **Initial RQ: Downside risk-adjusted beta? 한국 주식시장에서의 유효성?**

Source: Rom and Ferguson (1993), Investing.com

Literature Review: Evolution of Beta

1. CAPM Beta (Sharpe, Treynor, Lintner, Mossin 1960s)

$$\beta_i = \frac{Cov(r_i, r_m)}{\sigma^2(r_m)}$$

- 시장대비 변동성
- (시장의 beta는 1, 이때 주식 A의 beta가 2면 주가가 시장이 움직이는 정도의 2배만큼 움직임)

2. Downside and Upside Beta (Ang et al. 2006)

$$\beta^- = \frac{\mathrm{cov}(r_i, r_m | r_m < \mu_m)}{\mathrm{var}(r_m | r_m < \mu_m)}, \quad \beta^+ = \frac{\mathrm{cov}(r_i, r_m | r_m > \mu_m)}{\mathrm{var}(r_m | r_m > \mu_m)}.$$

- B- : 시장 수익률이 +일 때 존재하는 시장 대비 변동성
- B+ : 시장 수익률이 - 일 때 존재하는 시장 대비 변동성

3. 4-way Semibetas (Bollerslev et al. 2022)

$$\widehat{\beta}^{\mathcal{N}}_{t,i} \equiv \frac{\sum_{k=1}^{m} r^-_{t,k,i} f^-_{t,k}}{\sum_{k=1}^{m} f^2_{t,k}}, \quad \widehat{\beta}^{\mathcal{P}}_{t,i} \equiv \frac{\sum_{k=1}^{m} r^+_{t,k,i} f^+_{t,k}}{\sum_{k=1}^{m} f^2_{t,k}}$$

$$\widehat{\beta}^{\mathcal{M}^-}_{t,i} \equiv \frac{-\sum_{k=1}^{m} r^+_{t,k,i} f^-_{t,k}}{\sum_{k=1}^{m} f^2_{t,k}}, \quad \widehat{\beta}^{\mathcal{M}^+}_{t,i} \equiv \frac{-\sum_{k=1}^{m} r^-_{t,k,i} f^+_{t,k}}{\sum_{k=1}^{m} f^2_{t,k}}$$

- B_N : (시장 수익률 -) and (주식 수익률 -) 일때 존재하는 시장 대비 변동성
- B_P : (시장 수익률 +) and (주식 수익률 +) 일때 존재하는 시장 대비 변동성
- B_M- : (시장 수익률 -) and (주식 수익률 +) 일때 존재하는 시장 대비 변동성
- B_M+ : (시장 수익률 +) and (주식 수익률 -) 일때 존재하는 시장 대비 변동성

Source: Ang et al. (2006), Bollerslev et al. (2022)

Theory Development

Reference paper 1: Bollerslev et al., 2022. Realized semibetas: Disentangling “good” and “bad” downside risks

- US equity market
- Only B_N, B_M- (semibetas with negative market return) are priced
- Risk premium for B_N is double that of B_M- and three times the traditional B

Reference paper 2: Pyung Kun Chu, 2022. Semibeta asset pricing in Korean stock market

- KOSPI
- B_N, B_P, B_M- are statistically significant
- B_N has positive risk premium, B_P and B_M- have negative risk premium

Research Question:

What is the significance of semibetas in KOSDAQ and the overall Korean stock market (KOSPI + KOSDAQ)?

Hypothesis: the traditionally more volatile KOSDAQ exchange may reveal more significant effects of semibetas

Source: Bollerslev et al. (2022), Chu (2022)

Method

Data

- KOSPI and KOSDAQ constituents and index daily returns from FnGuide
- at least 10 available daily return observations for each month
- winsorized at the 1% and 99% levels to reduce the impact of outliers

Replication results (realized semibeta calculation)

Table 1
Summary statistics.

	β	β^N	β^P	β^{M+}	β^{M-}
Mean	0.71	0.54	0.58	0.21	0.20
Std. Dev.	0.71	0.41	0.46	0.26	0.27
Min	−1.19	0.00	0.00	0.00	0.00
P25	0.24	0.23	0.25	0.05	0.03
Median	0.67	0.45	0.47	0.13	0.10
P75	1.13	0.75	0.77	0.28	0.25
Max	2.89	2.03	2.49	1.40	1.54
Correlation matrix	1.00				
	0.61	1.00			
	0.58	0.14	1.00		
	−0.34	0.04	0.21	1.00	
	−0.34	0.10	0.19	0.38	1.00

This table reports summary statistics of monthly semibetas constructed from daily stock returns. Refer to Section 2.1 for the definition of variables. The sample includes all KOSPI constituent stocks and covers the period from January 1980 until December 2020. Std. Dev., P25, and P75 represent the standard deviation, 25th percentile, and 75th percentile, respectively.

```
             B       B_N       B_P      B_M+      B_M−
Mean  0.705398  0.512269  0.577713  0.200058  0.189620
Std   0.681700  0.314793  0.404269  0.200650  0.234393
Med   0.633748  0.462844  0.494296  0.145800  0.118445

             B       B_N       B_P      B_M+ B_M−
B          1.0       NaN       NaN       NaN  NaN
B_N   0.606231       1.0       NaN       NaN  NaN
B_P   0.593889  0.144489       1.0       NaN  NaN
B_M+ -0.313035  0.064997  0.219143       1.0  NaN
B_M− -0.320792  0.101049  0.198143  0.362169  1.0
```

- Average of concordant semibetas (B_N, B_P) > ‘mixed’ semibetas (B_M+, B_M-) → 시장과 같은 방향으로 갈때 시장 대비 변동성이 크다
- Concordant semibetas have strong correlation with traditional B
- Highest correlation among 4 semibetas: B_M+ and B_M-
- Lowest correlation among 4 semibetas: B_M+ and B_N

Source: Chu (2022)

Method

Fama-Macbeth Regression

$$r_{t+1,i} = \theta^{C}_{t+1} + \theta^{N}_{t+1}\beta^{N}_{t,i} + \theta^{P}_{t+1}\beta^{P}_{t,i} + \theta^{M+}_{t+1}\beta^{M+}_{t,i} + \theta^{M-}_{t+1}\beta^{M-}_{t,i} + \boldsymbol{X}'_{\boldsymbol{t,i}}\boldsymbol{\theta}^{\boldsymbol{X}}_{\boldsymbol{t+1}} + \epsilon_{t+1,i},$$

Replication results

Table 2
Fama–MacBeth regressions with the semibeta asset pricing model.

	(1)	(2)	(3)	(4)	(5)
Constant	0.96***	1.21***	6.60***	1.24***	1.21***
	(2.74)	(3.33)	(4.81)	(3.46)	(3.17)
β	0.35**				
	(2.23)				
β^N		0.85**	1.63***	1.10**	0.83*
		(2.31)	(4.34)	(2.17)	(1.83)
β^P		−0.92***	−0.49**	−1.73***	−1.44***
		(−3.63)	(−2.12)	(−4.45)	(−3.76)
β^{M+}		0.60	1.00*	0.93	0.83
		(1.09)	(1.73)	(1.52)	(1.32)
β^{M-}		−1.44***	−1.61***	−1.40***	−1.42***
		(−2.97)	(−4.30)	(−2.75)	(−2.99)
R^2 (%)	3.28	7.12	12.52	8.85	8.61

(1)

```
Constant: 1.269940244286385 (3.27) (0.00)
CAPM: 0.2497617261043102 (1.49) (0.14)
R^2: 3.07537707223463
```

(2)

```
Constant: 1.1912926116782911 (3.21) (0.00)
N: 1.2548615974974622 (2.32) (0.02)
P: -0.9839156847791121 (-2.98) (0.00)
M_pos: 1.3528114159497595 (2.09) (0.04)
M_neg: -0.8605377887649295 (-1.43) (0.15)
R^2: 7.136747581959817
```

- Reference paper results
  - Only B_M+ insignificant → Investors may not care much when stocks (-) and market (+) since loss in stocks offset by gains in market
  - B_N has + risk prem → investors won't prefer stocks with high B_N (high sensitivity to market when both returns negative)
  - B_P and B_M- has – risk prem → investors prefer stocks with high B_P or B_M- (high sensitivity to market when stock returns positive)
- Conflicting results for 'mixed' semibetas (B_M+ and B_M-)
  - Risk premium have same signs but almost twice as different in magnitude
  - Newey and West t-stat, p-value also differ (B_M- should be significant)

Source: Chu (2022)

To-do

- Debug and finalize F-M Regression code
- Perform regression analysis on:
  - KOSDAQ
  - KOSPI + KOSDAQ
  - Covid-era*