Quantitative Method of Risk Evaluation and Performance Monitoring for systematic trading strategies

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Abstract: This article outlines fundamentals of risk and performance measurements for systematic trading strategies. The problem is that the standard methods of performance evaluation are not sufficient for high-frequency trading strategies with asymmetrical non-Normal law returns distribution. Article provides insight into *QRatio* (QR) as a new performance measure for systematic trading strategies. The implementation of the method for risk evaluation and performance monitoring in the real trading environment has been discussed.

1. Introduction

It is well known that the performance of any investment cannot be measured by reward or equity change only, but must include evaluation of the risk. The evaluation of the risks based on return standard deviation [1] is not sufficient because: a) it does not provide meaningful information about the performance of systematic trading strategies with higher frequency of execution and absolute reward; b) it is not intuitive for practitioners whose preference is to measure risk in terms of losses in dollars.

Demand to design appropriate risk-management vehicle initiates innovative developments in the field of risk evaluation. The aim of the article is to describe a risk management method appropriate for systematic trading strategies. The method was created because of the need to have a proper tool to evaluate risk and monitor performance of the systematic trading strategies. The key features of systematic trading strategies are: formal rules based on technical analysis, possibility of back and forward testing and high frequency execution [2].

The implementation of the above method in risk management approach and the monitoring system is also discussed.

2. Risk and Performance Fundamentals

Most systematic trading strategies have asymmetrical non-Normal reward distribution. That's why we cannot rely on the traditional risk metrics approaches to measure and control risks and monitor performance. Traditional risk metrics such as the Sharpe-ratio [1] is siutable for Normal distribution as far as they take into account the first two statistical moments (mean and standard deviation). We propose new equation to evaluate aggregated risk involved into systematic trading strategy execution. The aggregated risk includes three types of specific risks: Position Risk, DrawDown and Exposure.

1. Position Risk is a max loss that occurs on one separate position/trade (for example, this loss can be triggered by stop-loss order).
2. DrawDown is a max loss that occurs during series (sequencies) of losing position.
3. Exposure is a max unrealized P&L that could be observed during the evaluation/reporting period.

To measure the aggregated risk we have introduced a new aggregated risk measure which we call *QRisk*. The parameter *QRisk* has been defined as

$$QRisk = 1 - \exp\{-(w_1 \cdot R_1^2 + w_2 \cdot R_2^2 + w_3 \cdot R_3^2)\}, \quad (1)$$

where R_1 is Position Risk - the maximum realized loss on one position, R_2 is DrawDown – maximum loss from the set of consecutive losing positions, R_3 is Max Exposure –maximum unrealized loss of portfolio of open positions; w_1, w_2 and w_3 are weights. All *R*'s are measured in percentages of the total trading capital and numerical values of *R*'s are collected during execution of a strategy. Weights, w_1, w_2 and w_3 are dependent on specific trading strategy and evaluated based on

back testing data in time of development. Equation (1) captures main fundamental features of trading risks involved in systematic trading. It is easy to see that Eq.(1) incorporates the non-linear dependency on all above listed risks.

To measure the overall trading performance for the certain period (day, week, mounth), we evaluate the *QRatio*

$$QRatio = \frac{Reward}{QRisk}, \tag{2}$$

where *Reward* is average return for *N* time-intervals with return r_i per interval,

$$Reward = \frac{1}{N}\sum_{i=1}^{N} r_i, \tag{3}$$

and *QRisk* is given by Eq.(1).

In contrast to the well known industry standards (such as the Sharpe ratio [1]) the *QRatio* includes the parameter *QRisk* in the denominator

3. Risk Reward Frontier

The basis for analysis is extensive statistical trade data of back testing or real trades' data for the N periods of time. This is the raw modelling data for Quant Method, based on which we find out each component of the risk in Eq.(1) and calculate *QRisk*.

Based on these raw data we are able to create a table that defines the relationship between the Risk/Reward and the trading size for specific trading strategy that we research, see Table 1.

Reward %	QRisk %	Trading Size Units
10.5	0.006	S_1
12	0.01	S_2
13	0.015	S_3
15	0.023	S_4
22.5	0.118	S_5
30	0.373	S_6
37.4	0.9	S_7
45	1.875	S_8
52.4	3.45	S_9
60	5.8	S_{10}
67.4	9.14	S_{11}
74.87	13.59	S_{12}
81.6	19.26	S_{13}
88.2	24.7	S_{14}
97.34	34	S_{15}
105	43	S_{16}
112.3	52.27	S_{17}
120	61.6	S_{18}
127.3	70.5	S_{19}
135	78.4	S_{20}
142	85	S_{21}
150	90	S_{22}
165	96.7	S_{23}
179.7	99.2	S_{24}
195	99.87	S_{25}
209.65	99.987	S_{26}
225	99.999	S_{27}

Table 1.

Next step of our data elaboration is creation of the Risk/Reward Frontier (RRF). The RRF allows us to choose optimal trading size based on Risk/Reward investment preferences and monitor performance of the trading strategy.

To develop RRF we use Table 1, which presents Reward and Risk depending on trading size S_k. Once Table 1 is built, it becomes a foundation for selecting trading size appropriate for a given strategy. This is the key feature of money management rules. The value of the trading size S_k depends on the specific trading strategy and an investor's personal risk/reward preferences.

The RRF according to the Table 1 is depicted in Fig.1.

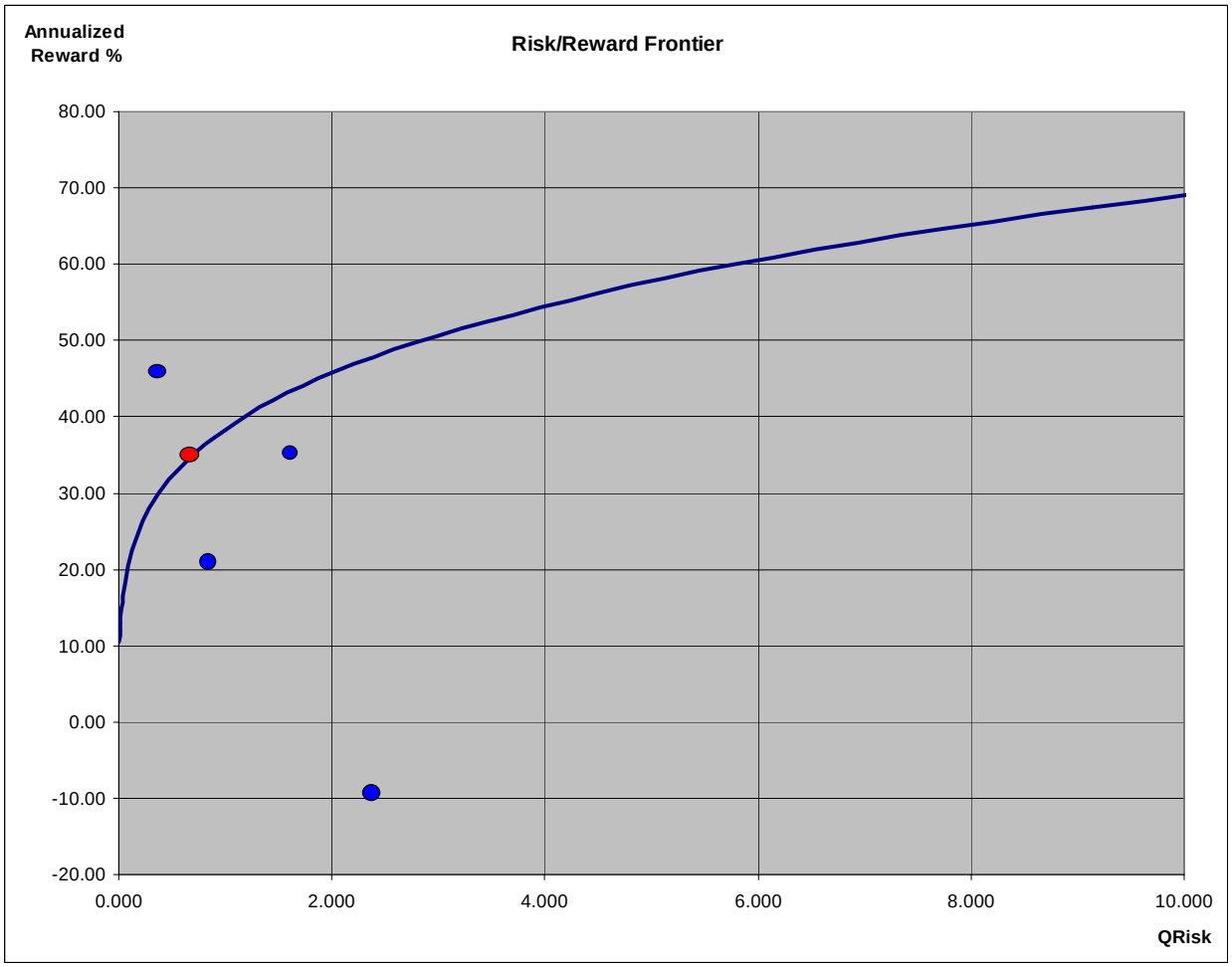

Fig. 1

The red dot on the chart represents example of the Reward to Risk ratio chosen for particular investment style. This is kind of an ideal expectation for a trading strategy. In this case trader finds an appropriate trading size based on chosen *QRisk* = 0.9% and *Reward* = 37.4%. The size in this case is S_7 from Table 1.

To measure performance we have to calibrate weights, w_1, w_2 and w_3 based on trading data for specific trading strategy. Then performance monitoring is a process to compare real trading result (*Reward* and *QRisk*) with RRF for the given time-period. The blue dots on Fig. 1 represent performance of a strategy for three trading periods. Risk manager can define acceptable risk-zones within RRF. For instance, the blue dot above frontier will represent the outperformed trading period, and below is the underperformed.

Conclusions and outlook

We have presented a methodology to evaluate the aggregated risk by calculating the parameter *QRisk*. defined by Eq.(1). A new performance measure has been introduced by Eq.(2) as the ratio of average return to the *QRisk* for given time period. The dependence between Reward and *QRisk* has been displayed by the Risk Reward Frontier, which provides visualization of trading performance. We use RRF to compare performance achieved in real trading (blue dots on the Fig. 1) with expected/ideal performance (red dot on the Fig.1).
This method is a tool to build a proper money management rules in time of strategy development and allows to control risk and monitor performance in real time.
The methodology presents fundamentals to develop and implement risk measurement and performance monitoring system well adapted for systematic and high-frequency trading strategies.

References

1. W. Sharpe, *The Sharpe ratio*, Journal of Portfolio Management, vol. 21, no. 1, 1994, pp. 49-58.
2. R. Pardo, *The Evaluation and Optimization of Trading Strategies*, 2nd Edition, Wiley, 2008.