Chapter 2 — Risk

The primary reason traders stop trading a system is that they experience a drawdown larger than they anticipated, larger than they can afford, larger than their risk tolerance.

To manage risk, we must first measure it.

We begin with some definitions. Then use the list of trades produced by specific test runs to illustrate how:

- Risk is measured and quantified.
- The distribution of risk is plotted.
- The highest safe position size, safe-f, is calculated.
- Results are normalized relative to risk.
- Risk-normalized profit potential, CAR25, is estimated.
- CAR25 is used to compare alternatives.

Definitions

We begin with a discussion of drawdown as a measure of risk, analysis of the visibility of intra-trade prices, and willingness to hold a position through a drawdown.
Drawdown Defined

Drawdown is defined as the drop in account equity, measured as a percentage relative to the highest equity achieved prior to the drawdown. Figure 2.1 shows two major drawdowns—one of 10% and one of 20%.

As Figure 2.2 illustrates, loss of equity into a drawdown is not symmetric with the gain required to recover from it. The gain needed to recover from a drawdown is greater than the loss that caused the drawdown.

Figure 2.2 also illustrates another view of drawdown—the time required to recover. Assuming a system has an expected annual growth of 15%, recovery from a 20% drawdown will take about 20 months.

It is one thing to look at a chart showing an historical record. Perhaps of a trading system, perhaps of a broad market index, perhaps of a country’s economy. The chart shows several deep drawdowns, each followed by recovery. The person imagines the final outcome and believes any current drawdown in a system, market, or economy will be followed by an equally full and pleasant recovery. It is both easy and patriotic to have faith in a recovery, but painful to personally experience the discomfort throughout the entire period. Every forecast should include consideration of how it might be different this time—or not different, as the case may be.
A system’s equity is either at a new high, or it is in a drawdown. Most systems are in drawdowns most of the time—70 to 90% of the time is not unusual.

Continuing to trade a system that is in a drawdown requires that you have confidence that:
1. The drawdown is within your risk tolerance.
2. Compared with the trading history and expected performance, the current drawdown is not unusually deep or long.
3. The system will recover to make a new equity high in a reasonable period of time.
4. The system is still the same. The trading opportunities still exist. The signal patterns programmed into the model still exist in the data and precede the trades. The system is healthy and in good synchronization.

**Holding Period Tolerance**

Assume you are trading a system, it has an open long position that was initiated from a Buy signal, and the price of your issue is falling.
Is there some level of drawdown in your account equity that would cause you to not take the next trade? Or, more seriously, that would cause you to exit the open trade without waiting for the system exit?

What is the period of time you are willing to hold through without taking a subjective action? Five minutes, one hour, one day, one week? Or is it independent of a specific period of time? Can you always wait until the system issues the exit?

**Trade Exits**

The answers depend in part on how your system exits trades. However a new position has been opened, there are five general ways to exit.

- Logic—trading system rules that issue a Sell signal.
- Maximum holding period, including inactivity.
- Profit target.
- Trailing exit.
- Maximum loss exit.

The system must have at least one of these, and it may have as many as all five. The exit prices may be set at entry and left unchanged for the entire trade, or they may be adjusted intra-trade.

One of the definitive aspects of using a quantitative system is that all of the rules are in the system. There are no external rules, either objective or subjective. When the system issues a Buy, a long position is taken, and it is held until the system issues a Sell.

In order to apply the pattern recognition, risk control, and position sizing techniques described in this book and my other materials, the answer to “what is the period of time you are willing to hold through?” must be “until the system issues the exit.” What does that imply?

Since drawdown can increase rapidly over a multi-day market decline, that period must be short enough that price changes, including drawdown, within it can be ignored. The system will always hold through a period at least this long. I recommend the period between potential changes to position be no longer than one trading day. (Any shorter period, such as hourly, will work equally well providing intra-day data with appropriate bar lengths are used. To avoid awkward sentence construction, please interpret “daily” to mean “daily or more frequently” unless otherwise stated.)

Establishing the basic period as daily does not restrict entry and/or exit from occurring intra-day. End-of-day traders are able to use limit and stop orders to enter or exit at an intra-day price. However, with bars of any length, the inability to resolve intra-bar price action limits the number of potential trades in a single bar to the open, the close, and at most one intra-bar trade.
Manage Weekly?

If you are considering managing less frequently than daily, consider the following scenario.

You are managing weekly—updating data and checking for new signals over the weekend for possible action on Monday. Your risk tolerance is a maximum drawdown of 20%.

Today is Wednesday. The system entered the week with a 15% drawdown. The past three days have been volatile, the drawdown is now 23%, and indications are for a further price drop.

Having rules in place that you will wait for the system to signal the exit is causing some anxiety. Prudence suggests you should exit the trade. Of course, you have the ability to override the rules and enter the sell order. But augmenting the rule-based system with discretionary actions, no matter how or why they were taken, distorts the analysis of risk.

Futures traders have to consider another actor—the broker, margin clerk, and clearing agency. They will close your position as soon as their capital is at risk. Usually waiting until the close of trading, but inquire to be certain.

My point is that managing a trading account less frequently than daily may increase risk in ways that were not anticipated.

Maximum Adverse Excursion (MAE)

Maximum adverse excursion is a measure of the most unfavorable point in a trade, or in a period of time. MAE can be expressed as a positive number or negative; in points, dollars, or percentage. By convention we will express MAE as a positive number, and in whatever unit is appropriate. We want MAE to be small.

MAE is a measure of the risk we acknowledge.
For clarity, I refer to a bar as a day. The analysis and discussion applies equally well to bars of any length, and also to trades treated as bars.

Maximum Favorable Excursion (MFE)

Similar to MAE, maximum favorable excursion records the most favorable price. In a long trade, it is the highest high. When using mark-to-market, whenever there is a new MFE and it establishes a new high for the account equity, adjust the equity to reflect that gain.

If you subscribe to the idea that there are two absorbing boundaries—success and failure—a new maximum equity may cause you to stop trading because you have gained enough.
Accumulated MAE (AMAE)

Every trade has its own MAE, computed and reported daily. The accumulated drawdown spans trades and measures the highest marked-to-market bankable equity to lowest marked-to-market equity. AMAE is the drawdown we use to measure risk.

Your goal in trading the system is to determine the proper maximum safe position size, on a trade-by-trade basis, so that the AMAE rarely exceeds your risk tolerance.

Bad Stuff Can Happen

In spite of your best system development efforts, there might be—probably will be—situations where a larger loss than the system—or you—anticipated occurred, but there are still open trades.

Management and measurement should coincide.

If it is necessary to do so, your action to declare the system broken, override the rules, exit open positions, and take the system offline should coincide with a point in time or in the trade where drawdown is measured. That is the point at which trades are marked-to-market.

If the intra-day drawdown is too severe, use shorter bars and mark-to-market after each bar. Or choose a less volatile issue to trade.

Your measurement period must agree with your management period.

Does intra-trade drawdown matter?

Yes. Consider the Will Rogers system.

\begin{quote}
Don’t gamble; take all your savings and buy some good stock and hold it till it goes up, then sell it. If it don’t go up, don’t buy it.
\end{quote}

Written as a trading system, that might be:

\begin{quote}
Buy when the price rises above its 100 day moving average
Sell when there is a 5% profit
\end{quote}

Figure 2.3 shows the equity curve, based on closed trades, for trading SPY using that system beginning in 1999. During periods spanning years 2000 to 2007 and 2008 to 2013—the long horizontal lines—there is an open position that is in a drawdown while you wait for the 5% profit.
Figure 2.3 Closed trade equity for Will Rogers system

Figure 2.4 shows the equity curve with daily account balance changes. The two major drawdowns that you would be holding through are 45% and 55%.

Imagine if the system had been trading Enron rather than SPY.
Mark-to-Market Equivalence

Figure 2.5 shows a table representing three multi-day trades. Entry to a long position is made at the close of the first day, at the closing price. Exit is at the close of the final day, at the closing price. The column headed “Trade” gives the gain of that trade—exit price divided by entry price. “Trade Sequence” gives the cumulative gain for the trade sequence. “Daily Change” is the day-by-day percentage change from the previous day. “Daily Cumulative” is the cumulative gain for the sequence of days within each trade. Note agreement between “Trade” and “Daily Cumulative” at the end of each trade. “Daily Sequence” is the cumulative gain for the sequence of days for the entire three trade sequence. Note the agreement between “Trade Sequence” and “Daily Sequence” at the end of the trade sequence.

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<th>Date</th>
<th>SPY Close</th>
<th>Trade</th>
<th>Trade Sequence</th>
<th>Daily Change</th>
<th>Daily Cumulative</th>
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From a mathematical perspective, the net equity change from a sequence of trades is identical whether the trades are considered as complete trades or as sequences of marked-to-market days.

From a trading management perspective, marking-to-market daily gives finer resolution to the performance of the system and the opportunity to make intra-trade subjective trading decisions, should they become necessary.
From a trading system design perspective, marking-to-market daily transforms every system, no matter how often it buys and sells, into a system that has 252 daily results every year. This reduces distortion that occurs at the start and end of every evaluation period. It also increases the number of data points available for trade selection, and entry and exit signals.

Converting from impulse signals to state signals provides the opportunity for better measurement and better management. State signals are discussed in more detail in Chapter 3.

Although the trades extend over multiple days, the system design and system management focus is on the mark-to-market period—daily. This does not imply changing positions every day. It does imply evaluating every day, and willingness to change positions daily. It allows us to ask the questions “What is the distribution of next day return?” and “Should the position for the next day be long, flat, or short?”

In terms of changes to account equity and drawdown, an n-day trade is equivalent to n one-day trades.

Quantifying Risk Tolerance

Recall the discussion of risk tolerance from Chapter 1. Every trader or trading company has a level of risk tolerance. It is the level of drawdown that, when exceeded, causes the trader to accept that the system is broken and must be taken offline. Risk tolerance can be quantified.

Repeating the risk tolerance statement introduced in Chapter 1:

I am trading a $100,000 account and looking forward two years. I am willing to accept a 5% risk of a 20% drawdown, measured from highest equity to date.

It has four parameters:

- Account size.
- Forecast horizon.
- Maximum drawdown.
- Degree of certainty.

Account Size

The initial balance of the trading account at the beginning of the period. With the understanding that the utility of money is an important issue, it is ignored here. But, needing specific numbers for examples, the initial balance is set at $100,000. Adjust to reflect your trading.

Since we are measuring in percentage changes, it is not a critical issue at this point.