VII. Consumer Confidence and Option Pricing

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Outline

- Motivation and Literature
- Sentiment indices
- Methodology
- Data and empirical analysis
- Conclusion
Motivation

- Empirical asset pricing literature has provided ample evidence that sentiment has a role to play in equity pricing.
- Prior literature also suggests that different types of options are used by different types of investors to serve different purposes—clientele effect.
- These motivate our research to address the following questions:
  1. Does investor sentiment affect option prices by changing the option-implied risk-neutral skewness?
  2. If so, do institutional sentiment and individual sentiment affect option prices in the same way?
Volatility Smile and Risk-neutral Density

- Implied σ
- Index levels

- 24 days
- 115 days
- 206 days
- 297 days

- 0.4 - 0.3 - 0.2 - 0.1 0 0.1 0.2 0.3
- -0.4 -0.3 -0.2 -0.1 0 0.1 0.2 0.3
- 0
- 0.05
- 0.1
- 0.15
- 0.2
- 0.25
- 0.3
- 0.35
- 0.4
- K/F−1
- 24 days
- 115 days
- 206 days
- 297 days

- 3000 3200 3400 3600 3800 4000 4200 4400 4600 4800 5000
- 0
- 0.5
- 1
- 1.5
- 2
- 2.5
- 3
- 3.5
- × 10³
- index levels

- Consumer Confidence (USTC)
Baker and Wurgler (2006): construct sentiment proxy based upon economic variables and find a negative relation between beginning-of-period sentiment and subsequent stock returns, esp. for small, young, highly volatile, growth, and distressed stocks which are more difficult to arbitrage.

Lemmon and Portniaguina (2006): sentiment index as proxied by consumer confidence is able to forecast the returns of small stocks and those with low institutional ownership.
Han (2008): using three sentiment indices, the paper reports a positive relation between investor sentiment and risk-neutral skewness of S&P 500 index options, which is consistent with behavioral explanation.
Blackburn, Goetzmann and Ukhov (2007): make a careful distinction between value investors, growth investors, and switchers and infer risk aversion from option prices; the authors show that value investors have a higher level of risk aversion than growth investors and a trading strategy based on trading risk between the two types generate moderate profits.

Lemmon and Ni (2010): individual stock options are widely traded by individual investors for speculation while index options are motivated by more sophisticated investors for hedging purposes.
four popular proxies for sentiment in the literature

- consumer confidence index constructed by the University of Michigan (CS)
- net position of large speculators in the S&P 500 index futures market compiled by the Commodity Futures Trading Commission (LS)
- the difference between the percentage of bullish advisors and percentage of bearish advisors computed by Investor Intelligence (BB)
- a measure of market-wide sentiment based upon economic variables in Baker and Wurgler (2007 JEP) (BW)
Bakshi, Kapadia, and Madan (2003) shows that any payoff can be spanned and priced using an explicit positioning across option strikes.

The volatility contract $V(t, \tau)$, the cubic contract $W(t, \tau)$, and the quadratic contract $X(t, \tau)$ are weighted sums of OTM calls and puts.

\[
V(t, \tau) = \int_{S_t}^{\infty} \frac{2(1 - \ln(\frac{K}{S_t}))}{K^2} c(t, \tau; K) dK + \int_{0}^{S_t} \frac{2(1 + \ln(\frac{S_t}{K}))}{K^2} p(t, \tau; K) dK
\]

\[
W(t, \tau) = \int_{S_t}^{\infty} \frac{6 \ln(\frac{K}{S_t}) - 3(\ln(\frac{K}{S_t}))^2}{K^2} c(t, \tau; K) dK - \int_{0}^{S_t} \frac{6 \ln(\frac{S_t}{K}) + 3(\ln(\frac{S_t}{K}))^2}{K^2} p(t, \tau; K) dK
\]

\[
X(t, \tau) = \int_{S_t}^{\infty} \frac{12(\ln(\frac{K}{S_t}))^2 - 4(\ln(\frac{K}{S_t}))^3}{K^2} c(t, \tau; K) dK + \int_{0}^{S_t} \frac{12(\ln(\frac{S_t}{K}))^2 + 4(\ln(\frac{S_t}{K}))^3}{K^2} p(t, \tau; K) dK
\]
Methodology: Model-free Risk-neutral Skewness

- the risk-neutral variance and skewness can then be expressed as follows,

\[
\text{VAR}(t, \tau) \equiv E^q[(R_{t, \tau} - E^q(R_{t, \tau}))^2] = e^{r\tau} V(t, \tau) - \mu(t, \tau)^2
\]

\[
\text{SKEW}(t, \tau) = \frac{E^q[(R_{t, \tau} - E^q(R_{t, \tau}))^3]}{E^q[(R_{t, \tau} - E^q(R_{t, \tau}))^2]^{3/2}} = \frac{e^{r\tau} W(t, \tau) - 3e^{r\tau} \mu(t, \tau)V(t, \tau) + 2\mu(t, \tau)^3}{[e^{r\tau} V(t, \tau) - \mu(t, \tau)^2]^{3/2}}
\]

- we do not have a continuum of option prices hence interpolation and extrapolation are used to generate 1000 implied volatilities between 0.01% and 300% across moneyness (K/S)
Methodology: Regression models

- we use the following baseline regression

\[ \text{Skew}_t = a + b_1 \text{Sent}_{t-1} + b_2 \text{Vol}_t + b_3 \text{Skew}_{t-1} + \varepsilon_t \]

- in the robustness tests, we include additional control variables
  1. relative demand for options
  2. recent 6-month index returns
  3. options written on large-cap indices
  4. jumps in future returns
options written on four indices: S&P 500 (SPX), Nasdaq 100 (NDAQ), Russell 2000 value index (RSV), and Russell 2000 growth index (RSG)

monthly data from June 2001 to January 2010: we use end-of-month prices to construct RN volatilities and skewness

conventional selection criteria: (1) non-zero trading volume; (2) average of best bid and best offer prices; (3) out-of-money (OTM) options only and we need at least 2 OTM calls and puts

we construct constant 2-month to maturity RN skewness as this maturity is one of the most frequently traded in the market
Empirical Analysis: Summary Statistics

Table 1 provides summary statistics for RN skewness
- average skewness all negative; volatility smile/smirk
- SPX most negatively skewed, NDAQ least

Table 2 reports summary statistics for sentiment measures and control variables
- the implied volatility over the sample is relatively high, all above 20% and higher for growth indices (≈29%) than value indices (22%-25%)
- consumer confidence index (CS) highly autocorrelated (0.95)
Table 3 reports correlation coefficient of the sentiment indices and RN skewness

<table>
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<tr>
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<th>BB</th>
<th>LS</th>
<th>CS</th>
<th>NDAQ</th>
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Empirical Analysis: Baseline Regression

Table 4 reports regression results when we pair CS with LS

- model 1 uses LS as the sole sentiment proxy, model 2 uses CS as the sole sentiment proxy, while model 3 uses both
- consistent pattern that individual sentiment measure CS is positively related to RN skewness of growth index options and significant, even in the presence of LS
- the institutional sentiment LS is significant only for value index but it’s negative, counter-intuitive
- lagged dependent variable Skew_{t-1} is always highly significant

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Table 5 reports regression results when we pair CS with BB

- we again observe the consistent pattern that individual sentiment measure CS is positively related to RN skewness of growth index options and significant, even in the presence of BB
- the institutional sentiment BB is hardly significant except in one case
- lagged dependent variable Skew_{t-1} is always highly significant

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Empirical Analysis: Baseline Regression

Table 6 reports regression results when we pair CS with BW for a shorter sample (June 2001 to Dec 2007)

- we once again observe the consistent pattern that individual sentiment measure CS is positively related to RN skewness of growth index options and significant, even in the presence of BW
- the institutional sentiment BW is significant only for RSV but the relation is negative
- lagged dependent variable Skew_{t-1} is always highly significant

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Empirical Analysis: Robustness Tests

- Table 7 reports robustness test when we include relative demand and past index returns as control variables. Results are qualitatively the same: CS remains positive and significant for the RN skewness of growth index options, 0.56 (3.03) for RSG and 0.81 (2.70) for NDAQ.
- Demand pressure is only significant for NDAQ with negative coefficient: higher demand for OTM put options leads to more negative skewness.
- Table 8 reports robustness test when we use large-cap Russell 1000 value and growth options but no coefficient is significant.
- Table 9 reports robustness test to include the future realized skewness as proxy for the possibility of jumps.
- Individual sentiment CS is still significantly related to the RN skewness of growth index options, 0.53 (3.56) for RSG and 0.94 (2.86) for NDAQ.
there is a clear pattern that individual sentiment has significant impact on the RN skewness of growth index options

the growth stocks tend to be small, young, more volatile stocks with strong growth prospect and they tend to be held by individual investors

hence growth stocks, and the RN skewness of growth index options, are more easily affected by sentiment of individual investors, consistent with Lemmon and Portniaguina (2006) and Lemmon and Ni (2010)

results for sentiment and RN skewness of value index options are difficult to conclude

our findings imply that apart from fundamental risk-based factors, behavioral analysis is also required in the pricing of options, esp. whose written on growth indices
To conclude

- In this study, we test the relationship between individual and institutional sentiment and risk-neutral skewness inferred from options written on value indices (SPX and RSV) and growth indices (NDAQ and RSG) over the sample period from June 2001 to January 2010.

- Results show that individual sentiment is positively and significantly related to RN skewness of growth index options even in the presence of institutional sentiment proxies.

- This pattern is robust to the inclusion of additional control variables.

- We find mixed results for institutional sentiment and, when they are significant, the coefficient is always negative, which is not consistent with behavioral finance explanations.

- Our results suggest options on growth stocks are more likely to be affected by individual sentiment and hence more affected by the behavioral of unsophisticated investors.