CHAPTER 8

Trend Systems

The previous chapters developed the tools for calculating trends – a traditional moving average, various weighted averages, exponential smoothing, and regression. To profit from identifying the trend requires trading rules and specific parameters that define the trend speed and an acceptable level of risk, among other factors. This chapter first discusses the rules that are necessary for all trading strategies and gives examples of actual systems. The selection of trend speed is handled only briefly here but is continued with a detailed analysis of these and other systems throughout the book, and especially in Chapter 21. It is most important to find trends that are robust – that is, ones that work across many markets and under varied economic conditions. At the same time, they must satisfy an investor's risk tolerance. It is a difficult balance.

Trend systems are the preferred choice of Commodity Trading Advisors (CTAs) and many hedge funds. Some advisors are reported to be using the same trend systems devised in 1980. CTA total assets under management reached a record $343 billion in 2017, but a small part of the $3.37 trillion managed by all hedge funds. It attests to the long-term success of trend following.

WHY TREND SYSTEMS WORK

Trend analysis is the basis for many successful trading programs, some with audited performance spanning nearly 40 years. Being able to identify the trend is also important if you are a discretionary trader looking to increase your chances for success by trading on "the right side of the market." Trend systems work because:

- *Long-term trends capture large price moves caused by fundamental factors.* Economic trends are most often based on government interest rate policy, which is both slow to develop and incremental. In turn, interest rates directly affect foreign exchange, the trade balance, mortgage rates, carrying charges, and the stock market.

- *Persistence*. Some stock price moves defy analysis. They continue to rise beyond any normal assessment of value. Only by staying with the trend could you capture the gains of Apple, Amazon, Tesla, and even Bitcoin. In the case of Bitcoin, extreme trends have been both up and down.
- *Prices are not normally distributed but have a fat tail*. The fat tail refers to the unusually large number of directional price moves in many stocks and futures markets that are far longer than would be expected if prices were randomly distributed. Profits generated by the fat tail are essential to the long-term success of trend following.
- *Money moves the markets*. Most trends are supported by the flow of investor funds. While this causes short-term noise, it also delivers the long-term trends. As trends become clearer, additional money flows in to continue the trend.

Trend trading works when the market is trending. It doesn't work in markets that are not trending. There is no magic solution that will generate profits for trending strategies when prices are moving sideways, and there is no one trending technique that is always best. You'll find that most trending methods have about the same returns over time but with different risk profiles and different trading frequency.

How Often Do Markets Trend?

Is there a way to measure how often markets trend? One analyst defines a trend as 10 consecutive closes in the same direction, but that seems arbitrary and a small window. What if there were 9 days up and one small down day?

A trend is a relative concept. It depends on the trader's time horizon and it is relative to the frequency and size of price swings that are acceptable to the trader. Ultimately, a trend exists if you can profit from the price moves using a trending strategy.

The Fat Tail

The *fat tail* is a statistical phenomenon caused by a combination of market fundamentals and supported by human behavior. The net effect is that prices move in one direction much longer than can be explained by a random distribution. As a simple example, consider coin flipping as a classic way to produce a random distribution. In 100-coin tosses:

- 50 will be a head or a tail followed by the opposite head or tail.
- 25 will be two heads or two tails in a row.
- $12\,1/2$ (if we could have halves tosses) will be 3 heads or 3 tails in a row.
- About 6 will be 4 heads or 4 tails in a row.
- About 3 will be 5 in a row.
- 1 or 2 will be 6 in a row of either heads or tails.

If price moves are substituted for coin flips, then heads would be a move up and tails a move down. If the pattern of up and down price moves follows a random distribution (and the up and down moves were of the same size), then it would not be possible to profit from a trend system. But prices are not normally distributed. Instead of one run of 6 out of 100 days of trading, we may see a run of 12, or 3 runs of 6.

These long runs can translate into very large trading profits. It is not necessary to have every day go in the same direction in order to profit, only that the downward reversals during an uptrend not be large enough to change the direction of the trend and end the trade. The more tolerance for the size of the interim reversals, that is, the more risk you are willing to take, the more likely the fat tail can be captured.

If there are more runs of longer duration for every 100 daily price moves, what is the shape of the rest of the distribution? Figure 8.1 gives a theoretical representation of an actual price distribution compared to a random distribution. The extra movement that goes into creating the fat tail comes from the frequency of short runs. There are fewer runs of 1 and 2 and more runs greater than 6. The total remains the same. Readers interested in this subject should read the section "Gambling Techniques: The Theory of Runs" in Chapter 22.

Distribution of Profits and Losses

As a trader, you would want to know, "How often is there a profit from a fat tail? To find the answer, we'll apply the most basic trending system, a simple moving average that buys when the trendline turns up and sells short when it turns down.

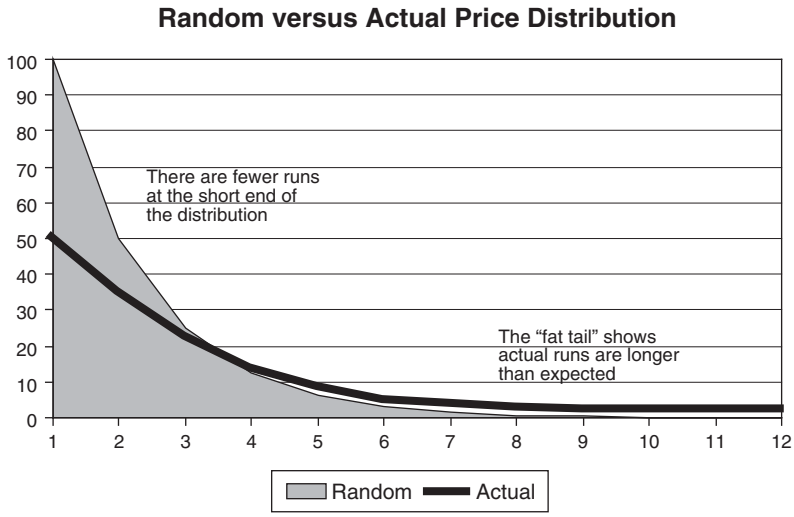

FIGURE 8.1 Distribution of runs. The shaded area shows the normal distribution of random runs. The solid dark line represents the distribution when there is a fat tail. In the fat tail distribution, there are fewer short runs and an unusually large number of longer runs or a single exceptionally long run.

This will be discussed in more detail in the next sections. For now, we need to know that results depend on both the market and the calculation period. Applying a simple 40-day moving average strategy to five diverse futures markets, 30-year bonds, the S&P, the euro currency, crude oil, and gold, the results of individual trades can be collected and displayed as a histogram (frequency distribution). The results of the S&P are shown in Figure 8.2.

In the frequency distribution, the bottom axis shows the starting value of the bins that hold the size of the profitable or losing trades, and the left scale shows the number of trades that fall into that bin. If the distribution was normal, then the shape would be a bell curve. This distribution is clearly extended far to the right, with one very large profit showing in the $18,750 bin. That one profit offsets 15 losses in the bar with the highest frequency, −$1,250. But the S&P is not the only market with this distribution. Table 8.1 shows the distribution sample, where bin1 = −$5,000 and bin20 = +$18,750. The tails to the right are very long and those to the left very short. It is important to remember that a pure trend strategy needs this distribution to be profitable.

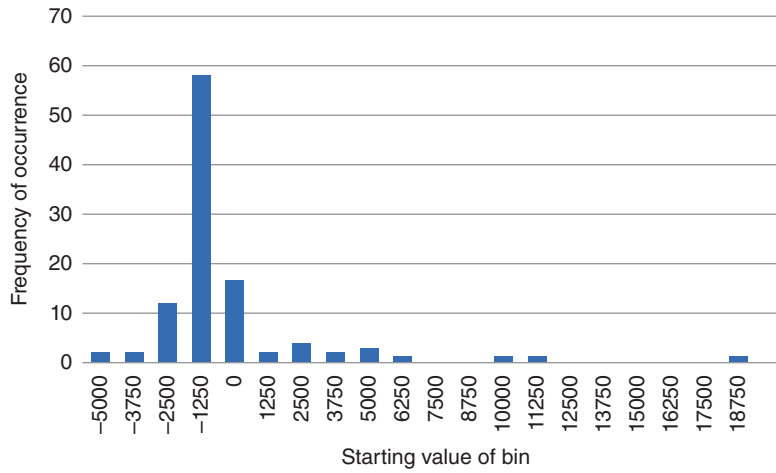

FIGURE 8.2 Frequency distribution of returns for SP futures using a 40-day simple moving average strategy. Results show a fat tail to the right.

TABLE 8.1 **Frequency distribution for a sample of five diverse markets, showing the fat tail to the right and a short tail to the left.**

Bin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Bonds	0	2	8	17	53	27	6	3	2	3	1	0	0	1	1	0	0	0	1	0
S&P	2	2	12	58	17	2	4	2	3	1	0	0	1	1	0	0	0	0	0	1
Euro	1	0	4	7	26	75	20	2	2	3	1	0	2	1	1	0	0	2	0	0
Crude	0	3	22	92	2	0	4	0	1	0	0	0	0	0	0	0	0	1	0	0
Gold	0	1	4	8	20	70	16	4	0	2	0	3	0	0	0	0	0	1	0	0

Time Intervals, Market Characteristics, and Trends

Trends are most easily seen using long-term charts, weekly rather than daily data, or daily rather than hourly data. The farther you step back from a chart, the clearer the trend. If you display a daily chart, there will be some obvious trending periods and some equally clear sideways moves. Change that to a weekly chart and the trends will seem much clearer. Change that to an hourly chart and you'll see mostly noise. Lower frequency data translates into better performance when using longer-term trends. While there are always fast trends that show profits in back-testing, they tend to be less stable and inconsistent in their returns. Trends using longer calculation periods are more likely to track economic policy, such as the progressive lowering of interest rates by the central bank or a plan to allow the currency to weaken, which stimulates exports and reduces debt.

Market sectors differ in their trending qualities. Interest rate futures, money markets, and utility stocks are among the many investment vehicles closely tied to government rate policy and reflect the same long-term trend; this trend can persist for years. Foreign exchange is more complex and may be manipulated by monetary policy. Governments are more accepting of changes in the exchange rates if they occur slowly, but they will work hard to keep them within a target range. The Bank of Japan has been known to intervene often, while the Swiss National Bank had only one spectacular intervention in January 2015, an attempt to stabilize the franc in front of a possible Greek financial crisis. Most foreign exchange markets show clear but shorter trends compared to interest rates.

Equities

The stock market presents another level of difficulty. Individual stocks are driven by many factors, including earnings, competition, government regulation, management competence, and consumer confidence. Because the volume of trading in individual shares may vary considerably from day to day, these factors do not often net out as a clear trend. Stock prices may run up sharply on anticipation of better earnings or approval of a new drug and reverse just as quickly within a few days. Liquidity, or volume, is an important element in the existence of a steady trend.

Individual stocks are also affected by concurrent trading in the index markets. When the S&P futures or the ETF SPY are bought and sold, all stocks within that index are bought and sold. If one company in the S&P 500 has just announced the loss of a major contract, but the overall market is strong, the share price of the suffering company may be dragged higher by arbitrage due to massive buying of the S&P index. This behavior makes for erratic price patterns in individual stocks. This individuality allows us to understand why Charles Dow created his indices, trying to bring order to chaos.

Emerging markets are the exception. The introduction of a new market, such as the fictitious East European Stock Index, would be lightly traded but may be very trending. Initial activity would be dominated by commercials, such as banks, all of which would have a similar opinion on the economy of Eastern Europe. As the

general public starts to participate it adds liquidity while it also introduces noise, which in turn makes the trends less clear. Finding the trend then requires a longer time interval. Readers interested in this process should review the discussion of noise in Chapter 1.

When using a trending strategy, select both the markets and the time frame that work with you. Longer calculation periods, lower frequency data, and markets that are more closely linked to their underlying fundamentals will all perform better.

BASIC BUY AND SELL SIGNALS

All trends lag the price movement. It is both the advantage and the disadvantage of the method. As the calculation period gets larger, the trend lags further. Figure 8.3 shows Amazon prices from April 2010 through February 2011 with a 40-day moving average. Clearly, the moving average is smoother than the prices because, on any day, only two of the values change. The lag exists because the value of the average is closest to the price 20 days ago, or half the length of the calculation period. But that value is plotted under today's price. When prices are going steadily up or down, the lag will be largest, as we see on the right side of Figure 8.3. It is the lag that allows us to stay in a trade.

The most common way to trade a moving average is to be long when prices are above the average and short when below. The rules are:

- *Buy* when prices cross above the trendline.
- *Sell short* when prices cross below the trendline.

Even with these simple rules, there are important choices to be made. Do you buy at the moment rising prices cross the trendline during the trading session, or do you wait for the price to close above the trendline? As seen in Figure 8.3, prices

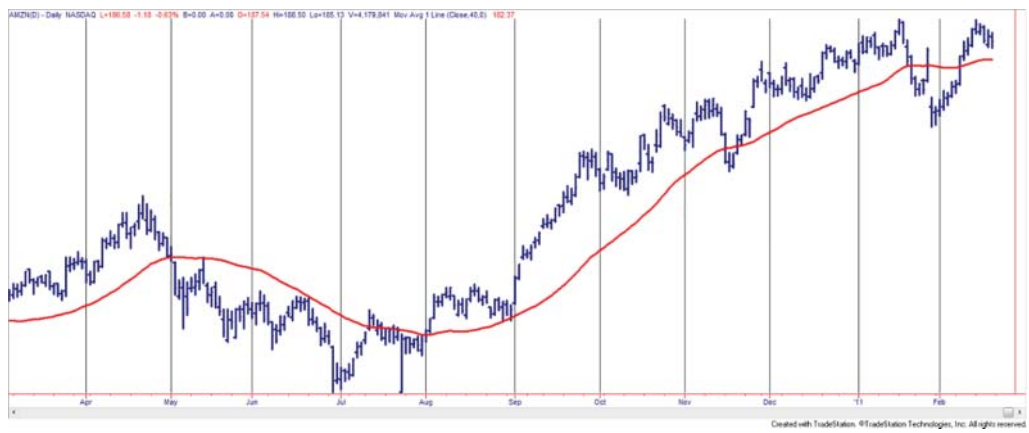

FIGURE 8.3 Amazon (AMZN) with a 40-day moving average.

may cross back and forth through the trendline before settling on a final direction. If you subscribe to the belief that the closing price of the day is the most reliable price, then the number of trading signals can be reduced by using the rules:

- *Buy* when prices *close* above the trendline.
- *Sell short* when prices *close* below the trend line.

Another school of thought prefers the average of high and low prices, or the average of the high, low, and closing prices. A buy or short sale signal occurs when the (*high* + *low*)/2 or (*hight* + *low* + *close*)/3 crosses above or below the current trendline value. In both of these cases, the averages could not be calculated until the end of the trading session because none of the three component values would be known until then.

Using the Trendline for Signals

The purpose of the trendline is to smooth erratic price moves and uncover the underlying direction of prices. Then it seems more reasonable to use the trendline to generate the trading signal.

- *Buy* when the change in the trendline is up.
- *Sell short* when the change in the trendline is down.

The penalty for using the trendline as a trading signal is its lag. Figure 8.3 shows that, using a 40-day moving average, prices cross above the trendline during July a few days ahead of the point where the trendline turns up. The benefit using the trendline as the signal is that there are far fewer false signals (as in July and November); therefore, it has a higher percentage of profitable trades and lower cost. As we will see later, using the price cross will be best for short-term trading and the trend direction for longer-term trading.

As an example, Table 8.2 shows five calculation periods for Amazon beginning with 5 days and doubling the period for each test. This maintains the percentage

TABLE 8.2 **Comparison of entry methods for 10 years of Amazon (AMZN). Signals using the trendline direction are shown on the left, and price penetration on the right.**

	Signal Using Trendline			Signal Using Price Cross			
Trend Calculation Period	Total Profit/ Loss	Profit Factor	Number of Trades	Total Profit/ Loss	Profit Factor	Number of Trades	Increase in Trades
80	48.24	1.34	84	57.16	1.31	106	26%
40	94.42	1.46	120	32.21	1.12	164	37%
20	111.97	1.45	196	(7.31)	0.98	252	29%
10	(87.67)	0.81	292	(90.82)	0.82	370	27%
5	(90.31)	0.84	439	(49.15)	0.92	597	36%

change in the calculation period and gives a better distribution sample (this is discussed further in Chapter 21). The two columns headed *Number of Trades* shows that the trendline method has from 26% to 37% fewer trades and, for the most part, better performance. The *Profit Factor* is a performance ratio equal to the gross profits divided by the gross losses.

Using the trendline for signals is better in all but the fastest trend. But the fast trends are not the best choice for tracking fundamental price moves. It is very possible that, for faster trading, the lag in the trendline is too much of a burden to overcome and the price penetration is better. This will be discussed further in Chapter 16, "Day Trading." It is always necessary to confirm the results by testing other markets.

Anticipating the Trend Signal

Consistency is important. The system that is tested and the one that is traded should be the same. In this book the closing price is used for most of the calculations; however, any combination of open, high, low, and close could be substituted. The normal process for generating a trading signal is to wait until prices close, then calculate the new moving average or trendline value, then see whether a crossing occurred or the direction of the trendline changed according to the basic buy and sell rules. But using the closing price for the calculation of the entry signal means that you could not enter a new trade on the close, unless you can anticipate the signal; otherwise, you must execute the trade in the after-hours market or on the next open. That means your trading performance is not going to match the way you tested.

One solution to this dilemma is to capture the prices shortly before the close, generate the trading signals, then enter the buy and sell orders for execution on the close. Occasionally the order will be wrong because prices changed direction in the last few minutes of trading, but the cost of exiting the trade will usually be small compared to the improvement in overall execution. As a general rule, entering sooner is better.

The other alternative is to calculate, in advance, the closing price that will generate a signal using either the trendline method or the price crossing method. For an *n*-day moving average the calculation is simple – the new moving average value will be greater than the previous value if today's price is greater than the price dropped off *n*-days ago. Because all the other values in the average remain the same except for the first and last, the answer only needs those two values. If a 40-day average is used and the oldest price p_{t-40} was 30.25, then any price greater than 30.25 today would cause the trendline to move up. Then an order can be placed shortly before the close to *buy at 30.26 stop*. There is more on projecting prices at the end of this chapter.

Not All Entries Should Be Anticipated

How important is this? A lot depends on the trending nature of the market. In Chapter 1 the discussion of market noise showed that the short-term interest rates had the lowest amount of noise and the equity index markets had the

most noise. Using the Eurodollar interest rates and S&P 500 futures as extreme examples, the method that used the trendline signal was compared when entries were taken on the current close, the next open, and the next close to assess the sensitivity of the total profits to entry delays. Table 8.3 shows the results.

All but one of the Eurodollar results were more profitable entering sooner. Longer trend periods were generally more profitable, reflecting the fundamentals of government policy. This is also seen in the profit factors, which measure reward to risk rather than only total profits.

The S&P favors waiting until the next close. In addition, short-term trends are not profitable. Both of these can be attributed to higher noise. Even after the sustained bull market that began after 2008, S&P daily prices will rarely move in the same direction three days in a row.

To help find which markets are best entering quickly and which should be delayed, review the section "Measuring Noise" in Chapter 1. It is a concept that has been applied to smart execution.

Profile of a Simple Moving Average System

Using the moving average trendline as the basis for system signals, we chose an 80-day calculation period because it represents a typical macrotrend system. The profile of results is typical of any moving average system. Figure 8.4 shows

TABLE 8.3 **Comparison of entries on the close, next open, and next close. Based on 10 years of S&P and Eurodollar interest rate futures, back-adjusted, ending in February 2011.**

	Eurodollar Interest Rates					
	Today's Close		Next Open		Next close	
Calculation Period	Total Profit or Loss	Profit Factor	Total Profit or Loss	Profit Factor	Total Profit or Loss	Profit Factor
80	16150	2.87	16325	2.89	15630	2.75
40	9603	1.61	9050	1.55	9383	1.61
20	7745	1.37	6258	1.29	3850	1.16
10	10773	1.40	8765	1.31	1165	1.04
5	3368	1.09	−1715	0.96	−870	0.98

	S&P 500					
	Today's Close		Next Open		Next close	
Calculation Period	Total Profit or Loss	Profit Factor	Total Profit or Loss	Profit Factor	Total Profit or Loss	Profit Factor
80	−12325	0.87	−10463	0.89	16363	1.20
40	−29138	0.75	−26013	0.78	5013	1.05
20	13088	1.12	13900	1.13	22738	1.20
10	−27925	0.83	−22738	0.86	−12550	0.93
5	−21725	0.90	−19588	0.91	−56350	−0.76

FIGURE 8.4 A trend system for NASDAQ 100 futures, using an 80-day moving average and taking the trading signals from the direction of trendline results.

the NASDAQ 100 futures from March through June 2018. Buy and sell signals are generated from the direction of the trendline; there were no transaction fees.

The trading signals in Figure 8.4 show that a strong uptrend was captured with only a minor loss exiting and reentering in September. After a strong January 2018, prices increase in volatility and begin a sideways pattern. The trend system holds its long position until the beginning of May, when it gets a series of losing trades searching for a new trend.

The profile of this NASDAQ example, using data from 1998 through June 2018, is shown in Table 8.4. It is typical of longer-term trend-following systems and also

TABLE 8.4 **Performance statistics for NASDAQ futures, 1998–June 2018.**

	All Trades	Long Trades	Short Trades
Total Net Profit	$1,584,665	$1,868,520	($283,855)
Profit Factor	1.47	2.22	0.85
Roll Over Credit	$0.00	$0.00	$0.00
Open Position P/L	$0.00	$0.00	$0.00
Total Number of Trades	201	101	100
Percent Profitable	36.32%	46.53%	26.00%
Avg. Trade Net Profit	$7,884	$18,500	($2,839)
Avg. Winning Trade	$67,844	$72,226	$59,921
Avg. Losing Trade	($26,312)	($28,261)	($24,889)
Ratio Avg. Win:Avg. Loss	2.58	2.56	2.41
Consecutive Winning Trades	5	5	3
Consecutive Losing Trades	11	5	12
Avg. Bars in Winning Trades	47.3	54.11	35
Avg. Bars in Losing Trades	10.09	11.06	9.38

shows the bullish bias of the U.S. equities market. Of the 210 trades over 20 years, only 36% were profitable. Those profits and the profitable trades greatly favored the long positions.

Of added interest are the number of bars in the winning and losing trades. Again, this shows a strong upward bias in prices, even though the 20 years included the disastrous NASDAQ "dot.com" sell-off in 2000 and the financial crisis in 2008. The average winning trade was held 47 days and the losing trades held 10 days. This supports the trend-following adage "cut your losses and let your profits run." The performance picture is that trend following gets in and out quickly when it has a loss but holds the trades whenever trends and profits develop. This category of strategy is called *conservation of capital*.

We can generalize the moving average trend-following profile as:

- The percentage of profitable trades is low – about 35%.
- The average winning trade must be significantly larger than the average losing trade; given only 35% profitable trades, the ratio must be greater than 10:3.5 to be profitable.
- The average winning trades are held much longer than losses.
- Because there is a high frequency of losing trades, there are also long sequences of losing trades.

There are many analysts trying to improve these statistics; that is, capturing the long-term trend by trading pieces of it. But doing that will change the risk characteristics of trend-following systems. For example, if you add profit-taking or stop-losses (Chapter 23), then you reduce or eliminate the chance of capturing the fat tail, which will be necessary for a long-term profit. Still, many traders do not like the idea of holding the trades for such a long time and giving back so much of the unrealized profits when the major trend changes direction. Different traders make different choices.

Other trending methods, such as a breakout, will have different profit and risk profiles. It is always best to know the alternatives first. A program to test the trend method, entry rules, and execution options, including *long-only*, is *TSM Trends*, available on the Companion Website.

Timing the Order

The timing of execution orders when following a system will affect its results over the long term. The use of a simple trend system or one with a band (discussed in the next section) will identify a change of trend, but it is also a point of uncertainty. Buying or selling at the exact time of the new trading signal often places the trader in a new trend at a loss, especially if the market is noisy. In an attempt to overcome these problems, a number of rules can be used:

- If the trade is triggered by an intraday signal, wait until the close to execute the order.

- *Buy* (or *sell*) on the next day's open following a signal on the close.
- *Buy* (or *sell*) with a delay of 1, 2, or 3 days after the signal.
- *Buy* (or *sell*) after a price retracement of 50% of the daily range (or some other value) following a signal.
- *Buy* (or *sell*) when prices move to within a specified risk level relative to a reversal or exit point.

The object is to enter a new position and see an immediate profit, or reduced risk. Some of these rules can be categorized as timing and others as risk management. If intraday prices are used to signal new entries and exits, a rule may be added that states:

Only one order can be executed in one day: either the liquidation of a current position or an entry into a new position.

While better entry points will improve overall performance, an entry rule that is contingent on price action, such as a pullback, risks the possibility of not entering at all. A contingent order that is missed is guaranteed to be a profitable trade. It might be better to combine the entry order, for example:

Buy (or sell) after prices reverse by 0.50 × ATR or enter on the next close.

Once you have decided on a timing rule, you must test it carefully. The perception of improvement does not always live up to expectations. In tests of trend-following systems conducted over many years, positions calculated on the close but delayed until the next open improved execution prices about 75% of the time but resulted in smaller overall total profits. Why? Fast breakouts that never retrace result in missed trades. Therefore, while three out of four executions returned a better price by a small amount, those improvements were often offset by the profitable breakouts that were never entered.

BANDS AND CHANNELS

A good way to improve the reliability of signals without altering the overall trend profile is by constructing a *band*, or *channel*, around the trendline. It can be used to effectively slow down trading without sacrificing the biggest profits and gives the trend time to develop. The time of trend change is also the time of greatest indecision.

Bands Formed by Highs and Lows

The most natural band is one formed from the daily high and low prices. Instead of applying the *n*-day moving average to the closing prices, it is applied separately to the highs and lows. Long positions are entered when today's high crosses the average of the highs and short sales when today's lows cross the average of the lows. To get a broad view of whether this is an improvement to entry points, the

TABLE 8.5 Results of using a moving average of the highs and lows, compared to the closes.

	Eurodollar Interest Rates				S&P 500			
	Close Crossing		High-Low		Close Crossing		High-Low	
Calculation Period	Total Profit or Loss	Profit Factor	Total Profit or Loss	Profit Factor	Total Profit or Loss	Profit Factor	Total Profit or Loss	Profit Factor
80	16320	2.94	13842	2.18	30027	1.54	36443	1.74
40	16035	2.18	15000	2.02	(10337)	0.91	12402	1.14
20	10172	1.44	5167	1.20	5987	1.05	16512	1.15
10	2727	1.08	3667	1.11	(49000)	0.76	(33751)	0.82
5	7812	1.20	(337)	0.99	(106950)	0.64	(43760)	0.81

two most extreme markets (the Eurodollar considered the trendiest and the S&P the noisiest) are tested for the volatile 10 years from 2001 through 2011 with the five calculation periods used in an earlier example. Results are shown in Table 8.5.

For a highly trending market, such as the Eurodollar interest rates, entering later on a penetration of either the highs or lows is not as good as entering on a price penetration of the close. Just the opposite is seen in the S&P results. Waiting longer to enter improves results noticeably and, in the case of the 40-day trend, it turns a loss into a profit.

We can conclude that a band can be a profitable variation to a simple trend system, but not for all markets. The next question is, "Are there other bands that work better?"

Keltner Channels

One of the original band calculations was by Keltner,[1] which goes as follows:

(Average daily price) $AP_t = (H_t + L_t + C_t)/3$

(10-Day moving average) $MA_t = average\,(C_t, 10)$

(Upper band) $UB_t = MA_t + AP_t$

(Lower band) $LB_t = MA_t + AP_t$

It would be best to substitute the true range, rather than the high-low range, as a better measure of volatility.

Percentage Bands

Another simple construction is a percentage band, formed by adding and subtracting the same percentage of price from a trendline based on the closing prices. If *c*

[1]Chester W. Keltner, *How to Make Money in Commodities* (Kansas City, MO: Keltner Statistical Service, 1960).

is the percentage to be used (where $c = 0.03$ means 3%), then:

$$\text{(upper band)} \quad B_U = (1 + c) \times MA_t$$
$$\text{(lower band)} \quad B_L = (1 - c) \times MA_t$$

where

MA_t = today's moving average value.

Therefore, if the moving average value for Merck (MRK) is $33, and the band is 3%, then the upper band is 33.99 and the lower band is 32.01. Because the moving average is much smoother than the price series, the band will be uniform around the moving average, narrowing and widening slightly as prices decline and rise.

The band can be more sensitive to change if the current price p_t is used to calculate the band instead of the moving average trendline. The bands are then:

$$\text{(upper band)} \quad B_U = (1 + c) \times p_{t-1} + MA_t$$
$$\text{(lower band)} \quad B_L = (1 - c) \times p_{t-1} + MA_t$$

The band is still centered around the moving average trendline to give it stability. In both cases above we used the current moving average value and price, which will be applied to the next day's price. Remember that percentages can't be used for back-adjusted futures.

Avoid using a fixed value, such as a $1 band. That would make it very sensitive at higher prices and less sensitive at lower prices.

Volatility Bands

Trying to put rules to volatility can be difficult. In general, stock prices are more volatile when they are low while commodity price volatility remains about the same. Yet both markets can be quiet or volatile for weeks at a time. By constructing a band that changes with volatility, we attempt to keep the sensitivity of the trend signals the same.

Most bands need to be scaled. Scaling is accomplished by using a constant value or *scaling factor* as a multiplier to increase or reduce the sensitivity of the band. If s is a scaling factor and c is a fixed percentage, then the following bands can be constructed:

$B_t = MA_t \pm c \times MA_t$ (percentage of trendline)
$B_t = MA_t \pm c \times p_t$ (percentage of price)
$B_t = MA_t \pm s \times ATR_t$ (average true range)
$B_t = MA_t \pm s \times stdev_t$ (standard deviation of returns or differences)

When $s = 1$, the full band is equal to 2 × ATR or 2 × *stdev*. *MA* was used to indicate a moving average, but any method of calculating the trend can be substituted, such as an exponential smoothing or a regression. Figure 8.5 shows the four types of bands applied to the S&P futures. All use a scaling factor of 2, which may be too close for some methods and too far for others. The ATR and *stdev* are

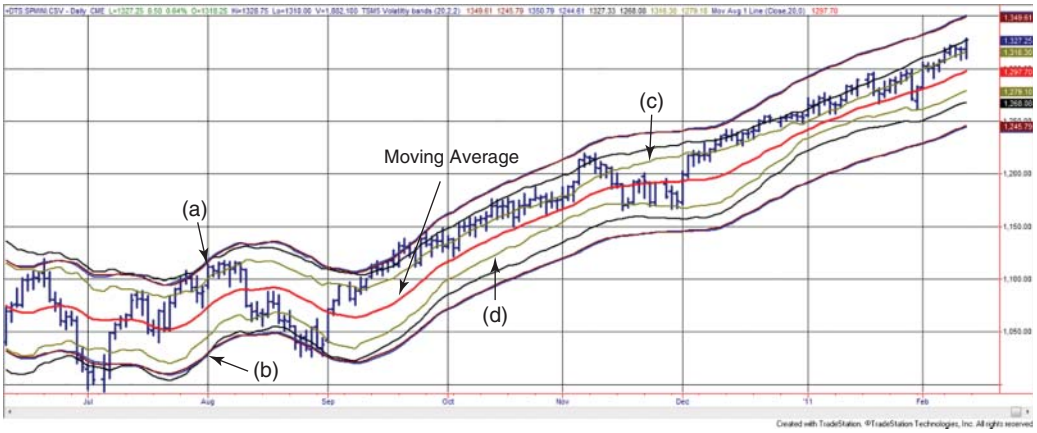

FIGURE 8.5 Four volatility bands around a 20-day moving average, based on (a) 2% of the trendline, (b) 2% of the price, (c) 2 x average true range, and (d) annualized 20-day volatility.

based on 20 days. When using futures, the standard deviation uses price differences instead of returns. The purpose of the chart is to show the relative shape of the bands and distance from the prices.

In Figure 8.5 the center line is a 20-day moving average. The first two methods of calculating bands, the percentage of trendline and percentage of price, are almost identical, very smooth, and are the farthest from the center. The next band closer to the moving average is the average true range. It moves slightly farther apart when prices are more volatile. The band closest to the trendline is the standard deviation, which is more sensitive to price volatility. Because the same scaling factor produces bands that are different for each method, their benefits are difficult to compare. By changing the scaling factors, we might make them all look alike.

It may be convenient to have separate exit and entry bands, the entries less sensitive than the exits so that the strategy exits quickly but enters slowly. Or, if the entry occurs on a penetration of the band, but the exit is based on the trendline, then trades are not reversed from long to short. That improves slippage because only half the number of shares or contracts are traded on each order and some false signals may be avoided. When trading, be sure to use yesterday's trend calculations with today's prices to get a signal.

An Adaptive Band for Mean Reversion

Developed by Lee Leibfarth in 2006, this method creates a band using a double-smoothed exponential that works well for identifying mean-reversion trades.[2] Volatility is measured using an adaptive range, the 5-day EMA of the 5-day EMA of the daily high minus the daily low. Figure 8.6 shows that the bands, called the Adaptive Price Zone (APZ), touch the highs and lows when volatility increases, providing an opportunity for a mean-reversion trade.

[2]Jean Folger, "The Adaptive Price Zone," *Modern Trader* (November 2015).

FIGURE 8.6 Adaptive bands constructed using double exponential smoothing shows points where a mean-reversion trade can be entered.

Bollinger Bands

Both the ATR and the standard deviation of returns or price differences provide the best measures of volatility. The most common calculation period is 20 days. John Bollinger has popularized the combination of a 20-day moving average with bands formed using 2 standard deviations of the price changes over the same 20-day period. They are frequently called *Bollinger bands*.[3] Because the standard deviation represents a confidence level, and prices are not normally distributed, the choice of two standard deviations equates to an 87% confidence band (if prices were normally distributed, two standard deviations would contain 95.4% of the data). Bollinger bands are combined with other techniques to identify extreme price levels. These are discussed later in this section.

Figure 8.7 shows Ford (F) plotted with a traditional Bollinger band. One of the characteristics of this band is that, once the price moves outside either the upper or lower band, it remains outside for a number of days in a row. This type of pattern was typical of what used to be called *high momentum*. Note that the width of the band varies considerably with the volatility of prices and that a period of high volatility causes a "bubble," which extends past the period where volatility declines. These features and more about volatility will be discussed in Chapter 20.

Figure 8.7 was created using the TradeStation indicator *Bollinger Bands*, which lets you vary both the calculation period for the trend and the number of standard deviations. But then, if it's not a 20-day average and 2 standard deviations, it's not a Bollinger band.

Bollinger bands can also be applied effectively to multiple time frames. An excellent example that uses a combination of weekly and daily data applied to the S&P 500 is seen in Figure 8.8. The price pattern follows the weekly Bollinger

[3]John A. Bollinger, Bollinger Capital Management, Inc. P.O. Box 3358, Manhattan Beach, CA 90266, www.bollingerbands.com. Also see *Bollinger on Bollinger Bands* (New York: McGraw-Hill, 2001).

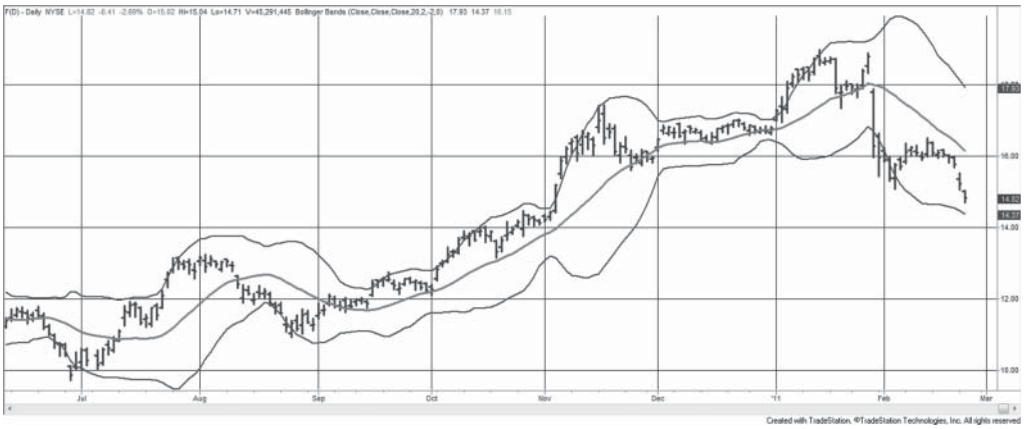

FIGURE 8.7 Bollinger bands applied to Ford.

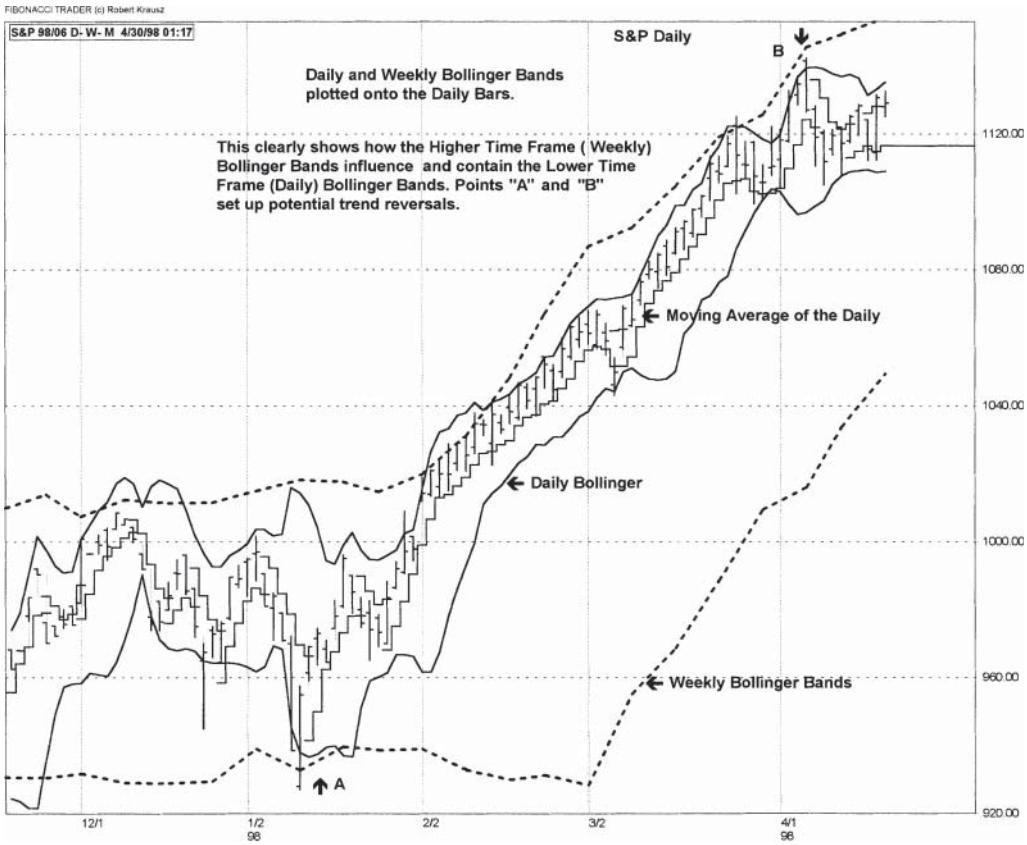

FIGURE 8.8 Combining daily and weekly Bollinger bands.

Source: Chart created using *The Fibonacci Trader,* by Robert Krausz. Used with permission from Fibonacci Trader Corporation, St. Augustine, FL, www.fibonaccitrader.com.

band higher, where the daily and weekly prices come together during the week of July 14.

Modified Bollinger Bands

One of the significant problems with Bollinger bands, as well as any volatility measure based on historic data, is that the bands will expand after increasing volatility but are slow to narrow as volatility declines. An excellent correction[4] for this requires the following calculations for the center line, D:

$$M_t = \alpha \times C_t + (1 - \alpha) \times M_{t-1}$$

$$U_t = \alpha \times M_t + (1 - \alpha) \times U_{t-1}$$

$$D_t = \frac{(2 - \alpha) \times M_t - U_t}{1 - \alpha}$$

where C is the closing price and α is the smoothing constant, set to 0.15 to approximate a 20-day moving average. To correct the bulge in the bands following a volatile period, the upper and lower bands (BU and BL) are calculated as:

$$m_t = \alpha \times |C_t - D_t| + (1 - \alpha) \times m_{t-1}$$

$$u_t = \alpha \times m_t + (1 - \alpha) \times u_{t-1}$$

$$d_t = \frac{(2 - \alpha) \times m_t - u_t}{1 - \alpha}$$

$$BU_t = D_t + f \times d_t$$

$$BL_t = D_t - f \times d_t$$

where f is the multiplier for the width of the band, suggested at 2.5 compared to Bollinger's 2.0. Figure 8.9 shows the modified Bollinger bands along with the original (lighter lines) for gold futures during the first part of 2009. While the new bands do not remove the bulge, they are faster to correct and more uniform in the way they envelop prices. Programs to calculate and display the original and modified bands are *TSM Bollinger bands* and *TSM Bollinger Modified*, available on the Companion Website.

Rules for Using Bands

Regardless of the type of band that is constructed, rules for using bands to generate trading signals are similar. The first decision to be made is whether trading strategy is a reversal strategy, changing from long to short and back again as the bands are penetrated. If so, the following rules apply:

- *Buy* (close out shorts and go long) when the prices close above the upper band.
- *Sell short* (close out longs and go short) when the prices close below the lower band.

[4]Dennis McNicholl, "Better Bollinger Bands," *Futures*, October 1998.

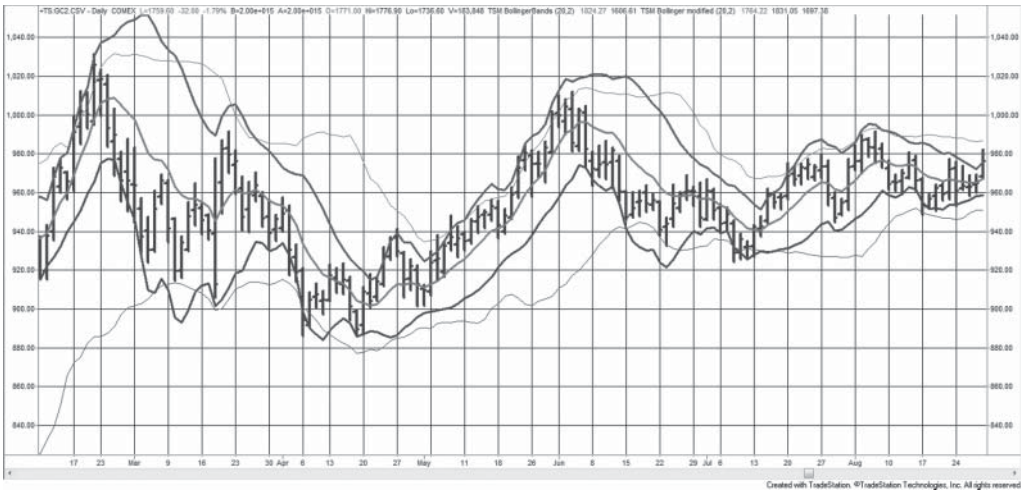

FIGURE 8.9 Modified Bollinger bands shown with original bands (lighter lines), applied to gold futures, February–August 2009.

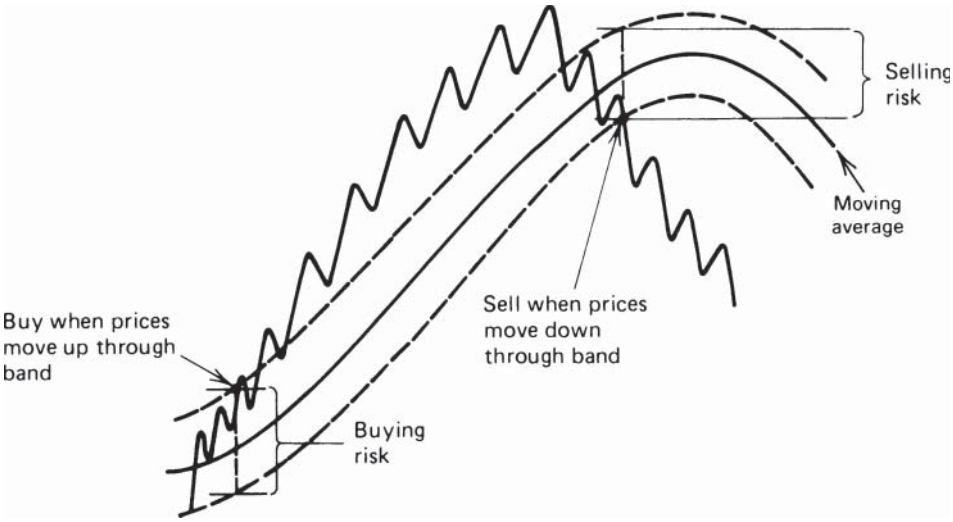

FIGURE 8.10 Simple reversal rules for using bands.

This technique is always in the market with a maximum risk equal to the width of the band, which changes each day (see Figure 8.10). Alternatively, you may prefer to exit from each trade when prices cross the trendline midway between the bands.

- *Buy* (go long) when prices close above the upper band. Close out longs when prices reverse and close below the moving average trendline (the center of the band).
- *Sell short* when prices close below the lower band. Cover your shorts when prices close above the moving average trendline.

The band is then used to enter into new long or short trades, and the trendline at the center of the band is used for liquidation. If prices are not strong enough

to penetrate the opposite band on the close of the same day, the trade is closed out but not reversed. The next day, penetration of either the upper or lower band will signal a new long or short trade, respectively. If you are trading a trending market, then using the high of the day for the longs and the lows for the shorts should produce some extra profits.

This technique allows a trade to be reentered in the same direction in the event of a false trend change. If a pullback occurs after a close-out while no position is being held (as shown in Figure 8.11), an entry at a later date might be at a better price. It also reduces the order size by 50%, which is likely to improve the execution price and add liquidity for large traders.

Using the trendline as an exit, risk is limited to half of the full band width. If the bands are narrow, there is a greater chance that an entry on an intraday high might also see an exit below the trendline on the close of the same day.

The "Squeeze"

Bollinger band squeeze is a variation on compression but measures the narrowing of the Bollinger bands. Wait until the Bollinger band compresses to some percentage of the average, for example, 50%, then buy or sell a new breakout through the bands. Compression has a history of success as a filter and trading on the same side as the trend often shows an improvement in performance.[5]

Bollinger on Bollinger Bands

While most trading strategies buy when there is an upward penetration of the top band and sell when prices move below the lower band, the use of Bollinger

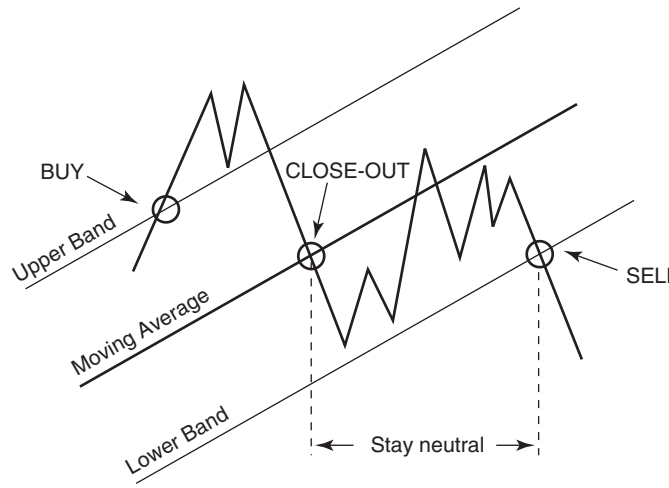

FIGURE 8.11 Basic rules for using bands.

[5]Kent Calhoun, "Bollinger Band MA Crossover Breakouts," *Technical Analysis of Stocks & Commodities*, October 2016.

bands is usually mean-reverting, or counter to the price direction. This can be risky, especially when prices are volatile. To reduce this risk, Bollinger recommends confirming a downside penetration using other indicators, primarily those based on volume and market breadth. If prices are moving lower but volume is not increasing, and negative breadth is not confirming the downward move, then a buy signal is realistic.[6]

Bollinger uses the concept that volatility is cyclic, but without a regular period. He sees very low volatility as a forecast for high volatility and very high volatility forecasting low volatility, similar to the way traders use VIX, the CME Volatility Index. He calls this "extreme seeking." Based on this, a major price rally with dramatically higher volatility, which expands the bandwidth to extremes, should be sold when the bandwidth begins to narrow. This only applies to upward price moves.

Combining Bollinger with Other Indicators

Williams[7] suggests that other indicators can be combined to capture volatile moves after a price contraction:

1. A standard 20-day, 2 standard deviation Bollinger band
2. A 20-day Keltner Channel
3. A 21-day Chaikin Oscillator to monitor the flow of funds

To enter a long position, the following conditions must be satisfied:

- The Bollinger bands narrow so they are fully inside the Keltner Channel while the Chaikin oscillator is below zero.
- The Chaikin Oscillator crosses above the zero line.

For short sales:

- The Bollinger bands narrow so they are fully inside the Keltner Channel while the Chaikin oscillator is above zero.
- The Chaikin Oscillator crosses below the zero line.

The Compromise between Reliability and Smaller Profits

As with most trading techniques, the benefits of one approach can also have negative factors. The use of a band around a trendline improves the reliability of the trading signal and reduces the total number of signals. The wider the band, the

[6] John Bollinger, "John Bollinger of Bollinger Bands Fame," *Technical Analysis of Stocks & Commodities* (May 2002).

[7] Billy Williams, "Biting off Profits with the Rattlesnake Breakout Method," *Futures* (October 2010).

fewer signals. Both of these characteristics are significant benefits. But wider bands mean delayed entries; therefore, you cannot capture as much of the trend and the average profits will be smaller. If the bands are too wide, then profits can disappear. The use of wider bands also means greater risk on each trade. It will be necessary to trade smaller positions or capitalize the account with a larger investment.

These are serious choices that must be made with every trading program. Although there are classic solutions to this problem discussed in Chapters 23 and 24, traders must choose the methods that complement their risk preference.

CHOOSING THE CALCULATION PERIOD FOR THE TREND

For any trend technique, the selection of the calculation period – the interval over which you will define the trend – is the most important decision in the ultimate success of the trading system. Entry rules, profit-taking, and volatility filters are improvements, but will rarely change a losing trend into a profitable one. Deciding the calculation period is more important than the method of identifying the trend. You can be profitable using a simple moving average, regression, breakout, or any other technique – if you can settle on the right calculation period.

The previous sections have used examples of calculation periods without any claim that one interval was better than another. We have discussed that the long-term trend tracks government interest rate policy or economic growth; therefore, there is good reason to choose a longer calculation period. We also saw that the trends were clearer when looking at a weekly chart rather than daily, and it was not clear that an intraday chart had any persistent trends. But for most traders, the risks associated with using a longer time frame are unacceptable; they prefer smaller profits and smaller losses associated with faster trading. Most strategy development software makes it easy to test a range of calculation periods to find the one that performed best in the past. This technique is called *optimization* and is discussed in Chapter 21. But the power of the computer is not always as good as human reasoning and common sense. The computer is best for validating an idea, not for discovering one.

Before the computer, analysts struggled with the same problem of finding the best calculation period. At first the trend period was based on multiples of calendar periods, such as a week or a month, expressed as trading days. Before 1980, these approaches were very successful. Many traders still subscribe to the idea that certain time intervals have intrinsic value. The most popular calculation periods have been: 3 days, the expected duration of a short price move; 5 days, a trading week; 20 to 23 days, a trading month; 63 days, a calendar quarter; and of course, 252 days, a calendar year. Implied volatility calculations traditionally use 20 days. It is not clear where the 200-day moving average, used for stocks, came from, but even numbers have always been popular.

More recently, a class of adaptive trends has appeared. These attempt to change the speed of the trend based on a characteristic of price movement, such

as volatility or noise. These techniques are another alternative to optimization and are discussed in Chapter 17.

A FEW CLASSIC SINGLE-TREND SYSTEMS

The following section includes classic examples of well-known systems that use a single trend.

A Simple *Momentum* System

In Chapter 7 the *n-day momentum* was defined as the change in price over *n* days. The simplest trend system is the one that buys when the *n*-day change is positive and sells when the *n*-day change is negative. For large values of *n,* the results will be surprisingly similar to a simple moving average system using the same entry and exit rules; therefore, we will not give examples here. Keep in mind that momentum can be effective even as it is very simple.

A Step-Weighted Moving Average

In 1972, Robert Joel Taylor published the "Major Price Trend Directional Indicator" (MPTDI), which was reprinted in summary form in the September 1973 *Commodities Magazine* (now *Modern Trader*). The system was tested in 1972 on historical data provided by Dunn and Hargitt Financial Services in West Lafayette, Indiana. It was one of the few well-defined published systems and served as the basis for much experimentation.

MPTDI is a moving average with a band. Its unique feature is that the calculation period and band width changed based on price volatility, defined as the current trading range. Because the method has distinct trading range thresholds (called steps), the method is called a *step-weighted moving average*. It is unique in its complete dependence on incremental values for all aspects of the system: the moving average, entry, and stop-loss points. For example, Table 8.6 shows what conditions might be assigned to gold.

TABLE 8.6 **MPTDI Variables for gold.***

Average Trading Range	Number of Days in Calculation	Weighting-Factors Progression	Entry Signal Penetration	Approximate Stop-Loss Point
50–150	2–5 days	TYPE A	100 pts	150 pts
150–250	20 days	TYPE B	200 pts	300 pts
250–350	15 days	TYPE C	250 pts	350 pts
350–450	10 days	TYPE D	350 pts	450 pts
450+	5 days	TYPE E	450 pts	550 pts

*100 points = $1 per ounce.

If gold were trading in an average range of 250 to 350 points each day ($2.50 to $3.50 per ounce, but remember this was 1972), the weighting factor for the moving average would be TYPE C, indicating medium volatility (TYPE A is lowest). Using TYPE C with a 15-day moving average, the most recent 5 days are given the weight 3, the next 5 days 2, and the last 5 days are weighted by 1. The entry signals use the corresponding penetration of 250 points above the moving average for a buy and 250 below for a sell. The intraday highs or lows are used to trigger the entry based on values calculated after the close of trading on the prior day. A stop-loss is fixed at the time of entry equal to the value on the same line as the selected volatility. The penetration of the stop-loss will cause the liquidation of the current trade. A new signal in the reverse direction will serve as both the exit for the current trade and the entry for a new trade.

There is a lot to say in favor of the principles of MPTDI. It is individualized with respect to markets and self-adjusting to changing volatility. Prices are step-weighted, given more importance to more recent data. The stop-loss limits the risk of the trade. The fixed risk differs from moving averages using bands based on volatility because they back away as volatility increases. But there are some rough edges to the system. The incremental ranges for volatility, entry points, and stops seem to be a crude measure. Even if they are accurate in the center of the range, they must get less accurate at the extremes where volatility causes an abrupt change in parameter values when it moves from one range to another.

MPTDI sets the groundwork for a smoother, more adaptive process. Before such a process can be developed, however, it is necessary to study price movement at discrete levels, such as those shown in MPTDI. From discrete relationships it is possible to generalize a continuous relationship. These adaptive methods are covered in Chapter 17.

The Volatility System

Another method that includes volatility and is computationally simple is the *Volatility System*.[8] It is an early use of the *average true range* (ATR). Signals are generated when a price change is an unusually large move relative to the ATR, calculated over n days as:

$$ATR_t = \frac{1}{n} \sum_{i=t-n+1}^{t} TR_i$$

where TR_i is the *true range* on day i. The *average true range* was defined in Chapter 5. For a calculation period of n days, the trading rules are given as:

- *Sell* if the close drops by more than $k \times \text{ATR}_{t-1}$ from the previous close.
- *Buy* if the close rises by more than $k \times \text{ATR}_{t-1}$ from the previous close.

[8]Richard Bookstaber, *The Complete Investment Book* (Glenview, IL: Scott, Foresman, 1984), p. 231.

The value of k is generally about 2.0. There are few trades but high reliability. What is particularly interesting about the volatility system is that the trend is defined only by a large move. When there is a price shock, the following movement is in the direction of the shock. You can test this using *TSM Volatility System* on the Companion Website.

The 10-Day Moving Average Rule

The most basic application of a moving average system was proposed by Keltner in his 1960 publication, *How to Make Money in Commodities*. His choice of a moving average calculation period was based solely on experience. The system itself is simple, a 10-day moving average applied to the average of the daily high, low, and closing prices, with a band on each side formed from the 10-day moving average of the high-low range (similar to a 10-day average true range). A buy signal occurs when the price crosses above the upper band and a sell signal when the price crosses below the lower band; positions are always reversed.

The *10-Day Moving Average Rule* is an early example of a volatility band. Keltner preferred this particular technique because it identifies minor rather than medium- or long-term trends, and there are some performance figures that substantiate his conclusion. A side benefit to the selection is that the usual division required by a moving average calculation can be substituted by a simple shift of the decimal place; in an era before the pocket calculator, who knows how much impact that convenience had on Keltner's choice?

The price history now shows us that price movement was much smoother up to the end of the 1970s and has been getting noisier ever since. A 10-day moving average, supplemented by a volatility band, was truly the state-of-the-art technology. While the shorter calculation periods are not generally successful for current price moves, the use of volatility to create bands has held up well over time.

TRIX, Triple Exponential Smoothing

A triple exponential smoothing technique that was first described by Hutson[9] has gained popularity over the years. Called *TRIX*, it first takes the natural log of the price to account for growth and then applies an exponential smoothing three times using the same smoothing constant. A buy signal is generated when the triple-smoothed trendline rises for two consecutive days; a sell signal occurs when the trendline falls for two days in a row. The exponential smoothing process usually starts by setting the initial trend value to the current price, $E1_0 = p_0$, but in this case $E1_0 = \ln p_0$. The rest of the process is:

$$E1_t = E1_{t-1} + s \times (\ln p_t - E1_{t-1})$$

$$E2_t = E2_{t-1} + s \times (E1_t - E2_{t-1})$$

[9]Jack K. Hutson, "Good TRIX," *Technical Analysis of Stocks & Commodities* (July 1983).

$$E3_t = E3_{t-1} + s \times (E2_t - E1_{t-1})$$

$$TRIX = (E3_t - E3_{t-1}) \times 10000$$

This original approach has seen some variations over the years. The most significant is not using the natural log of prices but changing the final step to a percentage change. The percentage change at the end speeds up the process. The smoothing constant should represent a short time period, between 3 and 20 days but recommended as 6 days. The number of days is converted to a smoothing constant using $s = 2/(n + 1)$. The alternative calculation is:

$$E1_t = E1_{t-1} + s \times (p_t - E1_{t-1})$$

$$E2_t = E2_{t-1} + s \times (E1_t - E2_{t-1})$$

$$E3_t = E3_{t-1} + s \times (E2_t - E1_{t-1})$$

$$TRIX_t = (E3_t - E3_{t-1})/E_{t-1}$$

A *signal line* is created by taking the 3-day moving average of the TRIX values. A buy occurs when TRIX crosses above the signal line and a sell when it crosses below the signal line. Using a signal line is a technique that will be seen with other momentum indicators, such as the MACD.

A 9-day TRIX is shown in the lower part of Figure 8.12 corresponding to the price of euro currency futures in 2013. The final step that takes the difference between the current and previous TRIX value removes the lag that would be expected, yet it is still reasonably smooth. Price peaks and TRIX peaks are nearly at the same place. The effect of the weighting on price data caused by double and triple smoothing was discussed in Chapter 7. Readers who are interested in similar methods should refer to Blau's *True Strength Index* and *True Directional Movement*.

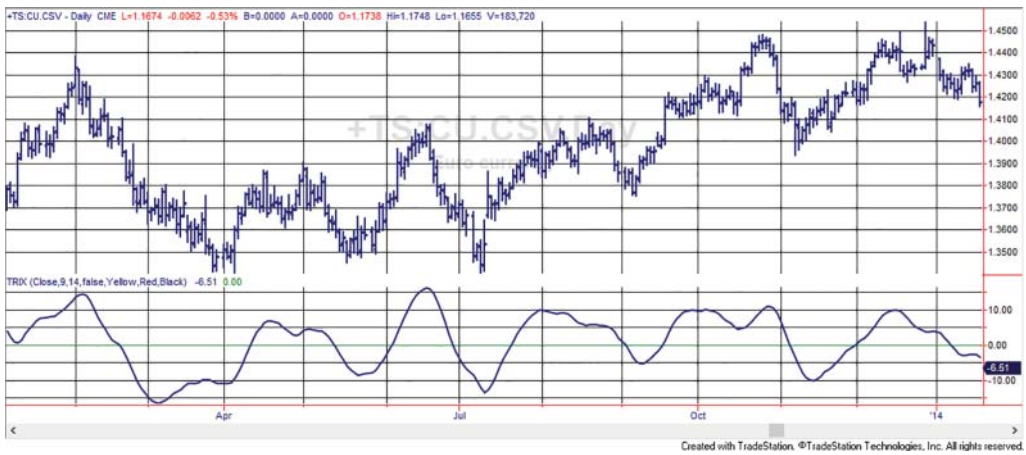

FIGURE 8.12 A 9-day TRIX based on euro futures shows that a triple smoothing does not create the lag that would be expected.

COMPARISON OF SINGLE-TREND SYSTEMS

Trend strategies dominate the world of algorithmic trading and managed futures in particular. But which method is the best? There are many rules that can be added to a basic trend strategy, including stop-losses, profit-taking, and entry timing, that change both the return and the risk profile. There are cases where an underlying losing strategy can be turned profitable by risk management or clever timing rules; however, it is always best to start with a sound trend-following method that is profitable without add-ons and has the risk characteristics most acceptable to you.

This chapter will not draw conclusions about which trending method is best. It may be that there is no best strategy, only trade-offs between risk and reward, fast or slow. By testing a small sample of markets for the same data interval and of the same calculation period, we can understand how the major trending methods differ, especially in their risk profiles. The most popular approaches, two event-driven trends (discussed in Chapter 5) and four time-driven trends, are:

1. *M*, an *N*-day momentum
2. *MA*, a simple moving average
3. *EXP*, exponential smoothing
4. *BO*, *N*-day breakout
5. *SWG*, swing breakout
6. *LRS*, linear regression slope

The markets used will be IBM, Ford, and Bank of America representing the equities, and Eurodollar interest rates, the *e*mini S&P, the euro currency, and crude oil futures markets. The data for equities has been adjusted for splits and the futures are continuous, back-adjusted contracts. Neither of these data adjustments affects the trend calculations or trading signals. The time period will be 1991 to 2018 for futures and 2000 to 2018 for stocks. Position sizes will be variable based on an investment of $25,000 for futures and $10,000 for stocks. A cost of $8 per trade for stocks and $8 per side per contract for futures will reduce the returns.

In Chapter 21 we will explore testing in depth, looking at the pattern of returns for different stocks and futures, and selecting the best parameters. Here, we are interested in the risk-and-reward profiles of these methods. It is one way a trader can decide if she can feel comfortable trading that system. A different calculation period will be used for some of the markets because some trend better than others.

Trading Rules

To see the characteristics of each system, the trading rules will be as simple as possible. Only the basic buy and sell signals will be used (where *sell* is both exiting longs and selling short). All six systems are always in the market. There are no

stop-losses or other risk controls; therefore, each system will show its own, natural risk profile. All entries and exits are done at the current closing price. While it is more realistic to trade stocks on the next open, futures trade nearly 24 hours each day and you cannot run your system, produce trading signals, and execute orders before the next open, which is 30 minutes after the close. Understanding that, an execution on the current close will be the fairest way to compare systems across markets.

The following is a brief description of the type of system, calculation method, and trading rules. Note that, for MA, EXP, and LRS, the trading signal is based on the direction of the trendline.

1. *M*, *N*-day momentum
   a. *Buy* when $close_t > close_{t-n}$
   b. *Sell* when $close_t < close_{t-n}$
2. *MA*, Simple moving average
   a. *Buy* when $MA_t > MA_{t-1}$
   b. *Sell* when $MA_t < MA_{t-1}$
3. *EXP*, Exponential smoothing
   a. *Buy* when $Exp_t > Exp_{t-1}$
   b. *Sell* when $Exp_t < Exp_{t-1}$
4. *BO*, *N*-day breakout
   a. *Buy* when $high_t > highest(high, \ t-1, \ n)$ and $close_t > close_{t-1}$
   b. *Sell* when $low_t < lowest(low, \ t-1, \ n)$ and $close_t < close_{t-1}$
5. *SWG*, Swing breakout
   a. *Buy* when the *current swing high* > *previous swing high*
   b. *Sell* when the *current swing low* < *previous swing low*
6. *LRS*, Linear regression slope
   a. *Buy* when *Slope(close,t,n)* > 0
   b. *Sell* when *Slope(close,t,n)* < 0

In the rules described above, the functions *highest*, *lowest*, and *slope* use the parameters (*price, current day, calculation period*), then $highest(high, \ t-1, \ n)$ will return the highest high for the n days ending on the previous day, $t-1$.

Spreadsheet Calculations

A spreadsheet is an easy way to see the returns of all but the swing method. The function *OFFSET* allows the calculation period (located in F3) to be changed,

resulting in all calculations and returns changing. It is a simple way of allowing different calculation periods to be tested. The calculations for the other five systems can be done in a single column, using the following setup and instructions:

1. Column A is the date.
2. Columns B, C, D, and E are the open, high, low, and closing prices.
3. F3 has the calculation period that will be used for all five strategies.
4. Column F calculates the momentum as =E163-OFFSET(E163,−F3+1,0). Calculations begin in row 163 because there will be a maximum of 160 days allowed.
5. Column G is the moving average =AVERAGE(E163:OFFSET(E163,−F3+1,0)).
6. Column H is the exponential smoothing, =H162+H3*(E163-H162). Cell H3 = 2/(F2 + 1), the standard conversion from days to smoothing constant.
7. Column I is the regression slope =SLOPE(E163:OFFSET(E163,−F3+1,0), A163:OFFSET(A163,−F3+1,0)).
8. Column J records if the most recent breakout is up (+1) or down (−1) =IF(E163>MAX(E162:OFFSET(E162,−F3+1,0)),1,IF(E163<MIN (E162:OFFSET(E162,−F3−1,0)),−1," ")).

The next five columns, K–O, show the continuous trend direction (+1 or −1) based on the calculations in F–J. Then cell K164 (momentum) =IF(F164>F163,1,−1). Once there is an initial direction, the cells are either +1 or −1. The breakout strategy, column J, takes 77 days before the first trend can be identified.

The last five columns give the cumulative profit or loss in points; that is, there is no conversion to dollars. Cell P165=K164*($E165-$E164)+P164. For the Eurodollar interest rates, the futures market conversion is $2,500 per big point. Then a move from 97.00 to 98.00 is worth $2,500. Results for one futures market and one stock, the S&P and AAPL, can be found in three spreadsheets, *TSM Trend Systems Comparisons SP* and *TSM Trend Systems Comparisons AAPL*, available on the Companion Website. The programs *TSM Trends*, *TSM Swing*, and *TSM Momentum* were used to produce the results that follow.

Results for Futures

Table 8.7 is a summary of the futures market results. The calculation periods, shown with the system name in column B, are different for most of the markets. Those with stronger trends have longer periods, although all are quite long. The swing filter varies the most and is larger when a market has more noise and smaller when it has more trend. In column K, the *ratio* is the T*otal PL* (Col C) divided by the *Max Drawdown* (col J). It is a good measure of success.

TABLE 8.7 Summary of futures market results.

A	B	C	D	E	F	G	H	I	J	K
	System	Total PL	Long PL	Short PL	Profit Factor	Trades	%Prof Trades	Days Held	Max Draw	Ratio
Eurodollars	MA 160	$7,982,720	$6,779,769	$1,202,951	4.61	102	34.3	69.4	($670,906)	11.90
	BO 160	$7,526,277	$6,972,466	$553,811	7.33	20	65.0	349.3	($700,168)	10.75
	LRS 160	$6,806,003	$6,368,009	$437,994	4.53	26	50.0	269.3	($1,030,097)	6.61
	EXP 160	$6,797,150	$6,002,226	$794,924	3.68	140	22.1	50.8	($808,109)	8.41
	Swing 2%	$3,905,013	$4,231,857	($326,844)	1.64	282	37.2	25.7	($732,784)	5.33
	MOM 160	$7,629,409	$6,943,497	$685,913	4.79	101	34.6	68.4	($641,178)	11.90
emini S&P	MA 160	$2,332,118	$3,321,853	($989,735)	1.62	181	28.7	39.6	($1,352,180)	1.72
	BO 160	$2,888,153	$3,645,825	($757,672)	2.37	27	44.4	256.0	($1,240,622)	2.33
	LRS 160	$5,182,348	$5,359,980	($177,632)	4.28	30	43.3	233.8	($1,664,422)	3.11
	EXP 160	$1,832,050	$3,061,964	($1,229,914)	1.38	287	15.0	25.3	($990,873)	1.85
	Swing 9%	$3,399,836	$3,093,387	$306,449	5.55	22	45.4	293.3	($896,000)	3.79
	MOM 160	$1,878,236	$2,813,001	($934,765)	1.51	179	29.0	37.2	($1,338,172)	1.40
Euro	MA 120	$2,658,518	$1,116,006	$1,542,512	1.62	210	33.8	34.2	($1,039,919)	2.56
	BO 120	$2,927,716	$1,629,240	$1,298,477	2.16	34	47.1	206.1	($1,219,941)	2.40
	LRS 120	$3,462,645	$1,593,347	$1,869,299	2.33	52	48.1	135.1	($1,080,985)	3.20
	EXP 120	$3,075,915	$1,635,219	$1,440,696	1.58	362	17.4	20.3	($1,195,265)	2.57
	Swing 2%	$4,852,806	$2,608,670	$2,244,136	2.18	159	47.2	44.3	($699,124.50)	6.94
	MOM 120	$2,609,894	$1,148,758	$1,461,136	1.61	209	33.4	34.2	($1,032,175)	2.53
Crude	MA 100	$4,871,166	$3,439,154	$1,432,012	2.01	259	35.1	27.8	($1,342,802)	3.63
	BO 100	$5,258,306	$4,064,040	$1,194,266	3.11	36	33.3	192.6	($976,864)	5.38
	LRS 100	$4,137,986	$3,003,342	$1,134,644	2.30	63	36.5	111.3	($1,252,882)	3.30
	EXP 100	$3,563,194	$2,592,276	$970,918	1.68	349	20.0	20.9	($940,706)	3.79
	Swing 4.5%	$4,553,426	$3,486,558	$1,066,868	2.32	114	38.6	61.9	($840,402)	5.42
	MOM 100	$4,861,582	$3,375,746	$1,485,836	2.02	258	34.9	27.9	($1,329,866)	3.66

The profits and ratios for Eurodollars are far higher than other markets because it has the strongest trend. On the other end of the spectrum is the S&P, which has the lowest ratio. The euro currency is fairly trending and shows balanced gains on both long and short positions, while the S&P strongly favors long positions and crude oil does better long but is also profitable on short sales.

Looking at the individual systems, exponential smoothing is consistently a poor choice over the standard moving average, and momentum results are almost identical to the moving average, which was explained when we looked at the calculations in Chapter 7. The swing system has varying results based on the swing filter – very good for crude oil and the euro, not as good for the Eurodollars and S&P.

It comes down to the three systems at the top of each group: the moving average, the breakout, and the linear regression slope. Of those, the moving average has far more trades and a much lower percentage of profitable trades, yet for Eurodollars it has the highest ratio. Otherwise, the linear regression slope has the best overall profile and is generally good for all markets.

You can't really go wrong, whichever method you choose. There is great similarity in the results. Taking only the *e*mini S&P for the moving average, breakout,

FIGURE 8.13 Cumulative profits of S&P futures for four strategies.

regression, and swing methods, Figure 8.13 shows that the returns of all four systems tracked closely until 2000, when the downturn due to the Internet bubble resulted in different patterns. Afterward they continued to track closely. In this case, the linear regression outperformed, but the swing method had the smoothest returns. If you study the other markets, you will find that the best system will vary but most perform similarly. It is more important to select markets that trend than it is picking the "best" system.

Results for Stocks

Based on a $10,000 investment and data from 1998 through July 2018, the results of the six trend strategies are summarized in Table 8.8. The first observation is that short sales are not profitable, with the exception of General Electric, which has been in a steady decline for years.

Overall, the exponential smoothing does poorly, except for AAPL, and the swing method is erratic. The moving average, breakout, and linear regression all perform well, even though the best performer varies from stock to stock. Figure 8.14 shows the comparative performance, including both long and short positions, of four systems applied to Boeing (BA). While the patterns are very similar, this time the moving average had the best returns.

Observations

By observing the performance pattern of the six systems, we can draw some interesting and valuable conclusions:

- Long-term trend following can be profitable.
- All basic trending strategies are profitable if the market trends.

TABLE 8.8 Summary of stock market results.

	System	Total PL	Long PL	Short PL	Profit Factor	Trades	%Prof Trades	Days Held	Max Draw	Ratio
AAPL	MA 120	$76,619	$84,754	($8,136)	2.98	119	31.9	42.9	($22,964)	3.34
	BO 120	$124,998	$124,582	$416	11.49	17	70.6	290.9	($40,584)	3.08
	LRS 120	$52,423	$70,524	($18,101)	2.3	35	45.7	143.3	($26,808)	1.96
	EXP 160	$84,684	$89,447	($4,763)	3.07	151	19.2	34.0	($20,489)	4.13
	Swing 6%	$49,980	$63,113	($13,132)	1.63	202	42.1	25.3	($9,491)	5.27
	MOM 120	$74,833	$82,968	($8,136)	2.93	118	31.4	42.6	($22,964)	3.26
BA	MA 160	$54,508	$49,696	$4,812.33	4.58	91	42.8	55.7	($6,667)	8.18
	BO 160	$36,122	$36,673	($550.75)	4.87	13	53.8	373.8	($8,087)	4.47
	LRS 160	$36,018	$38,069	($2,051)	3.69	24	45.8	208.6	($6,191)	5.82
	EXP 160	$3,897	$20,593	($16,696)	1.07	273	10.2	19.2	($19,398)	0.20
	Swing 6%	$29,205	$33,326	($4,120)	1.73	104	40.4	48.2	($7,616.8)	3.83
	MOM 160	$36,750	$32,443	$4,306	3.34	89	41.6	51.5	($6,667)	5.51
GE	MA 160	$13,760	$8,161	$5,599	1.57	128	32.8	39.9	($13,793)	1.00
	BO 160	$14,052	$6,897	$7,155	2.36	16	43.7	309.7	($11,751)	1.20
	LRS 160	$18,286	$9,878	$8,408	2.84	29	44.8	172.8	($6,239)	2.93
	EXP 160	$970	$885	$85	1.03	224	18.7	23.2	($10,766)	0.09
	Swing 6%	$1,516	$698	$818	1.03	107	37.4	47.1	($14,052)	0.11
	MOM 160	$8,582	$8,161	$421	1.36	127	32.3	38.0	($13,793)	0.62
V	MA 120	$23,532	$28,345	($4,813)	3.03	75	32.0	33.2	($9,199)	2.56
	BO 120	$21,827	$28,598	($6,770)	4.12	8	62.5	301.5	($7,190)	3.04
	LRS 120	$24,330	$28,745	($4,415)	5.79	14	35.7	173.5	($6,831)	3.56
	EXP 160	$5,256	$17,842	($12,586)	1.21	97	11.3	25.9	($12,664)	0.41
	Swing 6%	$9,380	$17,505	($8,126)	1.62	42	40.5	55.7	($6,486)	1.45
	MOM 120	$15,479	$20,375	($4,896)	2.33	73	30.1	28.4	($9,199)	1.68

- Exponential smoothing has the poorest performance.
- Momentum is very similar to a moving average, but the moving average is the better choice.
- Any one of the four systems shown in Figures 8.13 and 8.14 could be the best performer for a selected futures market or stock.
- A larger percentage of profitable trades is associated with fewer trades and higher risk.
- Short sales in equities are not generally profitable.

When adding other features to a system, it needs to be proved that those features improve the results, because the simple approach seems to be very good.

Looking for Patterns

In order to explain why long calculation periods were used for the tests shown in the previous examples, it is necessary to preview the explanations that will be found in Chapter 21, "System Testing." Looking first at futures (Figure 8.15), all

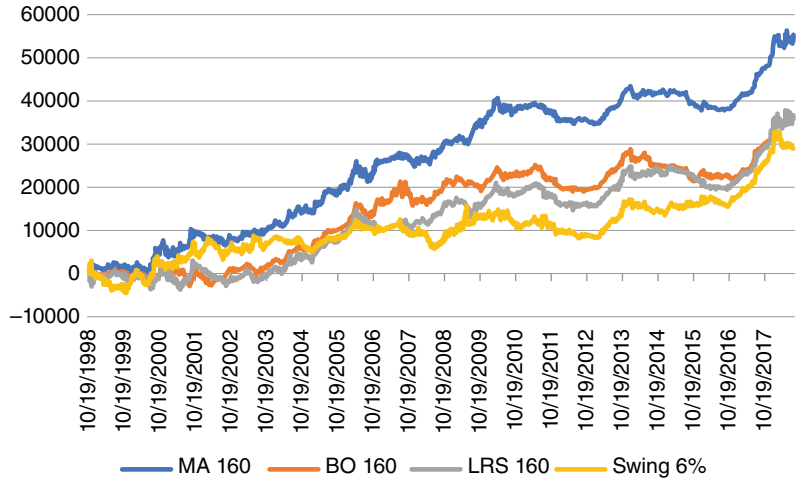

FIGURE 8.14 Results of trend strategies for Boeing (BA) from 1998 through July 2018.

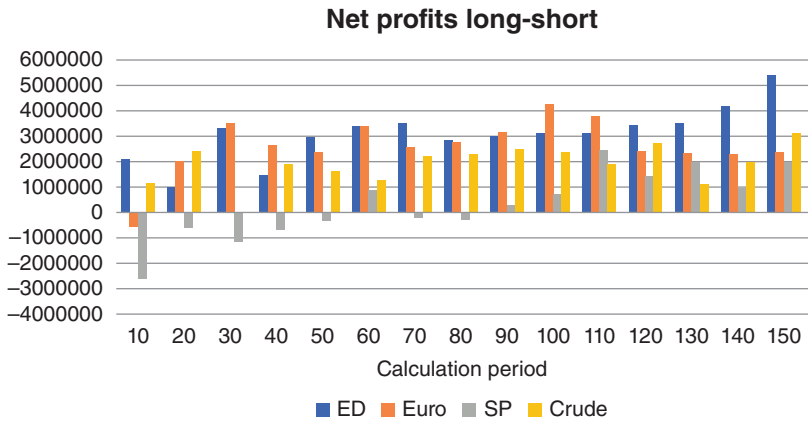

FIGURE 8.15 Moving average net profits from futures, 1998–2018.

four markets tend to improve as the moving average calculation periods increase. This is especially clear for the Eurodollars (ED) and the S&P. We expect that many commodities will have shorter trends than interest rates and FX markets because they are seasonal. The S&P is the only market posting significant losses using shorter calculation periods, the result of more price noise.

Using Amazon (AMZN), Boeing (BA), and Ford (F) for the moving average tests, we see a more erratic pattern in Figure 8.16, but there is still a tendency for improved returns with longer calculation periods. By using the period from 1998 through 2018, two major bear markets and some recently volatile price moves are included. Amazon has been in a long and sometimes volatile uptrend in its quest to take over the world, and a longer trend period allows us to hold the position through temporary drawdowns. Boeing has shown good trends and is benefiting from increased geopolitical tension, including the United States and North Korea, Iran, and possibly Russia. Ford has also been doing well since the

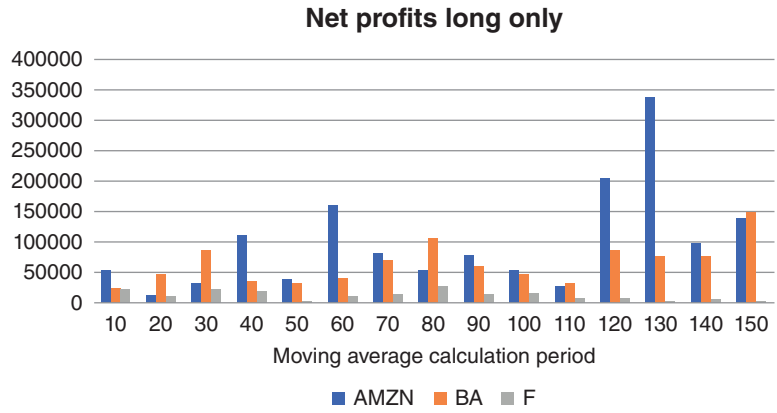

FIGURE 8.16 Moving average net profits for selected stocks, 20 years ending December 2018.

2008 financial crisis but favors a mid-range trend. Most stocks favor the long-term trends, although the overall picture is not as uniform as the sample of futures markets because individual stocks have unique personalities.

Strategy Comparisons: Stocks

Can we expect the same results from other trend systems? We already know that when prices trend, we should expect profits from any trending system, but verifying that premise is important.

Starting with stocks, Figures 8.17, 8.18, and 8.19 show the net profits from testing the moving average, breakout, and linear regression slope for Amazon (AMZN), Boeing (BA), and Ford (F), from 1998 through 2018, with calculation periods from 10 to 150 days, in steps of 10 days. Only long positions were taken due to the upward bias of equities, and the difficulties in capturing short sale profits. The first thing you should see is the overall profitability of all three stocks over all calculation periods for the different trending methods. This fits with the idea

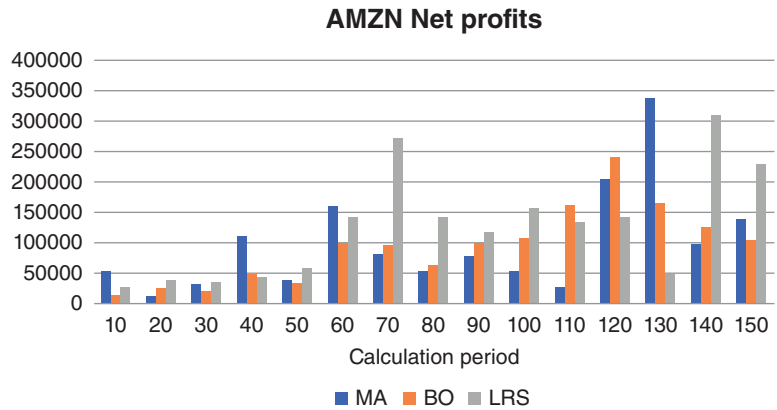

FIGURE 8.17 Amazon (AMZN) net profits from three systems.

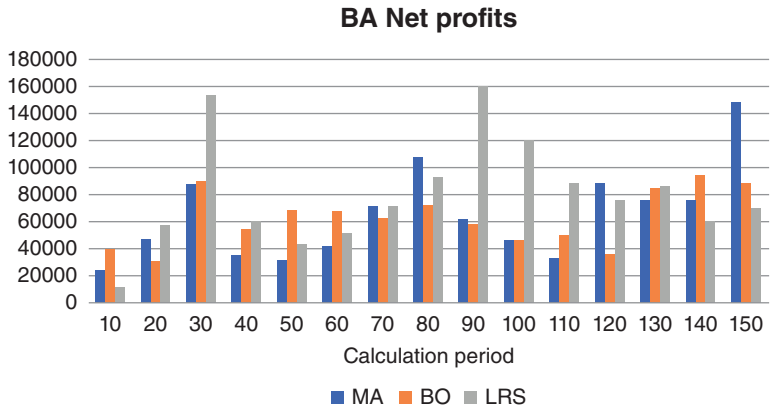

FIGURE 8.18 Boeing (BA) net profits from three systems.

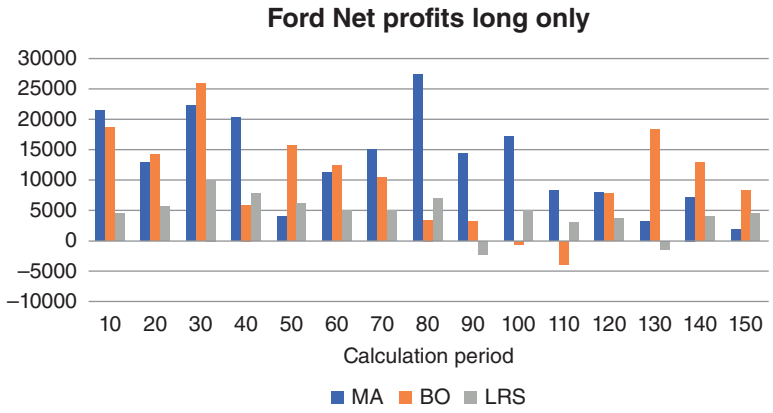

FIGURE 8.19 Ford (F) net profits from three systems.

that a macrotrend strategy should start at a 40- or 60-day period and go up and that, at any one time, any trending method could be the best.

Next, we look at the way profits distribute. AMZN and BA favor the longer trends, but F is the opposite, with all techniques favoring much shorter trends. As a trend follower looking for robustness, Ford presents a problem because there is a lack of a long-term trend. If we look at all three tests, each of the systems had periods where they were better than the others. Then, which of the three systems is best?

If we average the results of each system for all markets over all calculation periods, we can get a better idea of overall success. Table 8.9 shows that the regression was generally better but lower for Ford. There will always be exceptions, but all trending systems work in a similar way.

Strategy Comparisons: Futures

Futures offer a different type of diversification than stocks. Individual stocks can have very different dynamics and different earnings, but there is an overall

TABLE 8.9	Summary of system net profits for stocks.		
	MA	**BO**	**LRS**
AMZN	99,794	93,841	126,489
BA	65,478	63,333	80,244
F	13,029	10,172	4,456
Average	59,434	55,782	70,396

similarity in the movement of a large percentage of stocks in the S&P. When the economy is doing well, there is greater disposable income and more purchasing. When interest rates are lowered, companies pay less to service their debt and consumers pay less to take on more debt.

Interest rate futures have even more in common, that is, they are more highly correlated. The U.S. 5-year Treasury note will move much the same as the 10-year note. Even European interest rates will move with U.S. rates when there is action by the Fed. We also know that currencies are sensitive to interest rates because money seeks the highest rates, net of inflation. The stock market will also rally on lower rates given good news about the economy. But these futures sectors offer a considerable amount of diversification and have fundamentals that may cause them to make sustained moves not tied to interest rates. Energy and agricultural products have only a distant relationship.

The test results are shown in Figures 8.20 through 8.23, each the same 20 years of data in which markets saw bull and bear periods, as well as low and high volatility. We should expect patterns to be different for each market.

Starting with Eurodollar futures, which has a very strong trend, we see that longer calculation periods are better for all systems, and there are no periods that generated losses, even net of costs. The breakout system is best for longer term trends, but worse for short periods.

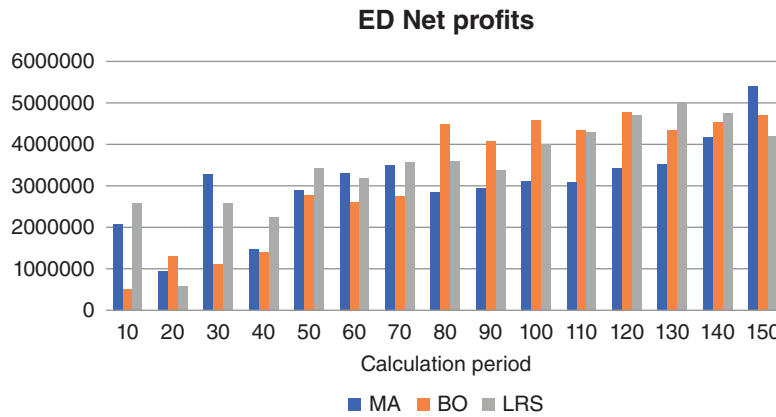

FIGURE 8.20 Eurodollar futures have a strong trend and benefit from any trend method.

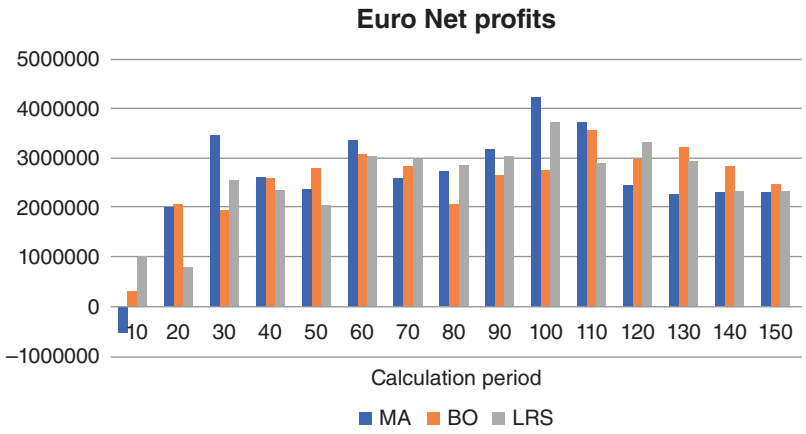

FIGURE 8.21 The euro currency (CU) has a strong trend but performs about the same for most of the calculation periods.

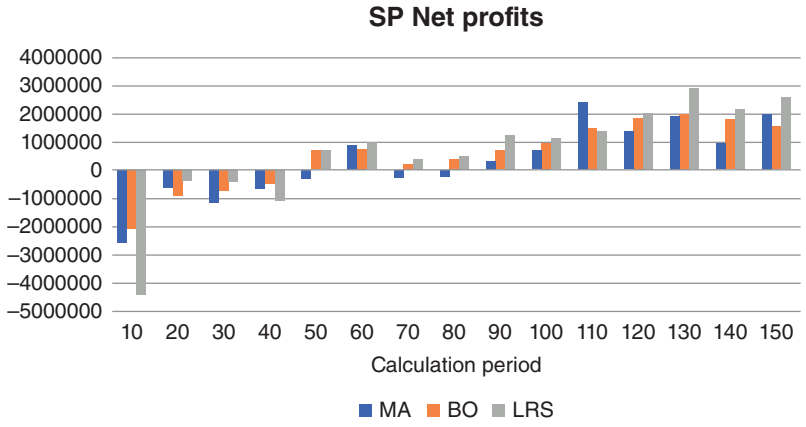

FIGURE 8.22 *e*mini S&P futures show a weak long-term trend and excessive noise in the short term.

Euro futures react to interest rates but are also affected by trade policy and geopolitical events. Money will flow into the U.S. when investors think that the stock market will rise or that interest rates are favorable. Nearly all calculation periods were profitable to much the same degree in all systems. It is clear that the euro is a trending market.

The *e*mini S&P futures – the most active of all markets – shows that it has a long-term trend but extreme noise in the short-term; that is, prices rarely move in one direction for more than a few days before a reversal (Figure 8.22). Still, there is an upward bias in the stock market due to broad participation by investors through their retirement accounts. That shows as a long-term trend, but not one that produces large profits. All three trend systems seem to perform about the same.

Crude oil is driven by geopolitical events, OPEC policy, and short-term supply and demand. For years the price sat at $20/bbl, ran up to $145/bbl in July 2008,

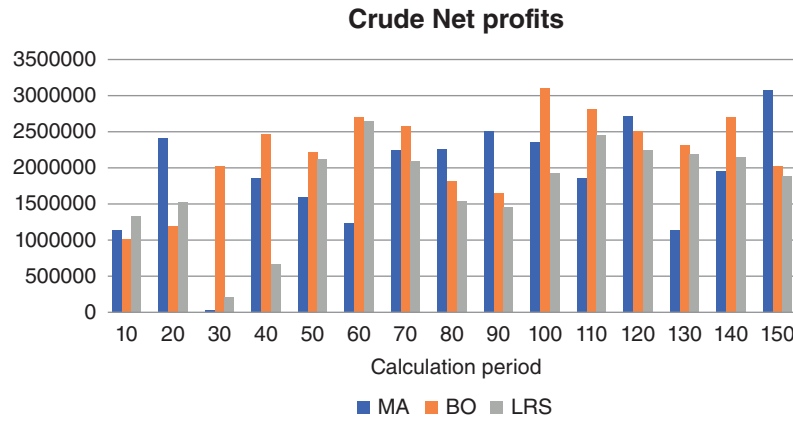

FIGURE 8.23 Crude oil futures (CL) has had wide-ranging, volatile price moves over the 20-year test period.

and back to $30. While there is a long-term rise in prices, the volatility of the price swings is best captured with the mid-range calculation periods, shown in Figure 8.23. There is no telling which of the three trends will be best at any one time.

Can you tell from looking at the four futures markets, which system is best overall? Table 8.10 shows that the results are very close. The moving average is only best for the euro while the linear regression is best for three markets.

Making a Decision

Given these test results, which of these trend methods would you choose? These tests represent only a small sample of markets. It may be that they favored the regression by chance. Perhaps that test period wasn't a good choice. Do you care which system worked best over 20 years, or should you only consider the last five or 10 years?

There is also the risk profile and the percentage of profitable trades. The moving average has many small losses and fewer larger profits. It typically has less than 35% profitable trades. At the other extreme, the breakout system has high risk, the difference between the highest high and lowest low over the calculation period,

TABLE 8.10 **Average results of the three trend strategies for four sample futures markets.**

	MA	BO	LRS
ED	3,076,472	3,230,321	3,478,999
Euro	2,604,648	2,553,821	2,555,869
SP	308,406	545,553	647,580
Crude	1,896,764	2,210,268	1,767,644
Average	1,971,573	2,134,991	2,112,523

but it may have 50% to 70% good trades because it allows prices to flop around without reversing the trade. The regression system falls somewhere in between in both risk and percentage of profitable trades.

There is not going to be one "right" system. Breakouts may be better for intraday trading and moving averages for long-term trends. Regression will be better for arbitrage and ranking. Each system has a preferred application.

In Chapter 21 we will take a closer look at testing, including parameters other than trend speed. With more information, it will be easier to make a decision.

Programs for Six Systems

In addition to a spreadsheet that gives comparative performance for the six systems, there are individual programs on the Companion Website that will provide much more detail: *TSM Momentum, TSM Moving Average, TSM Exponential, TSM N-Day Breakout, TSM LinReg Slope, and TSM Swing*. There is also one program, *TSM Trend,* that allows you to choose one or more of the four main systems. In the programs, the momentum, moving average, and exponential get signals from the trendline rather than a price penetration. Each program has useful options.

TECHNIQUES USING TWO TRENDLINES

There are situations where two trends of different calculation periods can be an improvement over one trend. It is often the case that there is a dominant, long-term trend driven by government interest rate policy. Trends based on fiscal policy can last for years and can be very persistent. Most traders, however, are not likely to hold a single long-term trade for the full period of its move. Even if convinced of the ultimate outcome of the trade, there can be very large price swings along the way. These traders would rather enter and exit the market many times, in the direction of the longer-term trend, each time taking a small profit but with much smaller risk. The net result may be lower total profits, but a much more comfortable risk level for each trade.

This problem can be solved with two simple moving averages or a combination of any two trendlines of different speeds. The slower trendline, using a longer calculation period, identifies the primary trend. The faster trendline is used for timing. The faster signal does not have to be a trend at all; it can be pattern recognition or any timing indicator, such as an RSI. In this section, we will use the same trending techniques previously discussed to create a 2-trend system. To implement this plan apply one of the following sets of rules (also shown in Figure 8.24).

1. *Buy* when the faster moving average crosses above the slower moving average. *Sell short* when the faster moving average crosses below the slower moving average.
2. *Buy* when the current price crosses above *both* moving averages and close out long positions when prices cross below *either* moving average. *Sell short* when

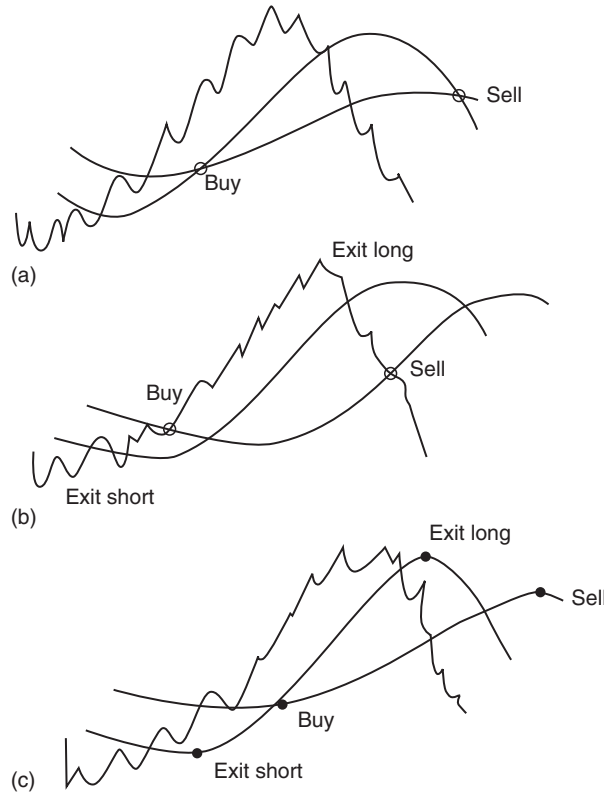

FIGURE 8.24 Three ways to trade using two moving averages. (a) Enter and exit when the trendlines cross. (b) Buy and sell when the price crosses the trendlines, staying out of the market when prices are between the trendlines. (c) Enter when both trendlines are moving in the same direction; exit when they conflict.

the current price crosses below *both* moving averages and close out short positions when prices cross above *either* moving average.

3. *Buy* when the faster trendline turns up and the slower trendline is up. *Sell short* when the faster trendline turns down and the slower trendline is down. *Exit* the trade when the two trendlines are moving in opposite directions.

The first set of rules always has a position in the market, going from long to short and back again as the faster trend crosses the long-term trend. The second and third sets of rules create a neutral zone, where no position is held. Rule 2 attempts to extract the stronger part of the move using price as a trigger while Rule 3 looks for both trendlines to provide confirmation. Exiting a trade, rather than reversing, adds liquidity by reducing the order size and allows you to enter the next trade in the same direction as the previous one, instead of always reversing.

Table 8.11 compares the euro futures using the 120-day moving average shown in Table 8.7 and a 100-day and 30-day crossover using Rule 1 above. The two trend periods for the euro were selected from Figure 8.17b, which has the advantage of hindsight. Still, returns were higher, the ratio was higher, and the number of trades

TABLE 8.11 **Comparison of a 120-day single moving average with a 100- and 30-day moving average crossover (Rule 1) for the euro futures, 1990–2018.**

	System	Total PL	Long PL	Short PL	Profit Factor	Trades	%Prof Trades	Days Held	Max Draw	Ratio
Euro	MA 120	$2,658,518	$1,116,006	$1,542,512	1.62	210	33.8	34.2	($1,039,919)	2.56
	MA 100×30	$3,441,223	$1,656,150	$1,785,073	2.05	77	36.4	90.4	($1,020,981)	3.37

FIGURE 8.25 Moving average crossover for euro futures using 100-day and 30-day periods.

lower, altogether a better profile. It simply means that a trend crossover system is a viable choice.

To visualize the way the system works, Figure 8.25 shows both trends with euro prices spanning mid-2010 to mid-2012. The buy and sell signals appear whenever the two trendlines cross.

If the strategy produces too many losses because of trades held only a few days, a small band can be placed around each of the trendlines. Prices must move higher through the upper band before a buy signal occurs and then back through the lower band before that signal is reversed. It is a small safety zone that can eliminate the frequency of bad trades even when the band is small.

Donchian's 5- and 20-Day Moving Average System

The method claiming one of the longest recorded trading histories, beginning January 1, 1961, is *Donchian's 5- and 20-Day Moving Average*.[10] In 1961, when moving averages were considered state-of-the-art, there was less noise, and agricultural markets were the most liquid, this system, the equivalent of a 1- and 4-week moving average, would have worked well. Even now, the use of calendar

[10]Richard D. Donchian, "Donchian's 5- and 20-Day Moving Averages," *Commodities Magazine* (December 1974).

periods – such as 21 and 63 days for a month and a quarter, respectively – may pick up trends driven by the action of major fund managers as they rebalance their portfolio each month while also responding to price direction resulting from quarterly earnings reports.

Donchian's idea was to use a volatility-penetration criterion relative to the 20-day moving average. The current price penetration must not only cross the 20-day moving average but also exceed any previous 1-day penetration of a closing price by at least one volatility measure. In this way Donchian places a flexible band around the 20-day trendline. One volatility measure can now be calculated as the average true range over one or more days.

The 5-day moving average is used for exits (along with others) and is also modified by prior penetration and volatility. These features tend to make Donchian's approach an early rendition of self-adjusting rules. To maintain a human element, Donchian requires execution of certain orders to be delayed a day if the signals occurred on specific weekdays or before a holiday. These refinements were based on years of actual operation.

Rather than try to implement Donchian's idea exactly, the program *TSM Donchian Moving Average System*, available on the Companion Website, uses the calculations:

1. A 5-day moving average
2. A 20-day moving average
3. The average true range based on the longer moving average period

These three calculations are then used with these rules:

- If position is not long and $Close_t > MA5_{t-1} + 1 \times ATR_{t-1}$ and $close_t > MA20_{t-1} + 1 \times ATR_{t-1}$, then *buy*.
- If position is not short and $Close_t < MA5_{t-1} - 1 \times ATR_{t-1}$ and $close_t < MA20_{t-1} - 1 \times ATR_{t-1}$, then *sell short*.
- If position is long and ($Close_t < MA5_{t-1} - 1 \times ATR_{t-1}$ $close_t < MA20_{t-1} - 1 \times ATR_{t-1}$), then exit long position.
- If position is short and ($Close_t > MA5_{t-1} + 1 \times ATR_{t-1}$ or $close_t > MA20_{t-1} + 1 \times ATR_{t-1}$), then cover short position.

Because the price level and volatility of the markets have changed dramatically since 1960, new positions should be sized according their volatility:

$$Position\ \ size = investment/(ATR \times Big\ Point\ Value)$$

where ATR is calculated over the longer moving average period and the *Big Point Value* is the conversion factor for a futures contract – for example, $50 for corn and $1,000 for U.S. bonds.

How did this strategy perform? Applying these rules to corn, which would have been the primary market during the 1960s, and with $8 per contract per side costs

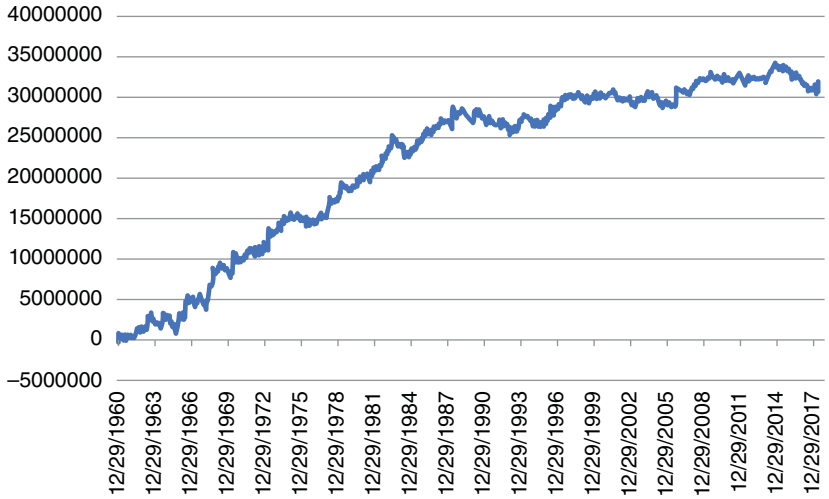

FIGURE 8.26 Donchian's 5- and 20-Day Moving Average System (somewhat modernized) applied to corn futures, 1960–2018.

(which were much higher until the mid-1990s), the cumulative profits are shown in Figure 8.26. Although the rate of return has slowed, it seems remarkable that a simple method could have been consistently profitable for 60 years. For those analysts who are interested, the program on the Companion Website allows the calculation periods to change as well as the penetration factor. Only corn was run for this example and no parameters were tested or changed.

Donchian's 20- and 40-Day Breakout

One level slower than the 5- and 20-day average is Donchian's 20- and 40-Day Breakout. Instead of 1 week and 1 month, this looks at 1 month and 2 months. The method is far less complicated and only considers simple breakouts and not volatility bands. The rules are:

Buy when *today's high* > *high* of the past 40 days

Sell short when *today's low* < *low* of the past 40 days

Exit longs when *today's low* < *low* of the past 20 days

Exit shorts when *today's high* > *high* of the past 20 days

Readers will recognize that this is the basis for the Turtles' trading method.

The Golden Cross and the Death Cross

The most popular stock market trending methods are the simplest, which does not mean they don't work. Of course, the 200-day moving average is shown as the key technical indicator on most financial networks, but 50 and 100 days are equally popular. It is not clear how these began, but doubling the period is a simple way

of keeping percentage changes the same and getting a good distribution of results over time.

The *Golden Cross* is the point at which the 50-day average crosses above the 200-day average, indicating the beginning of a bullish move in the market. It has yielded very good results for the past 60 years and avoided the damaging declines of 2008. When the 50-day average crosses below the 200-day, it is ominously called the *Death Cross*.

In Figure 8.27, the results of Golden Cross are shown with the Golden Cross plus the Death Cross. The combination is the better result but most of that was earned during the NASDAQ collapse of 2000 and the following bear market. Note that the bigger drawdown was in 2014 rather than during the financial crisis of 2008. There would also be additional interest income during periods when the long-only version was out of the market. A spreadsheet and program named *TSM Golden Cross* can be found on the Companion Website.

ROC Method

Another classic method for trading the major index is *Woodshedder's long-term indicator*.[11] It uses the rate-of-change (ROC), which is defined as the same as momentum.

- *Buy* when the 5-day ROC is below the 252-day ROC for two consecutive days.
- *Exit the long* when the 5-day ROC is above the 252-day ROC for two consecutive days.

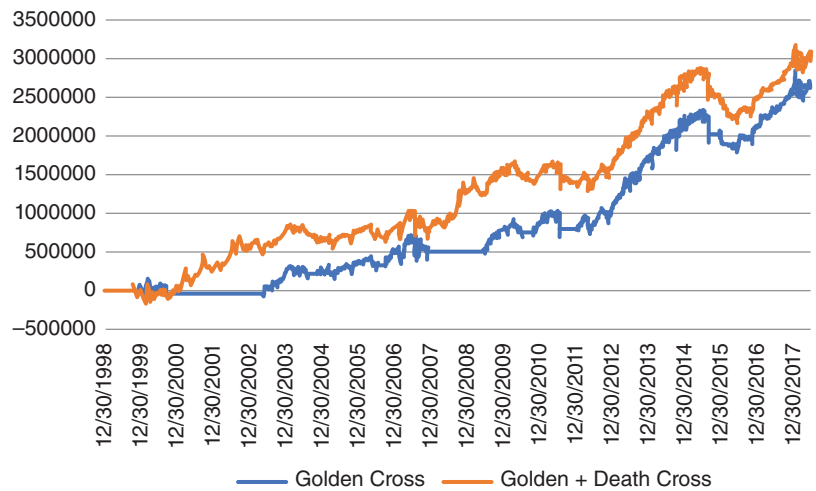

FIGURE 8.27 The Golden Cross applied to SPY showing both long-short and long-only returns compared to SPY.

[11] The *Woodshedder* blog can be found on the Internet and covers many other strategies. This method was reviewed by *MarketSci blog* on October 4, 2011, but used SPX (the cash index) rather than SPY.

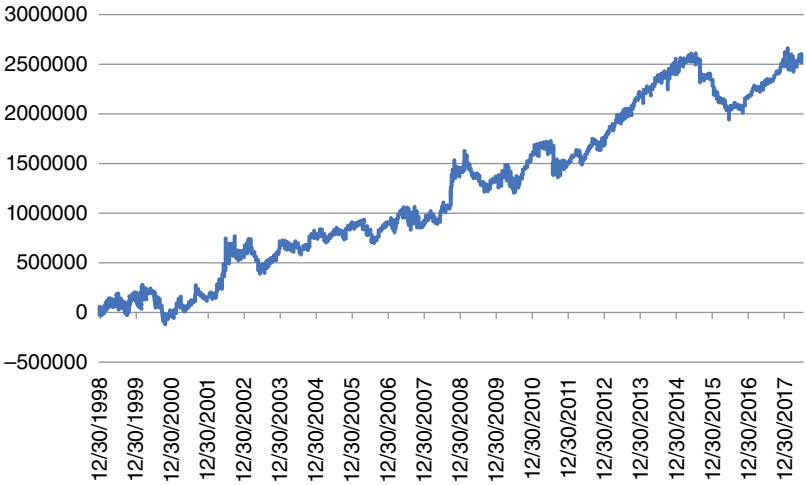

FIGURE 8.28 The ROC Method applied to S&P futures, 1998–2017.

- When there is no position, the system earns one-half of the cash 3-month T-bill rate.

Results are very good, posting profits for both long and short positions in S&P futures, with a total of 52 trades, 53% of them profitable for 20 years from 1998. The total profits are shown in Figure 8.28. The program, *TSM ROC,* can be found on the Companion Website.

Staying Ahead of the Crowd

There is always an attempt to find out where others are placing their orders and get ahead of them. For example, if you know that most trend-followers are using a 30-day calculation period, then using a 28-day average might edge them out. During the 1980s and 1990s there was a trend system that used 8 and 18 days to beat the 10 and 20 days that was most popular. The following calculations would use *fastperiod* = 8 and *slowperiod* = 18. The *differenceperiod* = 9.

$$FasterAverage = Average\ (close,\ fastperiod)$$
$$SlowAverage = Average\ (close,\ slowperiod)$$
$$TrendDifference = FasterAverage - SlowAverage$$
$$DifferenceAverage = Average\ (TrendDifference,\ differenceperiod)$$

The trading rules were:

Buy when today's *TrendDifference* > *yesterday's DifferenceAverage*

Sell short when today's *TrendDifference* < *yesterday's DifferenceAverage*

Although these calculation periods may not be profitable in today's markets, the idea of being slightly ahead of the crowd gives you *free exposure*, a small jump in profits caused by many orders following yours. If you can figure out where the crowd is buying and selling, then this concept will give you an edge.

Replication

Rather than trying to enter slightly ahead of the crowd, a technique called *replication* tries to copy a successful trading system without knowing the rules. An analyst tracks the performance of a portfolio of stocks or futures. If we know the markets that can be in the portfolio, it picks from a similar set of markets in such a way that it yields the same daily return. Each day the positions are adjusted to come as close to the returns of the target portfolio. Of course, the replicated portfolio lags one day behind.

This approach was developed by IBM to be used by the insurance industry as a way to speed up complex risk models. It was intended to be used with financial markets and cash flows but has also been adopted by fund managers as a new product. Further comment on this method can be found in Chapter 20.

THREE TRENDS

If two trends can improve trading, it should follow that three or more are even better. First, consider two trends. Compared to a single trend, there are a much larger number of combinations. Rather than optimize the calculation periods, can we find a logical relationship between the slower and faster trends? For example, should the faster trend period be 1/4 of the slower? For equities, should we use trends that align with quarterly and annual earnings? In commodities, should the combination of trends try to profit from seasonality?

We are smart enough to know that two trends that have nearly the same calculation periods will not be useful, but can a 10-day and 40-day trend, working together, generate profits? Consider this: If the 10-day trend is not profitable, and the 40-day trend is not profitable, each taken on their own, but the combination is profitable, would you trade it? These questions will be addressed in Chapter 21, but some of the concepts should be clear now. If, by computer testing, we were to "discover" that a combination of 2 or 3 trends was profitable, would you be convinced to trade it? "That depends." If a very large percentage of the combinations were profitable, it would be more tempting than if only 5 of 100 combinations were profitable.

Each Trend Must Have a Purpose

If longer-term trends are intended to track macro fundamental policy and were generally profitable, then that longer-term period would be a good candidate for one of the two or three trends. The shorter trend calculation period is not as clear, but using 1 week (5 days), 1 month (20 days), or 1 quarter (64 days) has some sense of logic, rather than optimizing.

Using the same rules as the Golden Cross, going long when the fast trend crosses above the slow trend, and going short when the fast trend crosses below

TABLE 8.12 Results of a 2-trend system using futures, 1991–2017.

	Trend	Number of Trades	Days Held	Total Long Profit	Total Short Profit	Profit Factor	Avg Trade Profit	% Prof Trades
Eurodollars	80	236	29	5,533,595	(1,019,032)	1.86	19129	27
	20	532	13	4,335,186	(1,837,553)	1.25	4694	29
	Both	88	78	5,100,400	(68,262)	2.54	51047	38
***e*mini SP**	120	243	28	3,236,779	(865,727)	1.52	9757	34
	20	532	13	1,595,730	(2,765,412)	0.89	−1707	31
	Both	77	89	2,526,750	(1,114,137)	1.35	18215	32

the slow trend, we compare both Eurodollar and *e*mini S&P futures, net of $8 per trade costs. Positions are sized for equal risk. For Eurodollars we use an 80-day moving average because that market is highly trending, and 80 days represent a typical macrotrend period. For the S&P we use a longer 120-day because we know that only a much longer trend works due to its high level of noise. Table 8.12 shows the results.

The combined trends have greatly reduced trades. For Eurodollars, which are very trending and have been in a sustained bull market, all profits were in long positions. The 2-trend results had smaller gains on long trades, but much smaller losses on short sales, giving the combined results a high profit factor, showing lower risk.

The *e*mini S&P did not fare as well. The 20-day trend had substantial losses on short sales, and the faster trading of long positions was not as good as holding the slow trend. The only improvement is in the profit per trade.

From this small sample, we might conclude that a 2-trend system improves an already trending market, but not a noisy one.

Adding a Third Trend

Is there a rationale for more than two trends? If the long-term trend is for market direction, and the shorter one is to reduce the length of the holding period, then the third could be used for entry timing. The third trend could be very fast, perhaps 3 days.

Gerald Appel[12] adds three rate-of-change (ROC) indicators together (in his calculation, ROC is the difference between the price today and the price *n* days ago) and applies the composite to the S&P index (SPX), all expressed in percent. He recommends buying when the composite crosses above 4% and exiting when it falls below 4%. If you consider the upward bias in the S&P, the 4% threshold may not seem arbitrary.

[12] Gerald Appel, *Technical Analysis: Power Tool for Active Traders* (FT Prentice Hall, 2005), p. 59.

Modified 3-Crossover Model

The justification for using three trends is that one or more slower moving averages may result in a buy or sell signal at a time when the prices are actually moving opposite to the position that is about to be entered. This can happen when we use the moving average for the signals rather than when the price crosses the trendline. A third, faster moving average can be used to confirm the direction and avoid entry into a trade that is going the wrong way. This filter can be added to any moving average or multiple moving average system with the following rule:

> *Do not enter a trade unless the confirming moving average is moving in the same direction as the position you want to enter.*

If we add a 3-day timing trend to the previous Eurodollar 80-20 crossover, we get the results in Table 8.13. In both cases there was a small improvement in the long profits and a decline in the short profits. The overall returns are slightly better. Then adding a timing trend seems to have positive results, more if you trade from the long side. A program to test any 3-trend crossover model is *TSM Modified 3MA Cross*, available on the Companion Website.

4-9-18 Crossover Model

During the late 1970s, the 4-9-18 Crossover Model was very popular. It seems likely that the selection of 4, 9, and 18 days was a conscious effort to be slightly ahead of the 5, 10, and 20 days frequently used in moving average systems during that period. Even now, high-frequency traders continue to look for the smallest edge that keeps them ahead of the competition. In addition to the marginally faster calculation periods, each moving average is (nearly) twice the speed of the prior, enhancing their uniqueness for recognizing different trends. Increasing the period in this way keeps a constant percentage difference.

The large amount of price noise makes three fast trends an unlikely combination. Tests on a sample of futures markets showed marginal profits, which is better than losses. None of the results would have convinced you to trade this. But in the days when Donchian was successful with his 10-day moving average and 5- and 20-day crossover, there is no doubt that it would have been profitable.

TABLE 8.13 **Adding a short-term trend to the 2-trend crossover system.**

	Trend	Number of Trades	Days Held	Total Long Profit	Total Short Profit	Profit Factor	Avg Trade Profit	% Prof Trades
Eurodollars	80-20	88	78	5,100,400	(68,262)	2.54	51047	38
	80-20-3	87	79	5,393,525	(378,012)	2.54	57649	39
***e*mini S&P**	120-20	77	89	2,526,750	(114,137)	1.35	18215	32
	120-20-3	72	96	2,657,212	(1,059,912)	1.40	22184	33

Ichimoku Clouds

This strategy is visually enticing, the result of projecting trends forward and coloring the space between indicators so that they look like clouds. The *Ichimoku Cloud*[13] consists of five moving average trends:

T1. *Tenkan-sen*, (9-day MA of the highs + 9-day MA of the lows)/2, also called the *Conversion Line*

T2. *Kijun-sen*, (26-day MA of the highs + 26-day MA of the lows)/2, also called the *Base Line*

T3. *Senkou A,* (T1 + T2)/2, plotted 26 periods in the future (leading)

T4. *Senkou B,* (52-day MA of the highs + 52-day MA of the lows)/2, plotted 26 periods in the futures (leading)

T5. *Chikou*, closing price plotted 26 days in the past (lagging), also called the *Lagging Span*

Senkou A and Senkou B are both plotted 26 days into the future and form the outline of one of the two clouds. The area in between is colored green when the cloud is rising and red when it is falling. By projecting the cloud forward, traders can easily see support and resistance areas as prices approach them. Figure 8.29,

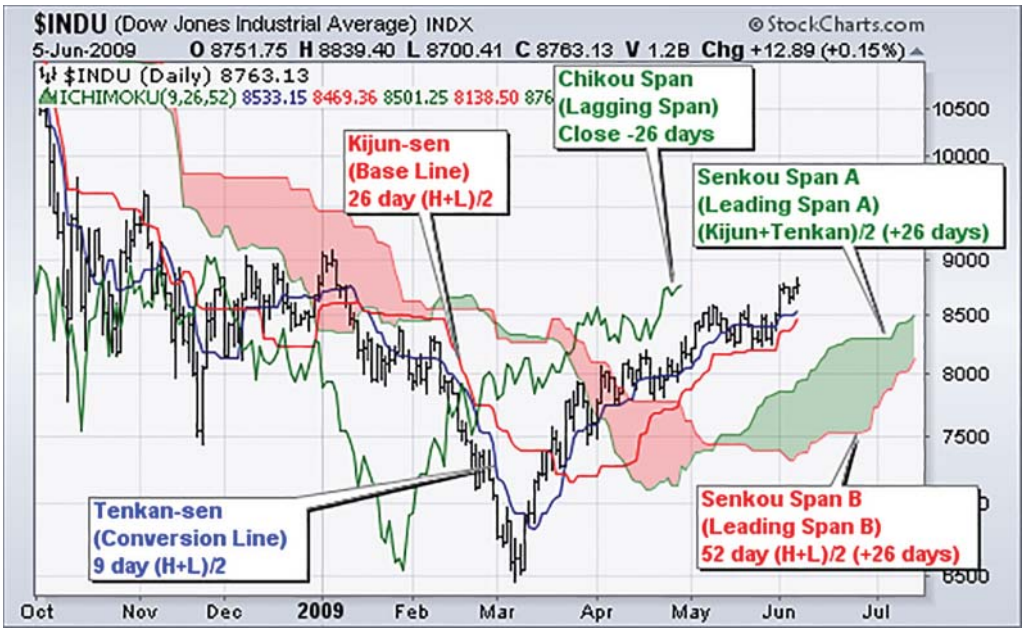

FIGURE 8.29 The Ichimoku Cloud shown on the Dow Industrials.
Chart courtesy of StockCharts.com.

[13]Developed by Goichi Hosada, published in his book in 1969 but developed in the 1930s. See www.StockCharts.com for more detail.

an example available on StockCharts.com, shows rising and falling clouds for the Dow Industrials.

Trading Rules for the Ichimoku Cloud

The "cloud" serves the purpose of a long-term trend filter. Positions are recommended only in the direction of the cloud, long when green, short when red.

Macrotrend signals:

Buy when the cloud turns from red to green or when the price moves above the cloud when the cloud is green (bullish).

Sell short when the cloud turns from green to red or when the price moves below the cloud when the cloud is red (bearish).

Shorter-term momentum and reentry signals:

Trades are taken only in the direction of the cloud.

Buy when the Conversion Line (T1) moves above the Base Line (T2).

Sell short when the Conversion Line (T1) moves below the Base Line (T2).

COMPREHENSIVE STUDIES

Because computerized testing platforms have made it easy for anyone to test any number of trends in combination, there have been very few comprehensive studies published since 1990. The exceptions are Colby's *The Encyclopedia of Technical Market Indicators* and Bulkowski's *Encyclopedia of Chart Patterns, 2nd Edition*, and *The Encyclopedia of Candlestick Charts*. All three show results in a standard form that makes it easy to compare the differences between systems. But most traders seeking a strategy will need to test it themselves and add their own special features. Both Colby and Bulkowski will give you a good idea of which methods and patterns to avoid.

There is a great deal to learn from putting the results of various systems and markets side by side. Earlier in this chapter there is an informative comparison of six major trending systems; in Chapter 21 single-trend strategies are compared for a standard set of 17 futures markets. In addition, a 2-trend crossover strategy was compared to the single-trend methods. The objective of the testing process is to find parameters that succeed over time and across many markets; this discussion is continued in Chapter 21.

SELECTING THE TREND SPEED TO FIT THE PROBLEM

Up to now, the selection of the best moving average, the one that will work in the future, has only been discussed in general terms. The success of a single calculation

period for a single-trend strategy does not mean that it is the right choice for trading. In fact, the best moving average speed for an institutional or commercial participant may be very different from that of a trader or investor.

For example, a mutual fund receives new investments that must be moved into the market, collectively, once or twice each month. In the same way, a cattle feed lot will choose one time each month to fix the price of new inventory. Each would like a better-than-average price when they buy or sell. They can do that by selecting a trend calculation period that generates one or two signals each month.[14] It is only important that the entry beat the average price that month. The next month they can start all over again. In the 3-trend crossover, we saw that the third 3-day trend helped entry timing.

A better price might also be gained using a momentum indicator, which shows when a price is overbought or oversold within some time window, but that will be discussed in the next chapter.

A trader's goal is very different. It is to find the combination of parameters that will produce the best performance profile over an investment horizon. This target profile could be simply maximum profits, or it could be a more complex combination of profits, risk, and time in the market. In Chapter 21, automated testing is used to find the combination of speed, stop-loss, and other rules that best satisfy an objective; a computer, however, is not always the answer.

Dominant seasonal factors are an important influence on the calculation period of the trend. While some stocks, such as travel and leisure, can be highly seasonal, their seasonal price patterns can be overwhelmed in any year by a strong trend in the overall market, as measured by the S&P 500. But the seasonal pattern is still there.

If you use a 12-month moving average for a seasonal market, you eliminate the chance of capturing the seasonal move. You end up with the net impact of inflation, or the change in the U.S. dollar. To capture the seasonal move, you will need a trend that is not longer than one calendar quarter, 64 days, perhaps even half that.

MOVING AVERAGE SEQUENCES: SIGNAL PROGRESSION

Consider the case where you have selected a 20-day moving average to trade. You enter the day long Biotech and you get a sell signal. However, you are unaware that the 18-day and 21-day moving averages did not get sell signals. This means that the data that was dropped off the calculation 20 days ago caused a slight shift not seen by most of the neighboring trends. This can be an important piece of information when assessing the reliability of the trend signal.

A moving average is simply a consensus of direction. It is an approximation of values intended to steer a trader to the right side of the market at the right

[14] Perry J. Kaufman, "Moving Averages and Trends" in Todd Lofton (Ed.), *Trading Tactics: A Livestock Anthology* (Chicago: Chicago Mercantile Exchange, 1986).

time. It is most fallible when prices are changing direction or going sideways. Any information that clears up the problem is valuable. For any trend system, it is helpful to look at steady progression of trend changes from the short term to the long term. This is seen in the following sequence, where *u* is an uptrend and *d* is a downtrend associated with the calculation period above those letters:

EXAMPLE E1 Orderly Trend Change

	Moving Average Period in Days																								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	20	21	22	23	24	25
Trend	u	u	u	u	u	u	u	u	u	u	u	u	u	u	u	u	u	u	u	d	d	d	d	d	d

In example E1, prices have turned up in such a way that the trend calculation periods 1 through 19 show uptrends while calculation periods from 20 and higher are still down. Unfortunately, normal price movement is not often as uniform as this example. The shorter-term trends can be very erratic, and often appear in smaller, alternating groups of up and down trends (see Example E2). This is easily explained because changing one day of data when only two, three, or four days are used in the moving average calculation can quickly change the direction of the trend. As you get to longer intervals, such as 20, 30, and 50 days, this is not the case. Most often, the trend sequence changes in a uniform, progressive manner, yet when it appears erratic, the trend change is not to be trusted.

EXAMPLE E2 Erratic trend change for the short calculation periods.

	Moving Average Period in Days																								
	1	**2**	3	4	**5**	6	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	20	21	22	23	24	25
Trend	u	u	d	d	u	d	u	u	u	u	u	u	u	u	u	u	u	u	u	d	d	d	d	d	d

There are cases where the longer trend begins to reassert itself and the results appear the same as in E1; however, the trend change occurs from the longer-term down (from right to left instead of left to right). The case we must watch for satisfies neither of these, but occurs in an erratic pattern, such as in Example E3. Here we see a dominant long-term uptrend with the very short end turning down. Because of another downturn a few days ago, which then disappeared, this most recent downturn also caused a shadow turn at 19 and 20 days. Is it a leading indicator or a false signal? All indications are that smooth changes in a trend are more reliable precursors of change.

Another case is given on the bottom line of E3. Here, the smooth trend changes from up to down is occurring from left to right; however, as it gets to 13 days, it also jumps ahead to 19 and 20 days, leaving days 14 through 18 still in an uptrend. For trends in this faster range, it appears best to wait for all fastest trends to change. As the calculation period becomes longer, it is unrealistic to expect all

faster trends to be the same; therefore, you will need to settle for an orderly change in a group of trends faster than the target trend period (the one you are actually trading).

EXAMPLE E3 Progression of trend changes.

	Moving Average Period in Days																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Trend	d	d	d	d	u	u	u	u	u	u	u	u	u	u	u	u	u	u	d	d	u	u	u	u	u
Trend	d	d	d	d	d	d	d	d	d	d	d	d	d	u	u	u	u	u	d	d	u	u	u	u	u

An example of actual trend sequences is shown in Figure 8.30. Moving average calculation periods of 5 to 50 days appear in increments of five days along the top,

	Moving Average Period											Moving Average Period									
Day	5	10	15	20	25	30	35	40	45	50	Day	5	10	15	20	25	30	35	40	45	50
1	U	U	U	U	U	U	U	U	U	U	1	U	U	U	U	U	U	U	U	U	U
2	D	D	U	U	U	U	U	U	U	U	2	D	D	U	U	U	U	U	U	U	U
3	D	U	U	U	U	U	U	U	U	U	3	D	U	U	U	U	U	U	U	U	U
4	U	U	U	U	U	U	U	U	U	U	4	U	U	U	U	U	U	U	U	U	U
5	U	U	U	U	U	U	U	U	U	U	5	U	U	U	U	U	U	U	U	U	U
6	U	U	U	U	U	U	U	U	U	U	6	U	U	U	U	U	U	U	U	U	U
7	U	U	U	U	U	U	U	U	U	U	7	U	U	U	U	U	U	U	U	U	U
8	D	U	U	U	U	U	U	U	U	U	8	D	U	U	U	U	U	U	U	U	U
9	U	D	D	D	U	U	U	U	U	U	9	U	D	D	D	U	U	U	U	U	U
10	D	D	D	D	D	U	U	U	U	U	10	D	D	D	D	D	U	U	U	U	U
11	D	D	D	D	U	U	U	U	U	U	11	D	D	D	D	U	U	U	U	U	U
12	D	D	D	D	D	D	D	U	U	U	12	D	D	D	D	D	D	D	U	U	U
13	D	D	D	D	U	U	U	U	U	U	13	D	D	D	D	U	U	U	U	U	U
14	U	D	D	D	D	D	U	U	U	U	14	U	D	D	D	D	D	U	U	U	U
15	D	D	D	D	D	D	D	D	D	U	15	D	D	D	D	D	D	D	D	D	U
16	D	D	D	D	D	D	D	D	D	D	16	D	D	D	D	D	D	D	D	D	D
17	D	D	D	D	D	D	D	D	D	D	17	D	D	D	D	D	D	D	D	D	D
18	D	D	D	D	D	D	D	D	D	D	18	D	D	D	D	D	D	D	D	D	D
19	U	D	D	D	D	D	D	D	D	D	19	U	D	D	D	D	D	D	D	D	D
20	U	D	D	D	D	D	D	D	D	D	20	U	D	D	D	D	D	D	D	D	D
21	U	U	U	D	D	D	D	U	U	U	21	U	U	U	D	D	D	D	U	U	U
22	U	U	U	U	D	U	U	U	U	U	22	U	U	U	U	D	U	U	U	U	U
23	U	U	U	D	D	D	D	U	U	U	23	U	U	U	D	D	D	D	U	U	U
24	U	U	U	U	D	D	D	U	U	U	24	U	U	U	U	D	D	D	U	U	U
25	U	U	U	U	D	D	D	U	U	U	25	U	U	U	U	D	D	D	U	U	U
26	D	U	U	D	D	D	D	D	D	U	26	D	U	U	D	D	D	D	D	D	U
27	D	D	D	D	D	D	D	D	D	D	27	D	D	D	D	D	D	D	D	D	D
28	D	D	D	D	D	D	D	D	D	D	28	D	D	D	D	D	D	D	D	D	D
29	D	U	U	U	D	D	D	D	D	U	29	D	U	U	U	D	D	D	D	D	U
30	U	U	U	U	U	D	D	D	U	U	30	U	U	U	U	U	D	D	D	U	U
31	U	U	U	U	U	D	D	D	D	U	31	U	U	U	U	U	D	D	D	D	U
32	U	U	U	U	U	U	U	U	U	U	32	U	U	U	U	U	U	U	U	U	U
33	U	U	U	U	U	U	U	U	U	U	33	U	U	U	U	U	U	U	U	U	U
34	U	U	U	U	U	U	U	U	U	U	34	U	U	U	U	U	U	U	U	U	U
35	U	U	U	U	U	U	U	U	U	U	35	U	U	U	U	U	U	U	U	U	U
36	U	U	U	U	U	U	U	U	U	U	36	U	U	U	U	U	U	U	U	U	U
37	U	U	U	U	U	U	U	U	U	U	37	U	U	U	U	U	U	U	U	U	U
38	D	U	U	U	U	U	U	U	U	U	38	D	U	U	U	U	U	U	U	U	U
39	D	D	U	U	U	U	U	U	U	U	39	D	D	U	U	U	U	U	U	U	U
40	D	D	U	U	U	U	U	U	U	U	40	D	D	U	U	U	U	U	U	U	U
41	D	U	U	U	U	U	U	U	U	U	41	D	U	U	U	U	U	U	U	U	U
42	U	U	U	U	U	U	U	U	U	U	42	U	U	U	U	U	U	U	U	U	U
43	U	U	U	U	U	U	U	U	U	U	43	U	U	U	U	U	U	U	U	U	U
44	U	U	U	U	U	U	U	U	U	U	44	U	U	U	U	U	U	U	U	U	U

FIGURE 8.30 Sequences of moving averages. Left is the original sequence. On the right the boxes outlined could be reversed.

and a history of the past 44 days are shown below. Each row shows the trend that we can see at the time; we can also see the rows below. Using the adjacent trends and the trends of the previous day, we can smooth the patterns. On the right, those trends that are boxed can be reversed to create a smoother process.

Another way of adding consistency is to count the number of up and down trends from the smallest to your target calculation period. Whichever has the largest count is the current trend.

EARLY EXITS FROM A TREND

By now we know that capturing the fat tail is necessary for the success of macro trend systems. However, there are always practical exceptions. One of the oldest truths for trend-following is "Take your losses and let your profits run." By imposing profit-taking, or even stop-losses, this can be changed to "Take your profits and let your losses run." There is a need to be very careful when making exceptions. But consider the following situation.

Interest rates declined for most of the 35 years from 1981 through 2015. For many traders, that's more than their entire professional career. To profit from this move, a slow trend system can track the 10-year Treasury note futures contract, a municipal or corporate bond index, or any number of income funds. If a 200-day trend were used, then there would be a lag of 100 days. That is, for a bond fund, the current value of the trendline would reflect the bond prices at the midpoint of the calculation period, 100 days ago. If the yield on interest rates had dropped a total of 2% during the past year, then the trendline could be lagging a full 1% behind current yields. If the trend changed direction, that can translate into a large loss in unrealized gains.

One advantage of long-term interest rate trends is that they are based on a sustained economic policy. If that policy changes, then the trend is over, even if the trendline has not yet reversed direction. When the Fed starts raising rates, or even hints that it will start raising rates sometime in the future, it has signaled a change in policy. You can reasonably conclude that the basis for the long-term uptrend in prices is over and that the trend in futures prices will turn down. A central bank rarely raises rates one month and lowers them the next. Because the very slow trend lags far behind the actual market price, it may be three months before the trendline signals a change of position. This will occur after a large part of your profits has been given back. Exiting the trade when the fundamentals change would be a safe way of capturing more profits and reducing market risk.

Caveat emptor. This is only true when a reliable government policy drives prices. Often, these decisions are clear only after the fact. In 2010 it seemed that Fed policy was going to change, yet 2011 posted a strong upward trend in bonds, with yields reaching record lows. Wait for a statement of policy. This trading method has been named *techno-fundamental*.

PROJECTING MOVING AVERAGE CROSSOVERS

Systematic trading is most successful when you can execute an order as soon as possible. Calculating your trading signals after the close of the market, then placing your order for the next open, or worse, the next close, is going to return less than executing on the same close that you just used for your new signals.

With a single *N*-day moving average, we know that a close today that is higher than the price *N* days back, which is being dropped off, means that the trendline will rise. If today's price is lower than *N* days ago, the trend will be down.

To predict where two moving averages will cross is more complicated. If the two calculation periods are *m* and *n*, the price that will cause them to cross (*CP2*) is:[15]

$$CP2 = m \times \left(\frac{\sum most\ recent\ m-1\ prices}{m} - \frac{\sum most\ recent\ n-1\ price}{n} \right)$$

Calculated each day, the projected crossover will begin to converge as it nears *CP2*. The difference between the projected crossover and the current price can also be considered a *relative strength indicator*. Lambert[16] used the change in the projected crossover to create a *Market Direction Indicator* (MDI):

$$MDI = \frac{100 \times (Crossover\ price_{\text{previous}} - Crossover\ price_{\text{today}})}{Average\ of\ past\ 2\ day's\ prices}$$

The point at which the MDI crosses the zero line moving higher is a buy signal, and the point where it crosses moving lower is a sell signal.

EARLY IDENTIFICATION OF A TREND CHANGE

John Ehlers uses a *quotient transformation* to find an early indication of a trend and estimate its duration.[17]

$$Output = \frac{Input + K}{K \times Input + 1}, where -1 < K < 1$$

Most oscillators can be used but the output must be rescaled to between −1 and +1. For example, the RSI ranges between −100 and +100, so dividing the value by 100 solves the problem. For the stochastic, which ranges between 0 and +1, subtract 0.50 and multiply by 2. He then applies his *roofing filter* to remove the spectral dilation. Those results are not normalized, so he applies an automatic gain

[15] Calculation courtesy of Alexander Solodukhin, Mizuho Alternative Investments, New York.

[16] Donald R. Lambert, "The Market Directional Indicator," *Technical Analysis of Stocks & Commodities* (November–December 1983).

[17] John Ehlers, "The Quotient Transform," *Technical Analysis of Stocks & Commodities* (August 2014).

FIGURE 8.31 Ehlers' Early Onset Trend indicator for SPY during 2018.

control (AGC) to normalize without affecting the pattern. Only Ehlers can do this. *TSM Ehlers Early Onset Trend* indicator is on the Companion Website. Figure 8.31 shows the results for SPY. The ADX (Chapter 23) is another indicator that tries to recognize when there is a trend.