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Risk Management For Intelligent Trading Portfolios

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Part II

Risk Management for Computerized Trading Models

Contents

1. Introduction

While part I of this series concentrated on demonstrating how changes in position size and risk exposure effect portfolio performance, part II focuses on how to translate the desired risk exposure into position size. Specifically we will be looking at methods to calculate position size in order to maintain constant risk exposure during the lifetime of an open position. We will use the insight gained in this part to determine trading system design issues and in the concluding part III of the series to evaluate different performance results with or without risk management when implemented in conventional and artificial intelligence based trading systems.

While this part is titled "Risk Management for Computerized Trading Models", much of what is described here should be useful for any trader, irrespective of the method he or she is using to create trading or investment decision.

2. Risk From The Trader's Perspective

In the previous part of this paper we have referred to risk generally as a percentage value of the portfolio being at risk (hence the term "value at risk" or VaR). Whilst this is an important and extremely useful generalization (it allows us to compare and aggregate risk of different instruments and positions on equal basis), it will not necessarily provide all measurement we need for making trading decisions. The risk dimension of a trading decision (as described in part I) consists of two aspects:

- Price Risk
- Position Size

If we are to measure the risk we enter into in a trading position, we will multiply the per-unit price risk with the position size (i.e. number of units) we are trading. If we are to maintain a certain level of the portfolio at risk (or limit the exposure to a certain level), we will have to divide the appropriate portfolio risk by the price risk, which returns the appropriate size of our position. VaR (or simpler price risk measurements such as volatility) will assume price risk to be an external variable which we have no control of, so that we can only modify position size in response. This is a valid approach for an a-posteriori analysis of risk, but we have a higher degree of freedom when making trading decisions.

From a trading method point of view, price risk is determined by two variables:
- Price volatility (volatility of asset returns)
- Distance between actual market price and planned worst-case exit price (stop-loss)

For example, a fund manager buying the GBP/US$ exchange rate at 1.6500 decides that if the price drops to 1.6300 he will exit the position since he decided that his original assumption would be invalidated by such an event. Hence, his price risk in the position is defined (a) by the volatility of prices when applying VaR analysis and (b) his decision to accept a loss of 200 basis points before closing out the position (plus any transaction costs). Whatever greater of these two is the primary source of risk.

Since in most circumstances the trader will place his stop-loss level outside the near-term price volatility range ("the noise"), price risk will almost always be primarily determined by the trading decision and the assumed stop-loss level, and not by price (return) volatility. Using volatility of returns as price risk measurement is therefore a proxy for risk in those situations where we do not have information on the trading strategy itself. It also becomes clear now, why systematic, i.e. computerized, trading models lend themselves much better to risk

management, because we have more information available on the way how trading decision are being made.

In formulating a trading strategy we therefore can assume an a-priori concept of price risk, where we can base our risk strategy on the amount of risk that we assume to take, not based on price volatility alone (as our risk decision will incorporate this information). This concept allows us to define a much more precise and useful risk estimate as part of our trading strategy.

In measuring risk traditionally, the type of trading strategy employed influences the price risk estimate only with regard to the time frame of investment. Generally, we assume that volatility grows with the square root of time. The longer our investment horizon, the higher the fluctuation of returns that we have to expect. This however is also related to returns.

In terms of standard deviations, each trader within his own time frame can expect an n-sigma event with the same probability [Peters94]. When defining a trading strategy however, this information can be an additional input into the calculation of our worst-case exit level (stop loss level) so that it is outside the expected noisy fluctuation, but during the lifetime of the open position the actual risk level will not depend on the type of price risk estimate we make using volatilities.

Does that mean that the VaR approach is not beneficial to defining risk management of trading strategy?

Value at Risk has been created as a measurement of risk across different types of instruments and different types of positions. That allows the manager of a trading desk, a department or indeed an entire firm, to define the risk exposure of the entire firm in one single, understandable number.

On that level, VaR is indeed used as a proxy for worst-case scenario formulation, i.e. as stop-loss level. With regard to each individual trader or position however, the VaR calculation will underestimate the risk the trader is prepared to take on an individual trade. If the trader is in a position to plan his strategy (i.e. define worst-case scenario exit points) than this provides a much better estimate of the actual risk taken (because any risk of executing the position not at the stop-loss level is due to other risk types, such as liquidity risk or even counterpart risk. See Part I for a comparison).

As mentioned already, this level of risk control is best achieved when integrating the risk control mechanism into the trading model itself; which is ideally a computerized, systematic trading strategy.

3. The Case For Trader's Risk Management

As it was already demonstrated in part I, the variation of position size as a result of risk management has a significant effect on portfolio performance. In fact, even if we attempt to keep a constant position size for each market we are looking to trade, it was shown that this would then result in an extreme fluctuation of risk, which we not only would not to be comfortable with in the real world, but would also limit our trading capability because the percentage return requires to recoup from a loss increases geometrically with the percentage loss (in other words, a 10% drawdown on our portfolio requires an 11.1% increase to recoup, 20% drawdown requires 25% …).

Real world limitations on trading portfolios (such as margin constraints, or regulatory constraints) will not allow us to increase our portfolio risk just to maintain the same trading size, hoping to win back any losses we might have incurred.

The trader must also be beware that the expected returns itself typically fluctuate widely. The simulated performance chart in part I, used to create the portfolio risk simulations, was

created using a standard random process with a defined probability of profits at 55%. Although many traders claim to exceed that level of profitability by a large margin, the most important issue from a risk management perspective is not how profitable our trading is over a given period, but how consistent our profitability is. In creating the simulated performance chart, each event was calculated with an a-priori probability of 55% profit. While in measuring historical probability of profitable returns, we can always find and define a number that describes the distribution of returns (and the a-posteriori probability of profit or loss) - but this number is not necessarily any guideline for future events.

If we believe that our measured profit probability is a correct predictor of the future, then we can only refer to this probability as being descriptive of the entire stream of profits/losses and not any single event! For example, a trader looks back at his trading track record of a single instrument (say, spot US$/DEM) and establishes that over the last 50 trades he made "on average" 30 basis points profit per trade and that his trading has a probability of being, say, 60% correct (to perform this calculation on a portfolio, we would simply aggregate all returns per instrument traded and use period returns (e.g. daily profits/losses) rather than per-trade returns and probabilities).

What conclusions can be drawn from this information once established? Many traders wrongly associate the average trading result (the expected return, the probability) with each individual trade. In other words, if the last 50 trades resulted in an expected return of 30 basis points (or 60% profitability), they believe that the very next trade will also come in at that probability of profit. In reality, the only statement that can be made, is that we can expect the average return of 30 basis points per trade, but again over another, next 50 trades. In other words, the probability tells us little about each individual trade, only about the whole. The predictive performance of a trader is a largely independent process (at least, this is the only assumption we can safely make).

In other words, if the trader guesses today's price movement right, this event does not influence whether tomorrow's prediction are right or wrong. Again, this does not mean, that on average the trader would not be profitable; it only means, that if we look at the very next trade we are going to make, we cannot rely on the probability of profits that we assumed from our previous performance. It is another, independent event, and the only save assumption we can make is that if we have no other means to establish the probability of profits, me must assume an exactly 50% chance of having a profitable event.

As it was demonstrated in [Vince92], the probability of the entire stream of profits or losses is entirely different from the probability of each exact sequence of events to occur. Assuming a stream of trades looking as follows: + - ++ -. This means that profits have a likelihood to occur at a rate of 5/3. But can we make a prediction on the next individual event? Assume the trade sequence is changed: --+++, or ++--+ or +++---, et c. Each of these individual (exact) sequences have the same probability to occur; IAW even when we can make an assumption on the entire stream, we cannot with the same probability assume the result of a particular event.

The reader will have noted that the previous paragraph made a difference between the average return in terms of value (the 30 basis points) as compared to the probability of profits or losses. In our real trading, we should actually be less concerned about our probability of having a profitable or losing trade - we should really be concerned about the amount of money that we lose or win on each trade.

We can quite well have a very bad predictive method in being "right or wrong" on market direction, but we will still do very well in performance terms if we can spot with our method those situations where the size of the profit exceeds the typical loss by a large margin. The opposite is also true: this is why it is so much easier to make predictions (and earning a living out of writing market newsletters and market research) than it is to make a profit in trading.

Based on what we discussed so far, we can state a very important principle: While the next trade must be considered an independent event in terms of probability of profit or loss, the size of the next trade's profit or loss is not independent - it is in a relationship with our

previous performance. What does that mean? How much money we can make today is partly determined by how much money we have available, i.e. how much money we have won or lost previously.

If we win in our trading strategy, we can trade larger or smaller, as our risk management will dictate. But if we lose, then we become increasingly limited in our trading and we will not be able to benefit from profitable trades in the way we actually might have anticipated. Formally, the relationship between the size of today's profit or loss and our portfolio size can be expressed using the formulae used in part I to describe fractional risk or see [Vince90, Vince92].

How can we use this information to improve risk management?

We have established that it is actually wrong to use a prediction of the next trade's profitability as a basis for determining the size of our position. We have also established that errors we make today in our judgement of position size can have a multiplicative effect over next periods or trades. Common sense would dictate that if we know our judgement on position size (and subsequently portfolio risk) can be wrong, be better err to the smaller sized risk because it will enable us to recoup faster from drawdowns that we from time to time experience. But how shall we calculate our position size? As was shown in part I, we will always trade at a certain level of fractional risk and we will always run the risk of being above our optimum level. The next chapter will introduce the reader to such a method that can easily be applied in either a systematic trading model or in any proprietary approach. The underlying concept is, that, if we cannot accurately predict our own performance, and as we cannot influence how the markets will behave, we should at least exercise control over those variables that we have actually control of. And that is the risk that we as traders take when entering a position.

4. Maintaining Constant Risk Exposure

Rather than describing the method we will show in abstract terms, it will be based on an example that can be easily translated to any other type of market, currency or position once the concept is established.

Let us assume the position that was described in a previous chapter, of a hedge fund manager. Say we believe that the British Pound will strengthen against the US Dollar, up from the current level of 1.6500 (US$ per Pound), believing that a downturn in UK economy and inflation will increase the real interest rate differential to the US Dollar and hence make Sterling investment more attractive We have allocated US$ 10 Mio of our portfolio to foreign exchange trading and we assume this will be the portfolio against which the risk of the position is being measured.

We also believe that a target rate of 1.6900 is realistic, and given market sentiment the rate should be well supported at 1.6400. We therefore decide to set a stop loss level at 1.6300, resulting in an anticipated return of 400 points vs. an initial risk of 200 points, which we can regard as an appropriate initial risk/return ratio.

But we are also required to make another decision on the trade. How does the risk we take in this position relate to the portfolio? If we traded only one currency pair, we could simply use the entire portfolio to buy US$ 10 Mio worth of British Pounds. Since our price risk of 200 basis points translates to cca 1.20%, we would automatically assume a portfolio risk of 1.20%. The problem with this approach is that it cannot easily applied to a portfolio of instruments, and it also does not give us the flexibility to increase positions when the price risk is low and we have to run larger positions because we would also otherwise not gain sufficiently. Also, sometimes we have to run larger price risk because of increased volatility in the markets.

It is therefore better to take a portfolio risk as a benchmark and work back the trading size through the equation. Say we allow ourselves to risk 1% of our portfolio on any given trade. Given the price risk that we assume and the portfolio risk that we decide as limit, we can now calculate the trade size that we pass on to our broker:

Portfolio Risk (1% of US$ 10 Mio) = US$ 100,000 to be put at risk for this position.

Per Unit Price risk is 200 basis points (0.0200 US$) - cca 1.21%.

Resulting Equivalent Exposure: US$ 100,000 / US$ 0.0200 = US$ 5 Mio

In order to match our price risk with our portfolio risk, we can therefore
buy US$5 Mio worth of British Pound against US$.

Although this calculation is very simple, it illustrates a very important concept: The price risk we assume can be estimated independently of the portfolio risk that we allow. If our trading strategy or market indicators require us to accept a higher per-unit price risk, we need not ask ourselves whether the strategy would be "too risky" for our portfolio. By putting the different price risk figure into the equation, we get the position size with which we are comfortably within our portfolio risk parameters.

But the real benefit with this method is not only how we can establish our initial position, but that it also provides us with a method to manage open position within the risk parameters we define for our portfolio and how it helps us to "smooth" our performance curve.

Let us assume that in fact we have been right with our decision and GBP/US$ trades the next day at the London open at 1.6650. When we perform a "mark-to-market", i.e. evaluate our open position at current market prices, we have an open profit of 150 basis points; when adding up the balances (calculation example shown below), we have added approximately US$ 45,000 to our portfolio as open profits.

But what else has changed? We still have our price risk level set at 1.6300, below the support at 1.6400 which be believed would be important. This has, however, almost doubled the price risk we estimate from 200 points to 350 - based on current levels. Say, we have reason to believe that after that strong move in the pound, the original support level of 1.6400 should actually not be touched again, because market support is now at around 1.6500, our original entry level. Will that affect the position we hold in the market?

Performing above calculation a second time, using updated parameters, it shows:

Portfolio Risk (1% of US$ 10 Mio + 45,000 Mark-To-Market profit) =
US$ 100,450 to be put at risk for this position.

New Per Unit Price risk is 250 basis points (0.0250 US$) - cca 1.50%.

Resulting Equivalent Exposure: US$ 100,450 / US$ 0.0250 = cca US$ 4 Mio

In order to match our price risk with our portfolio risk, we should hold a position of US$ 4 Mio in the Sterling, compared to the actual position we hold of US$ 5 Mio.

As a result, our risk management dictates that we Sell One Million US$ worth of British Pounds at 1.6650, realizing a part of the open profit in order to stay within our portfolio risk parameters.

As we can see, this method allows the trader to consistently evaluate the risk in the portfolio and to have a robust mathematical method to determine position size - independent of the trading strategy!

We can see that by managing the open position risk, we actually improve our performance consistency. As was discussed in the previous chapter and in part I, the consistency of

profitability is a more important contributor to higher performance than a higher actual level of profitability combined with highly fluctuating returns.

This method of managing position size has been successfully implemented by a number of American CTA's although it is rarely published and discussed - perhaps does it appear to simple?

The most important aspect of the managed position risk is that it must be applied consistently as often as a mark-to-market is performed. It has the added benefit that it can be very well used for a trend-following trading system because the trailing stop determines the price risk, but the risk management decides which fraction of the portfolio shall be maintained.

5. Risk Management in Systematic Trading Models

The constant risk exposure method can be applied to any trading strategy because it takes the price risk estimate as input from the trading strategy and matches the various risk constraints by calculating the variable that can be most easily adjusted by the trader - position size.

While this part of the series focuses on the risk management calculation rather than trading models (which is the next and concluding part), it is important to see that this risk management method lends itself very well to implementation in a computerized environment. Many trading systems have more difficulties in determining how to exit a trading position rather when to enter it. Traders who trade discretionary methods (such as charts or sentiment) often have a problem with "letting profits run and cutting losses short".

At Rabatin Investment Technology we have found that the importance of predictive patterns is grossly overestimated. Managing the risk and allocating between instruments has proven to be a far greater contributor to - at least non-losing - performance.

Systematic trading models allow the testing of parallel decision made in market prediction and risk management. The final part of this series will focus on these aspects.

6. Appendix

Calculating Foreign Exchange Profit/Loss

Our examples use the GBP/USD exchange rate, also commonly called "cable" by FX traders (because it was the first exchange rate traded parallel between two centres, i.e. London and New York, with prices transmitted via telegraphic cable). GBP/USD is quoted in US$ per one Pound Sterling.

When trading the GBP amount (i.e. buying or selling 5 Mio GBP), the resulting profit/loss would be calculated in US Dollars. For our purpose, we ask our hypothetical dealers to trade the US$ amount, since we want to match the traded amount with the portfolio currency (common practice with US CTA's trading foreign exchange).

The examples are shown below ("Credit" stands for currency bought and "Debit" stands for currency sold).

Initially we entered into the following position - Buying 5 Mio US$ worth of British Pounds:
Credit GBP 3,030,303.-- - Debit US$ 5,000,000.-- - Rate: 1.6500 (US$ per GBP)
The mark-to-market at 1.6650 resulted in the following account balances
Credit GBP 3,030,303.-- - now worth Credit US$ 5,045,454.--
Debit USD 5,000,000.-- (original position)

Net Position: Open Profit of US$ 45,454.-- (In Dollar terms)
When closing out US$ 1 Mio in open position due to our risk management requirement, we book
Credit USD 1,000,000.-- - Debit GBP 600,600.--
- At Rate: 1.6650 (US$ per GBP)
On the GBP amount (since we have to "give away fewer Pounds for each Dollar") ,so we have now made a profit of GBP 5,460.01, which translates to US$ 9,090.91, which is added as profit to our GBP balance.

7. References

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