The Implied Volatility Smirk Of Individual Option In S&P 500 Shows Its Underlying Asset's Return

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Idea Behind The Strategy

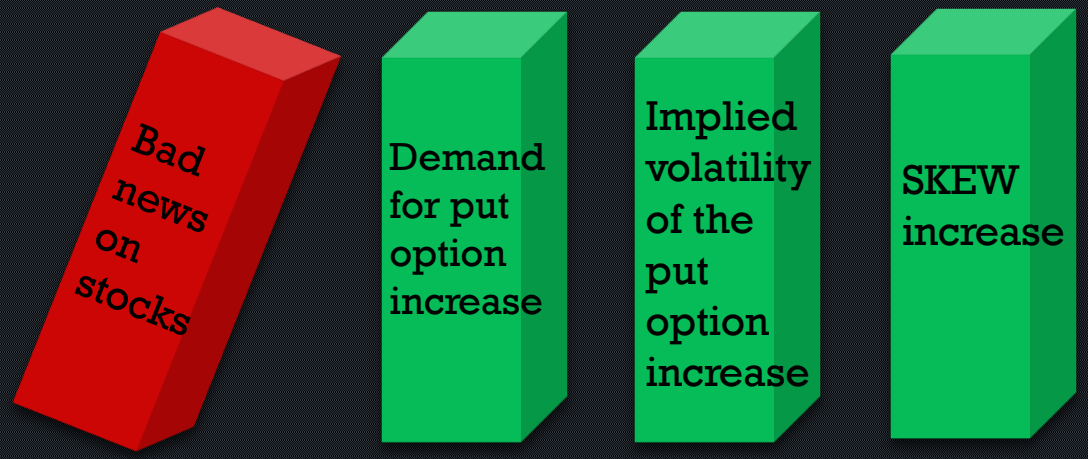
Garlean, Pedersen and Poteshman(2007) find demand of index option is positively related to option expensiveness measured by implied volatility, which consequently affects the steepness of the implied volatility skew, which is defined by the different between implied volatility of puts and calls .

If there is an overwhelming pessimistic perception of the stock, investors would tend to buy put options either for protection against future stock price drops(hedge purpose) or for a high potential return on the long put positions(speculative purpose). If there are more investors wiling to long the put than those wiling to short the put, both the price and implied volatility of the put would increase, reflecting higher demand and it leads to a steeper volatility skew.

In general, high buying pressure for puts and steep volatility skew are associated with bad news about future stock prices. Empirically, we can use out-of-money(OTM) puts to capture the severity of the bad news. When bad news is more severe, in terms of probability and magnitude, we expect stronger buying pressure on OTM puts and an increase in our SKEW variable.

This idea is based on Yuhuang, Xiao and Zhang's paper(What Does Individual Option Volatility Smirk Tell Us About Future Equity Returns).

Idea Summary



Define daily SKEW:

$$SKEW^{d} = IVOL^{OTMP} - IVOL^{AMTC}$$

(bench mark)

* IVOL : Implied volatility of an option recovered from Black-Scholes Model
*OTMP : out of money put option which $0.8 < K/S < 0.95$
*ATMC : at the money call option which $0.95 < K/S < 1.05$

Using implied volatility of ATM calls as the benchmark of implied volatility, because it is generally believed that ATM call are one of the most liquid options traded and should reflect investors' consensus of the firm's uncertainty.

Recover Implied Volatility From Black Scholes Model

The strategy focus stocks included in S&P 500 index, which mean those stocks' options are American Style, which is different from European Style options, the former ones can be executed before expiration. Black Scholes's model applies for European Style options. However we still can approximate the European option price using Black Scholes model, and most cases, they are very close. And we are able to recover the implied volatility from Black Scholes model. Therefore, we apply Black-Scholes Model to recover the implied volatility for those European style options.

Black Scholes Model:

$$C_{BS} = S_0 N(d_1) - K e^{-r\tau} N(d_2)$$

where $d_1 = \frac{ln\frac{S_0}{K} + \left(r + \frac{1}{2}\sigma^2\right)\tau}{\sigma\sqrt{\tau}}, d_2 = d_1 - \sigma\sqrt{t}.$

Newton-Raphson Method to recover Implied Volatility (IVOL)

$$\min \quad C(IVOL) - C_{BS}$$

Updating σ step (Vega): $S_0\sqrt{\tau}n(d_1)$

Portfolio Construction

Define weekly SKEW:

$$\mathrm{SKEW}^{\mathrm{w}} = \frac{1}{6} \sum_{\mathrm{d=Tuesday}}^{\mathrm{Tuesday+1w}} \mathrm{SKEW}^{\mathrm{d}}$$

Which means it is calculated by averaging daily SKEW over a week (Tuesday close to Tuesday close)

Portfolio Construction:

I. Recover implied volatilities for options whose underlying assets are in current S&P 500 list
II. Calculate the daily SKEW for each option.
III. Sorting the stocks based on the weekly SKEW, from smallest to biggest. Portfolio 1 include 20% of stocks with the lowest weekly SKEW, Portfolio 5 include the highest 20%.

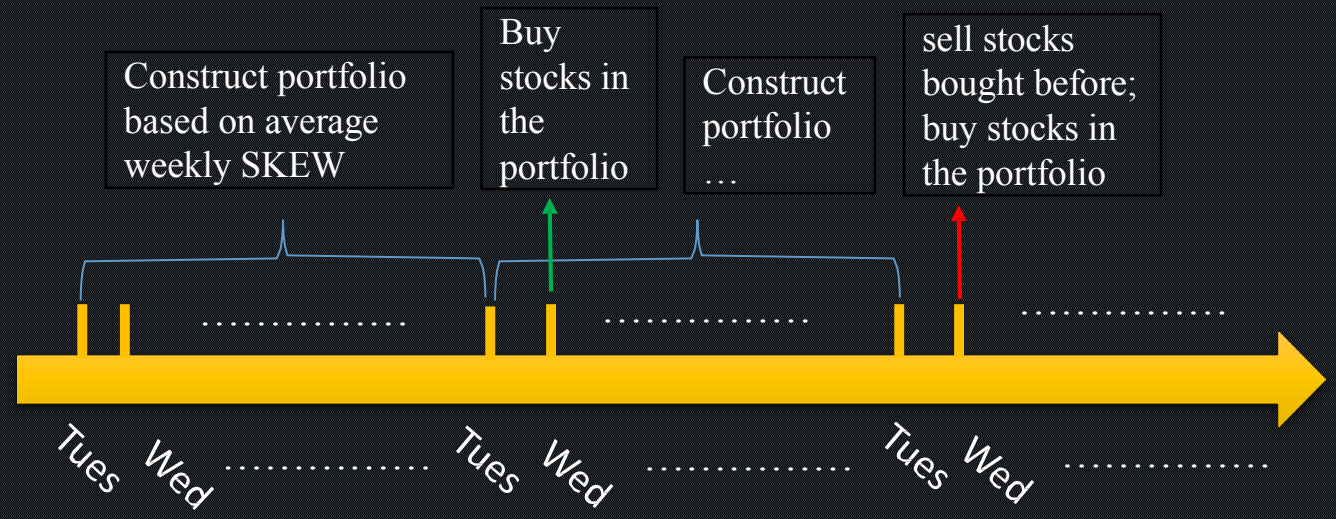
Trading Strategy and Time Line

Trading (Short stocks not allowed case):

Long the stocks in portfolio 1 on the following Wednesday, sell all the stocks on Wednesday next week. Continue (construct portfolio 1, buy stocks in portfolio 1, sell ……)

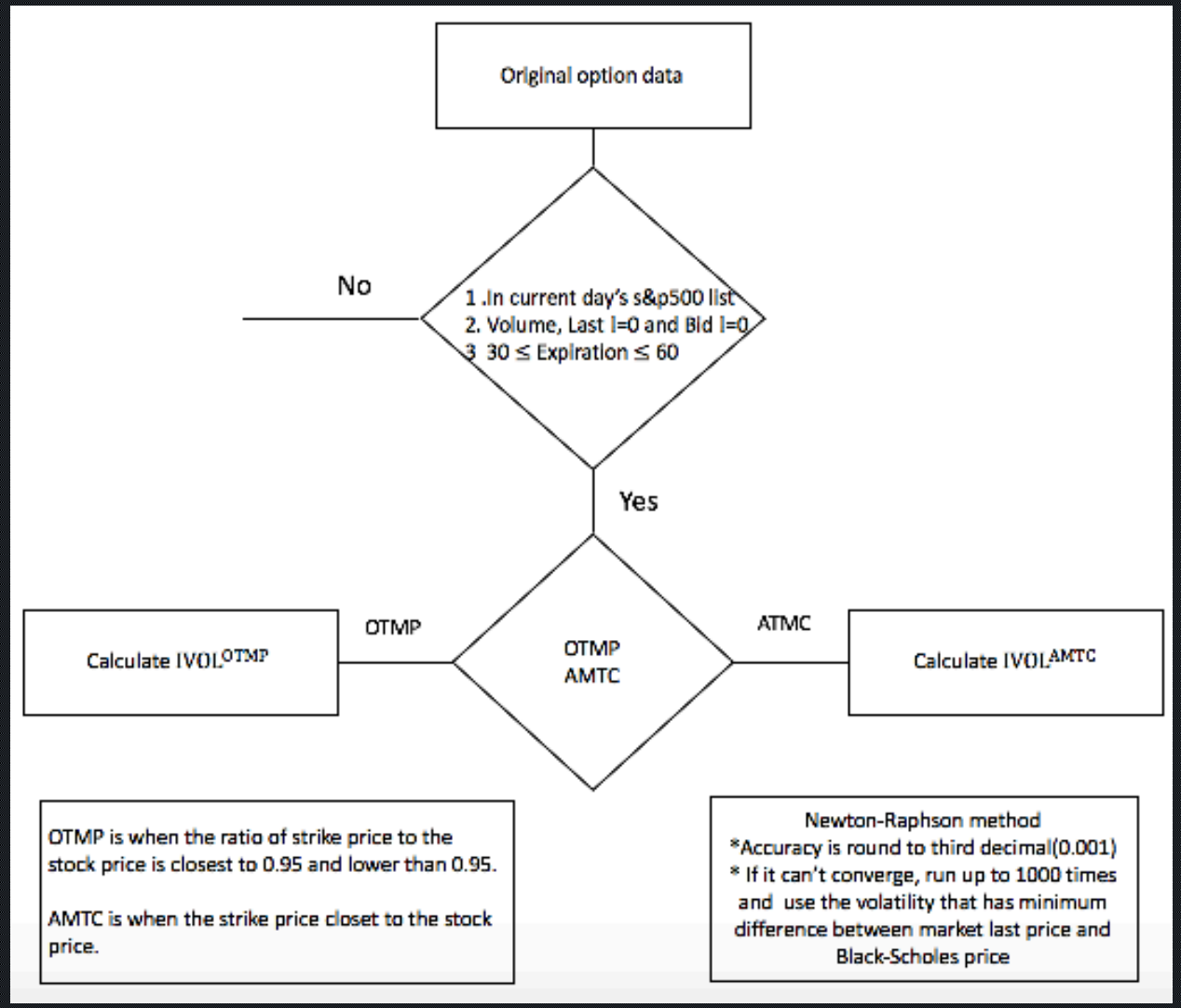
Initial account 10 million, investment ratio is 100%

Time Process



Programming and Algorithm

I. Calculate the $IVOL^{OTMP}$ and $IVOL^{AMTC}$ for each stocks in S&P 500



Programming and Algorithm

II. Sample result of recovering IVOL from Black-Scholes model (Aug 11, 2015)

	Underlying Symbol	Type	Underlying Price	Strike	ExpirDay	MidPrice	BSPrice	IVOL
0	A	call	39.42	40	0.027397	0.725	0.725	0.373223
1	AA	call	9.48	9.5	0.027397	0.25	0.25	0.41056
2	AA	put	9.48	9	0.027397	0.085	0.085136	0.42394
3	AAL	call	42.7	42.5	0.027397	1.245	1.245374	0.401673
4	AAL	put	42.7	40.5	0.027397	0.37	0.37065	0.422047
5	AAP	call	171.92	170	0.027397	6.55	6.550001	0.485805
6	AAP	put	171.92	160	0.027397	1.55	1.550245	0.514509
7	AAPL	call	113.5499	114	0.027397	2.515	2.515143	0.359872
8	AAPL	put	113.5499	107	0.027397	0.865	0.865002	0.42841
9	ABBV	call	68.25	68	0.027397	1.175	1.175355	0.227696
10	ABBV	put	68.25	64	0.065753	0.35	0.35007	0.253435
11	ABC	call	104.51	105	0.027397	1.125	1.125	0.192087
12	ABC	put	104.51	90	0.10411	0.15	0.15012	0.273845
13	ABT	call	50.39	50	0.027397	0.85	0.850001	0.186473
14	ABT	put	50.39	47	0.027397	0.045	0.045128	0.260023
…	…	…	…	…	…	…	…	…

Programming and Algorithm

III. Sample result of daily SKEW (Aug 11, 2015)

	Symbol	Underlying Price	SKEW
0	AA	9.48	0.01338
1	AAL	42.7	0.020374
2	AAP	171.92	0.028705
3	AAPL	113.5499	0.068539
4	ABBV	68.25	0.025739
5	ABC	104.51	0.081758
6	ABT	50.39	0.07355
7	ACN	103.58	0.063303
…	…	…	…

Programming and Algorithm

IV. Sample result of weekly SKEW (Aug 11, 2015 – Aug 18, 2015)

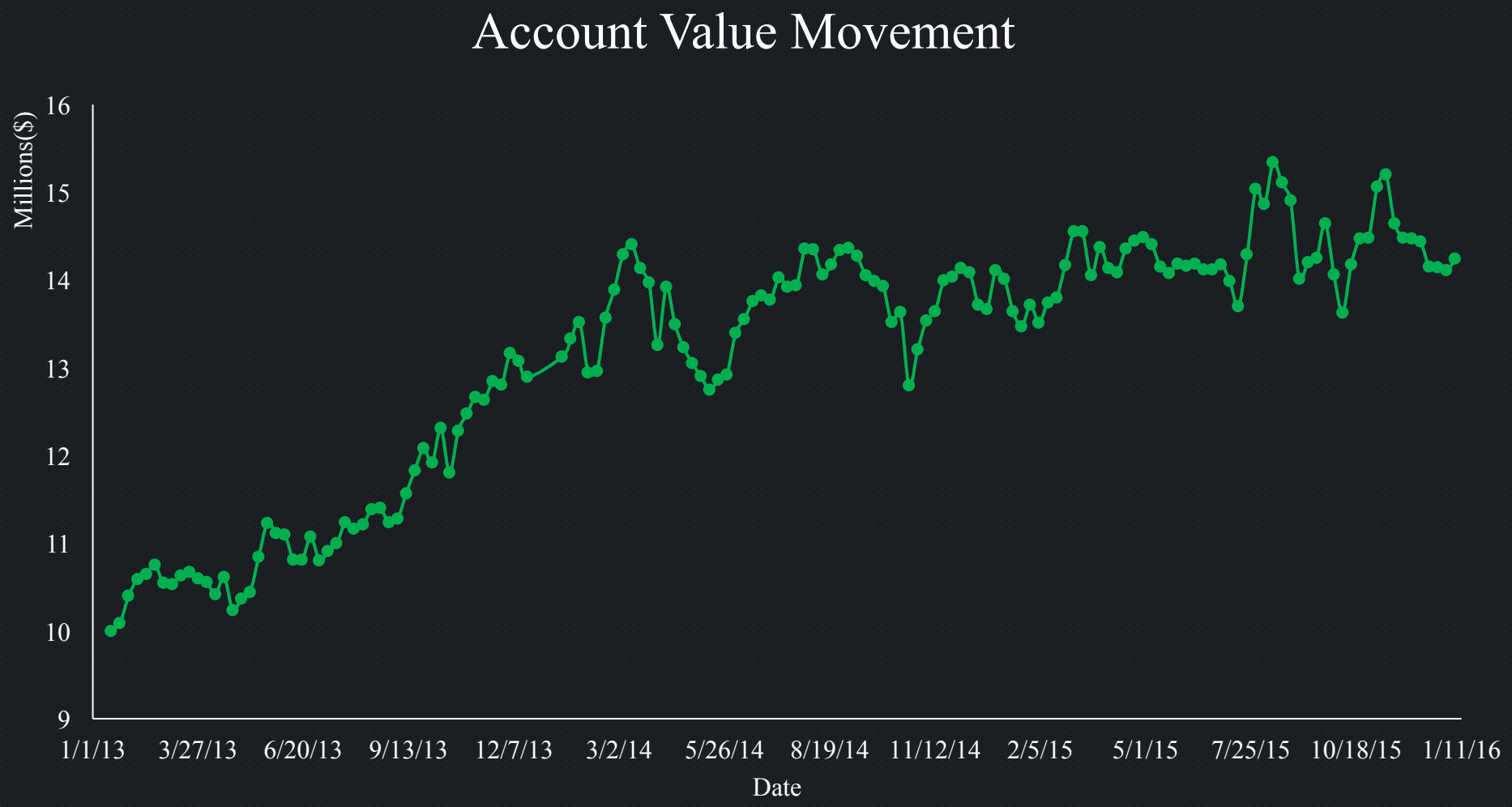
	Symbol	Tuesday	SKEW1	Wednesday	SKEW2	Thursday	SKEW3	Friday	SKEW4	Monday	SKEW5	Tuesday	SKEW6	Average SKEW
0	CRM	71.04	0.1510	71.4	-0.1447	72.99	-0.0841	74.04	0.0119	72.58	0.0036	71.63	0.0094	-0.009
1	WMT	72.58	-0.0062	72.11	-0.0296	72.38	-0.0127	71.91	0.0076	69.48	0.0475	71.93	0.0126	0.003
2	MU	18.19	-0.0056	17.7	0.0082	16.933	-0.0386	17.22	0.0286	16.39	0.0267	17.88	0.0291	0.008
3	HPQ	29.1	-0.0053	28.45	0.0142	28.71	-0.0142	28.61	0.0231	28.39	0.0202	29.32	0.0161	0.009
4	EOG	79.93	-0.1224	79.68	0.0337	79.93	0.0357	80.01	0.0415	80.41	0.0413	77.3	0.0316	0.010
5	DG	78.24	0.0827	79.19	-0.0139	79.23	-0.0365	79.4	-0.0121	80.09	-0.0606	78.71	0.1083	0.011
6	GME	45.62	0.0748	46.1	-0.0297	47.44	-0.0294	46.95	0.0781	46.99	0.0916	45.72	-0.1173	0.011
7	SPLS	14.16	0.0716	14.08	0.0373	14.23	0.0841	14.23	-0.0351	14.15	0.0205	14.12	-0.0795	0.016
8	PCLN	1294.71	0.0015	1286	0.0087	1283.8	0.0275	1306.56	0.0246	1291.83	0.0306	1307.73	0.0192	0.019
9	EMC	26.38	0.0178	26.37	-0.0016	26.62	0.0165	26.95	0.0374	26.42	0.0155	26.49	0.0275	0.019
10	GMCR	52.89	0.0138	50.28	0.0149	50.6	0.0099	50.94	0.0332	50.24	0.0193	52.96	0.0271	0.0197
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…

Result Summary and Analysis

Year	Initial Account($)	Maximum Loss	Final Account($)	Return(%)
2013	100,000,000	-4.146%	13,126,760.83	31.27%
2014	100,000,000	-8.007%	10,886,916.01	8.87%
2015	100,000,000	-8.192%	10,224,756.09	2.25%

* Short stocks is not included

Simulated Money Account



*Initial money account value is 10 million, test date is from Jan 19, 2013 to Dec 30, 2015. totally return is 37.22%

Thank You!