Indian Institute of Management Kozhikode

Case Study

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Performance of performance measures for a derivatives portfolio (A)

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Case Study– Teaching note

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1) Sharpe Ratio (SR) of an investment is given by

$$\frac{E(R_A) - R_f}{\sigma(R_A)},$$

where the numerator is the expected excess return of the investment over the risk-free rate and the denominator is the total risk of the investment, as measured by the standard deviation of its returns. Portfolio theory predicts that investor can expect higher returns, if they take higher systematic risk, and not total risk. Systematic risk aka undiversifiable risk is commonly measured using β, which is defined as,

$$\beta = \frac{Cov(R_A\,, R_M)}{Var(R_M)},$$

where the numerator is the covariance between our investment and a broad market index, while the denominator is the variance of the returns of the same index.

The alternative measure obtained by replacing $\sigma(R_A)$ in SR with β_A is known as the Treynor Ratio (TR). Whether Mr.Sharma should use SR or TR for evaluating an investment should depend on whether this investment is going to be part of a bigger portfolio with many other risky assets (in which case he should use TR) or this is going to be his only risky investment. If it is going to be the latter, then he should compute the SR as accurately as possible and use this investment if the SR turns out to be more than 1. On the other hand if the SR is less than 1, then a passive investing in the market index might be better for Mr.Sharma than the investment under consideration.

2) Before we decide on whether SR can be manipulated by adding options to the portfolio, we can look at the definition of 'manipulation'. One of the key criterion for a measure to be manipulation-free is the following:[2]

> **An uninformed investor cannot expect to enhance this measure by deviating from the benchmark investment.**

In other words, if a fund manager can increase the performance measure by simply adding some options to the portfolio, which is not based on any value related information on the underlying asset, then the measure is said to be manipulable. No special skills are needed on the part of the fund manager for such an enhancement.

Now does the SR pass this test of robustness against manipulation?
We will perform a simple experiment to answer this. Consider a portfolio that consists of a single blue chip stock. Now without having any information on the future performance of this stock, consider adding a short out-of-the money call option on this stock. To make the exposition simple, let us assume that the expiry of the option coincides with the investment horizon of this investor. This is the popular covered call strategy. The addition of a short call option has two consequences on the portfolio. First there is an additional cash inflow in the form of option

[2] Goetzmann et.al. (2007), Portfolio Performance Manipulation and Manipulation-proof Performance Measures, Review of Financial Studies.

premium received and there could be a possible reduction in the final return if the option ends in the money.

How these two changes affect the SR is illustrated through the Table 1, which compares the monthly returns of the original portfolio and the covered call portfolio. One month call options on the stock are sold at the beginning of every month with a strike equal to 6% above the stock price at that point (deep OTM options).

Table 1

Month	Closing stock price	Return	OTM Call premium	Returns of covered call		
1	32968.7		188.3			
2	35160.4	6.65%	200.8	6.61%		
3	35322.4	0.46%	201.7	1.04%		
4	35423.5	0.29%	202.3	0.86%	Imp vol	0.2
5	37606.6	6.16%	214.7	6.61%	K/S0	1.06
6	38645.1	2.76%	220.7	3.35%	T	0.0833
7	36227.1	-6.26%	206.9	-5.72%	rf	0.06
8	34442.1	-4.93%	196.7	-4.38%		
9	36194.3	5.09%	206.7	5.69%		
10	36068.3	-0.35%	206.0	0.22%		
11	36256.7	0.52%	207.0	1.10%		
12	35867.4	-1.07%	204.8	-0.51%		
13	38672.9	7.82%	220.8	6.61%		
14	39031.6	0.93%	222.9	1.51%		
15	39714.2	1.75%	226.8	2.33%		
16	39394.6	-0.80%	225.0	-0.23%		
17	37481.1	-4.86%	214.0	-4.31%		
18	37332.8	-0.40%	213.2	0.18%		
19	38667.3	3.57%	220.8	4.17%		
20	40129.1	3.78%	229.1	4.38%		
21	40793.8	1.66%	232.9	2.24%		
22	41253.7	1.13%	235.6	1.71%		
23	40723.5	-1.29%	232.5	-0.72%		
	risk-free	**6.00%**		**6.00%**		
	stdev	**12.6%**		**12.0%**		
	Exp ret	**12.3%**		**17.9%**		
	SR	**0.501**		**0.987**		
	Beta	**1.0**		**0.90**		
	TR	**0.063**		**0.131**		
	Alpha	**0%**		**6.1%**		

The returns for the covered call portfolio is calculated as,

$$\frac{\min(S_1, K) - S_0 + P_0}{S_0 - P_0},$$

where S_0 and S_1 are the stock prices at the beginning of this month and the next month respectively, K is the strike price of the one month call option and P_0 is the premium received for selling this option. The truncation in returns happen when $S_1 > K$. Call option premiums are obtained using the Black-Scholes model with parameters given in the table.

The expected returns and the standard deviations given in the table are annualized numbers. What we see here is that because of the shift (not necessarily a linear shift) and truncation in returns, there is a reduction in the volatility of covered call returns while the expected return has gone up. This has resulted in an almost 100% increase in the Sharpe ratio and all this is due to an "information-less" option strategy. This answers Mr.Sharma's second question.

3) We will next examine the effect of this simple option strategy on TR. In general, if we take two positively correlated variables and winsorize one of them (like it happens for the covered call returns), then in most cases the correlation between the two variables go down. A similar effect can also be seen on the beta.

We see this in our example dataset, where we have taken the stock itself as a proxy for the market, so that it has a beta of 1. The beta for the covered call has dropped as expected and thus once again leading to an 100% increase in TR.

4) Jensen's alpha is the vertical distance of an investment from the security market line (SML). If the expected return of an investment goes up and its beta comes down, then this investment will move north-west in the SML diagram, thus resulting in an increased alpha. Our example confirms this. Thus all the three traditional measures of performance can be enhanced most of the time using a simple covered call strategy.

5) The U-P ratio is an attractive alternative proposed to measure performance when return distributions are skewed. It is defined as the ratio of upper potential and the lower standard deviation. To compute the upper potential, only the returns in excess of risk-free rate are used whereas the returns below the risk-free rate are taken as zero excess returns. The average of these modified excess returns gives us the upper potential, which goes in the numerator of the U-P ratio. This average captures both the magnitude and the frequency of the average return in excess of the risk-free rate. Hence the name "upper potential". Sometimes it is also used with the risk-free rate replaced by other benchmark rates.

The denominator of the U-P ratio is the lower standard deviation (LSD), which is sometimes also known as partial standard deviation. First the lower variance is computed by taking the average of squared deviations from the risk-free rate of only those returns that are below the risk-free rate. The LSD is just the square root of this lower variance. This modified risk measure is supposed to capture any skewness that is present in the return distribution and is often used as a measure of downside risk.

The U-P ratio is used by investors to identify investments with higher upside potential (above the risk-free rate) with minimal downside risk.

6) We test the U-P ratio on the covered call strategy. Our stock has an average upper potential of 1.6% above the risk-free rate, as seen in the table below. A shift and truncation in the higher returns, can in general bring down the LSD (since returns below the risk-free rate move closer to the risk-free rate). The effect on upper potential can be both ways. In this particular example, we see that the LSD has indeed come down a bit while the upper potential has increased. Together this has led to a 30% increase in the U-P ratio.

Table 2

Month	Stock Return	upside potential	lower deviation	Returns of covered call	upside potential	lower deviation
1						
2	6.65%	6.15%	0	6.61%	6.11%	0
3	0.46%	0.00%	1.54E-07	1.04%	0.54%	0
4	0.29%	0.00%	4.57E-06	0.86%	0.36%	0
5	6.16%	5.66%	0	6.61%	6.11%	0
6	2.76%	2.26%	0	3.35%	2.85%	0
7	-6.26%	0.00%	0.004565	-5.72%	0.00%	0.003867
8	-4.93%	0.00%	0.002946	-4.38%	0.00%	0.002383
9	5.09%	4.59%	0	5.69%	5.19%	0
10	-0.35%	0.00%	7.19E-05	0.22%	0.00%	7.6E-06
11	0.52%	0.02%	0	1.10%	0.60%	0
12	-1.07%	0.00%	0.000248	-0.51%	0.00%	0.000101
13	7.82%	7.32%	0	6.61%	6.11%	0
14	0.93%	0.43%	0	1.51%	1.01%	0
15	1.75%	1.25%	0	2.33%	1.83%	0
16	-0.80%	0.00%	0.00017	-0.23%	0.00%	5.4E-05
17	-4.86%	0.00%	0.00287	-4.31%	0.00%	0.002314
18	-0.40%	0.00%	8.02E-05	0.18%	0.00%	1.05E-05
19	3.57%	3.07%	0	4.17%	3.67%	0
20	3.78%	3.28%	0	4.38%	3.88%	0
21	1.66%	1.16%	0	2.24%	1.74%	0
22	1.13%	0.63%	0	1.71%	1.21%	0
23	-1.29%	0.00%	0.000319	-0.72%	0.00%	0.000148
		avg up	**1.63%**			**1.87%**
		lsd	**2.3%**			**2.0%**
		up ratio	**0.72**			**0.93**

Thus, though U-P ratio, unlike SR, could be used for skewed return distributions, it can still be enhanced by “information-less” option strategies. So Mr.Sharma’s search for a simple manipulation-proof measure continues…