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 the use of trading rules and the selection of specific parameters that define the trend speed and an acceptable level of risk, among other factors. This chapter first discusses those rules that are necessary to all trading strategies and then 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, 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). Some advisors are reported to be using the same systems devised in 1980. Barclay Hedge (BarclayHedge.com) reports that hedge funds had a total of $1,762.9 billion under management as of the first quarter of 2012, and managed futures totaling $328.9 billion. Investments from both institutions and individuals have been flowing into the industry at an increasing rate, up almost 500% since 2002.

**WHY TREND SYSTEMS WORK**

Trend analysis is the basis for many successful trading programs, some with audited performance published for more than 30 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 persistent. In turn, interest rates directly affect foreign exchange, the trade balance, mortgage rates, carrying charges, and the stock market.
• *Prices are not normally distributed but have a fat tail.* The fat tail means that there is an unusually large number of directional price moves that are longer than would be expected if prices were randomly distributed. The fat tail will generate exceptional trend profits, which are essential to a trend system’s long-term success.

• *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 to the general public, 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. It is the risk profile and the trading frequency that distinguish one method from another, and those features will be discussed throughout this chapter.

**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 nine days up and one small down day?

A trend is a relative concept. It is relative to the trader’s time horizon, and it is relative to the amount of noise and price swings that are acceptable within the trending period. 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.
• 12½ (if we could have halves tosses) will be three heads or three tails in a row.
• About 6 will be four heads or four tails in a row.
• About 3 will be five in a row.
• 1 or 2 will be six 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 amount), then it would not be
possible to profit from a trend system. But prices are not normally distributed. Price runs have a fat tail, which means that, instead of one run of 6 out of 100 days of trading, we may see a run of 12, or 3 runs of 6. That distribution is enough to make trend trading profitable.

Another factor is that these long runs 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, 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. This will be
TRADING SYSTEMS AND METHODS

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 $18750 bin. That one profit offsets more than 30 losses in the largest bar marked $1250. But the S&P is not the only market with this distribution; actually, the S&P has relatively smaller fat tails than other markets. Table 8.1 shows the distribution sample. 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.

**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

<table>
<thead>
<tr>
<th>Bin</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonds</td>
<td>0</td>
<td>2</td>
<td>8</td>
<td>17</td>
<td>53</td>
<td>27</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>S&amp;P</td>
<td>2</td>
<td>2</td>
<td>12</td>
<td>58</td>
<td>17</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Euro</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>7</td>
<td>26</td>
<td>75</td>
<td>20</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Crude</td>
<td>0</td>
<td>3</td>
<td>22</td>
<td>92</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gold</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>20</td>
<td>70</td>
<td>16</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Time Intervals, Market Maturity, 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 translate into better performance when using longer-term trends. While there are always fast trends that show profits in backtesting, 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 in order to stimulate exports and reduce debt.

Diverse markets may have very different 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 is constrained 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. Most foreign exchange markets show clear but shorter trends compared to interest rates.

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 is 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.

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. A small number of traders with the same opinion will cause very clear trends in the price. 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**

Trends are based on the average always lagging price movement. It is the advantage and the disadvantage of the method. As the calculation period gets larger, the average lags further. Figure 8.3 shows Amazon prices from April 2010 through February 2011 with a 40-day moving average. Clearly, the moving average smooths prices. The basic idea behind using the moving average as a trend signal is to be long when prices are above the average and short when below. The rules are stated as

- *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 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 \((\text{high} + \text{low})/2\) or \((\text{high} + \text{low} + \text{close})/3\) 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.

**Figure 8.3** Amazon (AMZN) with a 40-day moving average.
Using the Trendline for Signals

The trendline represents the netting of all prices. Its purpose is to remove the price noise and show you the underlying price direction. Then it seems more reasonable to use the trendline to generate the trading signal. The change in the value of the trendline from the previous calculation to the current one is its direction—up, down, or unchanged. The direction of the trendline is a candidate for generating trading signals.

- *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 signal is that the trend turn is clear and more stable. During July and November, prices crossed back and forth through the trendline, but the trendline did not change direction; therefore, the trading signal remained the same.

Comparing Basic Trading Signals

The main differences between using a price penetration or the trendline to generate signals is that the trendline produces fewer trading signals, and those signals are delayed. If Amazon prices are used as an example, both methods of entry can be compared for a sample of calculation periods to see if one approach is consistently better than the other. Although this is a single example, it represents the general case.

As shown in Table 8.2, five calculation periods are used beginning with 5 days and doubling the period for each test. This maintains the percentage 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* show that the trendline method has from

<table>
<thead>
<tr>
<th>Trend Calculation Period</th>
<th>Signal Using Trendline</th>
<th>Signal Using Price Cross</th>
<th>Increase in Trades</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Profit/Loss</td>
<td>Profit Factor</td>
<td>Number of Trades</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>48.24</td>
<td>1.34</td>
<td>84</td>
</tr>
<tr>
<td>40</td>
<td>94.42</td>
<td>1.46</td>
<td>120</td>
</tr>
<tr>
<td>20</td>
<td>111.97</td>
<td>1.45</td>
<td>196</td>
</tr>
<tr>
<td>10</td>
<td>(87.67)</td>
<td>0.81</td>
<td>292</td>
</tr>
<tr>
<td>5</td>
<td>(90.31)</td>
<td>0.84</td>
<td>439</td>
</tr>
</tbody>
</table>
26% to 37% fewer trades and, for the most part, better performance. The Profit Factor is the performance ratio used by TradeStation equal to the gross profits divided by the gross losses. While not as good as the information ratio or Sharpe ratio, the results allow you to compare performance.

It appears that using the trendline signals is always better, but that is not necessarily the case. To be certain, you would need to compare a wide range of diverse markets rather than just Amazon. Even if these results seem compelling, it is always necessary to confirm the numbers to be confident of the answers and to be sure that you understand the process.

While it seems convincing that the trendline is best for the slower trends, it is not as clear for faster trading. For the case using a 5-day moving average, both methods netted a loss, but the price penetration shows a smaller loss. 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.

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 implies that you could enter on the close.

The process of waiting for the close price to perform the necessary calculations and generate a signal requires that orders be placed in the after-hours market or on the next open. While the trading system is indicating a new buy or sell signal as of the close of trading, you are entering the market significantly late. You are not following the system as it was tested. A practical solution to this dilemma is to record 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.

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 of 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 \( p_{10} \) was 30.25, then any price greater than 30.25 today would cause the trendline to move up, and any price greater than 30.25 would also cause an upwards price penetration. Then an order can be placed in advance to buy at 30.26 stop.
Trend Systems

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 the S&P 500 futures as the extremes, the method that enters using the trendline 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 Eurodollar results show a profit for trades entered on the close of the day that a signal occurred. Longer trend periods were generally more profitable, confirming the premise that trends are more dominant in the long term due to government policy. When entries were delayed to the next open or next close, the results were worse. This is best seen in the profit factors, which measure reward to risk rather than only total profits.

The S&P is also clear but not as clean as Eurodollars. Equity index markets are noisy; that is, prices moving up are not expected to continue up for any sustained number of days. A new buy signal will usually happen on a day when prices are moving higher, but waiting until the next open or the next close could be better because of the noise. This was true for all calculation periods except 5 days. As for the calculation period, there was no particular pattern, although absolute losses were smaller as the trend period got longer, a modest confirmation that longer trends are better. We know from other tests and other markets that this limited example is generally true, but market characteristics always create exceptions.

Profile of a Simple Moving Average System

Using the moving average trendline as the basis for system signals, we chose a 40-day calculation period because it tends to be the fastest one that also identifies the major price trends. The profile of results is typical of any moving average system. Figure 8.4 shows the NASDAQ 100 for one year, ending February 2011. 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 the major upwards move is captured, but not before there are a number of false signals due to the trendline changes during sideways price periods. However, given enough tries, the trend surfaces, and the system gains a large profit, similar to the fat tail discussed at the beginning of this chapter. The profile of this NASDAQ example, shown in Table 8.4, is typical of longer-term trend-following systems. Of the 150 trades over 10 years, only 52 of them were profitable, about 35%. However, the average winning trade was much larger than the average losing trade, with a ratio of 2.22, and winning trades were held much longer than losing trades, supporting the adage “cut your losses and let your profits run.” Finally, there were more consecutive losses than consecutive profits, but that follows because there are many more losses. The performance picture is that trend following gets in and out quickly when it has a loss but holds the trade whenever trends and profits develop. This category of strategy is called conservation of capital, referring to the feature that cuts losses quickly.
TABLE 8.3 Comparison of Entries on the Close, Next Open, and Next Close

Results vary with the trending nature of the market. Analysis uses 10 years of S&P and Eurodollar interest rate futures, back-adjusted, ending in February 2011.

<table>
<thead>
<tr>
<th>Calculation Period</th>
<th>Eurodollar Interest Rates</th>
<th></th>
<th></th>
<th>S&amp;P 500</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Profit or Loss</td>
<td>Profit Factor</td>
<td>Total Profit or Loss</td>
<td>Profit Factor</td>
<td>Total Profit or Loss</td>
<td>Profit Factor</td>
</tr>
<tr>
<td>80</td>
<td>16150</td>
<td>2.87</td>
<td>16325</td>
<td>2.89</td>
<td>15630</td>
<td>2.75</td>
</tr>
<tr>
<td>40</td>
<td>9603</td>
<td>1.61</td>
<td>9050</td>
<td>1.55</td>
<td>9383</td>
<td>1.61</td>
</tr>
<tr>
<td>20</td>
<td>7745</td>
<td>1.37</td>
<td>6258</td>
<td>1.29</td>
<td>3850</td>
<td>1.16</td>
</tr>
<tr>
<td>10</td>
<td>10773</td>
<td>1.40</td>
<td>8765</td>
<td>1.31</td>
<td>1165</td>
<td>1.04</td>
</tr>
<tr>
<td>5</td>
<td>3368</td>
<td>1.09</td>
<td>(1715)</td>
<td>0.96</td>
<td>(870)</td>
<td>0.98</td>
</tr>
</tbody>
</table>


We can generalize the trend-following profile as:

- The percentage of profitable trades is low—often less than 30%.
- The average winning trade must be significantly larger than the average losing trade; actually, given only 30% profitable trades, the ratio must be greater than 100:30 to be profitable.
- The average winning trades are held much longer than losses.
- There is a high frequency of losing trades; therefore, there are also long sequences of losing trades.

There are many analysts that have a lifetime goal of improving these statistics, that is, capturing the long-term trend but improving the percentage of profitable trades. Some

<table>
<thead>
<tr>
<th>TABLE 8.4</th>
<th>Performance Statistics for NASDAQ Futures, 10 Years Ending February 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total profit</td>
<td>$11,880</td>
</tr>
<tr>
<td>Number of trades</td>
<td>150</td>
</tr>
<tr>
<td>Number of winning trades</td>
<td>52</td>
</tr>
<tr>
<td>Percentage of winning trades</td>
<td>34.7%</td>
</tr>
<tr>
<td>Average winning trade</td>
<td>1424.71</td>
</tr>
<tr>
<td>Average losing trade</td>
<td>-41.28</td>
</tr>
<tr>
<td>Win/loss ratio</td>
<td>2.22</td>
</tr>
<tr>
<td>Average bars in winners</td>
<td>31.65</td>
</tr>
<tr>
<td>Average bars in losers</td>
<td>6.64</td>
</tr>
<tr>
<td>Consecutive winner</td>
<td>6</td>
</tr>
<tr>
<td>Consecutive losses</td>
<td>10</td>
</tr>
</tbody>
</table>
small amount of success is possible but not without changing the risk characteristics of trend-following systems. For example, if you add profit-taking (discussed throughout the book) or stop-losses (Chapter 23), then you reduce or eliminate the chance of capturing the fat tail, which has been shown to 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. A program to test the entry rules and execution options, including long-only, is TSM Moving Average, available on the Companion Website.

**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. If we accept the premise that the point of trend change is also the time of greatest indecision, then a simple way to avoid frequent false signals is by using a band.

**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 low crosses the average of the lows. To get a broad view of whether this is an improvement to entry points, the two most extreme markets (the Eurodollar considered the trendiest and the S&P the noisiest) are tested for 10 years with the five calculation periods used in an earlier example. Results are shown in Table 8.5.

<table>
<thead>
<tr>
<th>TABLE 8.5</th>
<th>Results of Using a Moving Average of the Highs and Lows, Compared to the Closes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Eurodollar Interest Rates</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Close Crossing</strong></td>
</tr>
<tr>
<td><strong>Calculation Period</strong></td>
<td><strong>Total Profit or Loss</strong></td>
</tr>
<tr>
<td>80</td>
<td>16320</td>
</tr>
<tr>
<td>40</td>
<td>16035</td>
</tr>
<tr>
<td>20</td>
<td>10172</td>
</tr>
<tr>
<td>10</td>
<td>2727</td>
</tr>
<tr>
<td>5</td>
<td>7812</td>
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</tbody>
</table>
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. If this had not been determined from the noise study in Chapter 1, these results would cause us to draw the same conclusion. 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:

\[
\begin{align*}
\text{(Average daily price)} & \quad AP_t = (H_t + L_t + C_t)/3 \\
\text{(10-day moving average)} & \quad MA_t = \text{average}(C_t, 10) \\
\text{(Upper band)} & \quad UB_t = MA_t + AP_t \\
\text{(Lower band)} & \quad LB_t = MA_t + AP_t
\end{align*}
\]

These days we would tend to use true range, rather than the high-low range as a better representation of volatility.

Percentage Bands

Another simple construction is a percentage band, formed by adding and subtracting the same percentage of price from the trendline based on the closing prices. If \( c \) is the percentage to be used (where \( c = 0.03 \) means 3\%), then

\[
\begin{align*}
\text{(Upper band)} & \quad B_U = (1 + c) \times MA_t \\
\text{(Lower band)} & \quad B_L = (1 - c) \times MA_t
\end{align*}
\]

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

\[
\begin{align*}
\text{(Upper band)} & \quad B_U = (1 + c) \times p_{t-1} + MA_t \\
\text{(Lower band)} & \quad B_L = (1 - c) \times p_{t-1} + MA_t
\end{align*}
\]

The band is still oriented around the moving average trendline to prevent it from jumping up and down too often. Using the price to generate the band also requires that yesterday’s price be used; otherwise the band would never be penetrated. Using a percentage band would work for stocks but not for futures. Most futures analysis uses back-adjusted data, and if the carry is mostly negative, then the oldest back-adjusted data could actually become negative. That doesn’t affect a moving average trading signal, but it does make any percentage price calculation wrong. Back-adjusted historic prices are simply not correct.

If only a small buffer zone is needed, rather than one that adjusts over time, then a band based on absolute point value could be used. For example, stocks trading between $20 and $40 could have a $1 band. If your goal is to avoid a few very small variations around the time of trend change, then an absolute point value band may be a simple alternative solution.

Volatility Bands

To the degree that volatility increases as prices increase, the percentage band is a volatility band; however, that relationship is both long term and not as good as actually measuring the individual volatility for many stocks and futures markets. Regardless of the method, creating a band that is responsive to volatility may improve the reliability of trend signals. The independent smoothing of the high and low prices over any calculation period forms a natural volatility band. Although it may be practical to use the same smoothing technique or the same calculation period as the underlying trend (e.g., 10-day or 10% smoothing constant) for the high, low, and closing prices, it is not a requirement. If the same smoothing criterion is used, the band will be uniform with respect to the moving average of the closing price; if not, all three trendlines may weave around one another, which creates some practical problems.

There are many choices for measuring volatility and creating a band around the trendline. All of the methods of forming bands are subject to scaling. Scaling is accomplished by using a constant value as a multiplier or scaling factor; it increases or reduces the sensitivity of the band. If $s$ is a scaling factor and $c$ is a fixed percentage, then the following bands can be constructed:

\[
B_p = MA_t + s \times c \times MA_t \quad \text{(Percentage of trendline)}
\]

\[
B_p = MA_t + s \times c \times p_t \quad \text{(Percentage of price)}
\]

\[
B_p = MA_t + s \times ATR_{t-1} \times MA_t \quad \text{(Average true range)}
\]

\[
B_p = MA_t + s \times stdev_{t-1} \times MA_t \quad \text{(Standard deviation)}
\]

When $s = 1$, the scaling effect is nullified; for $s > 1$, the width of the band is increased; and for $s < 1$, the band width is reduced. In the choices above, $MA$ 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 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 annualized volatility, which is most sensitive to price changes.

Because the same scaling factor produces bands that are different for each method, it is difficult to compare them without finding the scaling factors that come closest to average band width for each technique. The bigger decision is whether it is more sensible to use a very smooth band or one that reacts to changes in price volatility. That decision is up to each trader.

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 may avoid some false signals.

**Bollinger Bands**

Perhaps the simplest and most robust measurement of price volatility is the standard deviation of the prices themselves, calculated over recent price history. This was the last method listed in the previous section. 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 now frequently called
Bollinger bands. 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). In their normal use, Bollinger bands are combined with other techniques to identify extreme price levels. These are discussed later in this section.

Figure 8.6 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 8.6 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 8.7. The price pattern follows the weekly Bollinger 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\(^3\) for this requires the following calculations for the center line, \(D_t\):

\[
M_t = \alpha \times U_t + (1 - \alpha) \times M_{t-1}
\]
\[
U_t = \alpha \times M_t + (1 - \alpha) \times U_{t-1}
\]
\[
D_t = \frac{(2 - \alpha) \times M_t - U_t}{1 - \alpha}
\]

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

\[
m_t = \alpha \times (U_t - B_t) + (1 - \alpha) \times m_{t-1}
\]
\[
u_t = \alpha \times m_t + (1 - \alpha) \times u_{t-1}
\]

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

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

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

where $f$ is the multiplier for the width of the band, suggested at 2.5 compared to Bollinger’s 2.0. Figure 8.8 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 limited. The first decision to be made is whether the trading strategy is one that is always in the market (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.

This technique is always in the market with a maximum risk (without execution costs) equal to the width of the band, which changes each day (see Figure 8.9). Alternately, you may prefer to exit from each trade when prices move into the zone between the bands or when prices cross the original trendline.
• **Buy** (go long) when prices close above the upper band. Close out longs when prices reverse and close below the moving average value (the center of the band).

• **Sell short** when prices close below the lower band. Cover your shorts when prices close above the moving average value.

The band is then used to enter into new long or short trades, and the actual trend-line 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.

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 8.10), 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. The disadvantage is when the price changes direction and moves so fast that both the close-out and the new signal occur on the same day. Reversing the position immediately would be better in a fast market.

The high and low of the day may also be used as penetration criteria. Again using the outer bands for entry and the moving average for exit, apply the following rules:

- *Buy* when the high of the day penetrates the upper band, and close out longs when the low of the day penetrates the moving average.
- *Sell short* when the low of the day penetrates the lower band, and cover shorts when the high penetrates the moving average.

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.

**Timing the Order**

The type of execution order placed when following a system will affect its results over the long term. The use of a moving average band identifies a change of trend when a breakout occurs. Buying at the point of the upside breakout or selling during a downside breakout often results in poor entry prices, and has been known to place the trader in a new trend at the point where prices are ready for a technical correction. In an attempt to overcome these problems, a number of rules can be used:

- *Buy (or sell)* on the close after an entry (intraday) signal has been indicated.
- *Buy (or sell)* on the next day’s open following a signal.
- *Buy (or sell)* with a delay of 1, 2, or 3 days after the signal.
- *Buy (or sell)* after a price retracement of 50% (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 reduce 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 profit. It might be better to combine the entry order, for example,

*Buy (or sell) after prices reverse by $0.50 \times ATR$ 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 on 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.

The Compromise between Reliability and Delay

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 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 the average profits can decline to zero. 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.

Bollinger on Bollinger Bands

While most trading strategies buy when there is an upwards penetration of the top band and sell when prices move below the lower band, the use of Bollinger bands is usually mean-reverting, or counter to the price direction. However, this can be unnecessarily risky, especially when prices are volatile. 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.4

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 the CME Volatility Index (VIX). Based on this, a major price rally with dramatically higher volatility, that expands the bandwidth to extremes, should be sold when the bandwidth begins to narrow. This only applies to upwards price moves.

Combining Bollinger with Other Indicators

Williams\(^5\) suggests that a number of indicators can be combined to capture volatile moves after a price contraction, using:

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 constrict to inside the Keltner Channel while the Chaikin Oscillator is below zero.
- The Chaikin Oscillator crosses above the zero line.

For shorts,

- The Bollinger bands constrict to inside the Keltner Channel while the Chaikin Oscillator is above zero.
- The Chaikin Oscillator crosses below the zero line.

### APPLICATIONS OF A SINGLE 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 and timing improve performance but are considered refinements. The calculation period determines the frequency of trading and the nature of the underlying trend that will be targeted. 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 time interval.

The previous sections have used examples of calculation periods without any claim that one time interval was better than another. We have discussed that the long-term trend mimics government policy of interest rates 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 at a daily, and it was not clear that an intraday chart had any persistent trends. But for most traders, the risk of using this long time frame is unacceptable; they prefer smaller profits and smaller losses associated with

\(^5\)Billy Williams, "Biting Off Profits with the Rattlesnake Breakout Method," *Futures* (October 2010).
faster trading. There is now strategy development software that 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 simple 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. When these techniques were limited to a small group of analysts, these approaches were very successful. Many traders still subscribe to the idea that certain time intervals have 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.

More recently, a class of adaptive trends has appeared. These techniques 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.

The following sections include classic examples of well-known systems that use one trend, as well as a comparison of trading performance of the most popular single-trend techniques over a broad range of calculation periods.

**A Simple Momentum System**

In Chapter 7 the \( n \)-day momentum was defined as the change in price over \( n \) days. It's not actually “momentum” but that is the term commonly used by the industry. 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; therefore we will not give examples here. Keep in mind that momentum can be very 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 *Futures*). The system was promoted and implemented through Enterex Commodities in Dallas and 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 for current technicians and aspiring analysts.

MPTDI is a moving average with a band. Its unique feature is that the calculation period and band width change based on price volatility, 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.

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. The stop-loss serves to limit the initial risk of the trade and allow the coordination of a money management approach. The fixed risk differs from moving averages using standard bands because a moving average and its band can back away from system entry points if there is a gradual reversal of the price trend. 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 methods are covered in Chapter 17.
The Volatility System

Another method that includes volatility and is computationally simple is the Volatility System.\(^6\) Signals are generated when a price change is accompanied by an unusually large move relative to average volatility. If the average volatility measured over \(n\) days is

\[ V_i = \frac{1}{n} \sum_{t=i-n+1}^{i} TR_t \]

where \(TR_t\) is the true range on day \(t\) and \(V_i\) is the called the average true range on day \(t\) (defined in Chapter 5).

Trading rules are given as

- **Sell** if the close drops by more than \(k \times V(n)_{t-1}\) from the previous close.
- **Buy** if the close rises by more than \(k \times V(n)_{t-1}\) from the previous close.

The value of \(k\) is generally about 3.0. Note that the current price change is always compared to the previous volatility calculation.

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*. Of three mechanical systems presented by Keltner, his choice of a moving average was based on performance and experience. The system itself is quite simple, a 10-day moving average using 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 on penetration of the upper band and a sell signal when the lower band is broken; positions are always reversed.

The 10-Day Moving Average Rule is basic, but it does apply the fundamental volatility principle by using the high-low range as a band, and serves as an early example of moving averages. Keltner expresses his preference for this particular technique because of its identification of minor rather than medium- or long-term trends, and there are some performance figures that substantiate his conclusion. As an experienced trader, he prefers the speed of the 10-day moving average, which follows the market prices with more reasonable risk than slower methods. 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 history of prices 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 was first described by Hutson as another approach to trend following and over the years has gained in popularity. Called TRIX, it first takes the 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 followed a 2-day decline in the trendline. The exponential smoothing process usually starts by setting the initial trend value \( E_{10} = p_0 \), but in this case \( E_{10} = \ln p_0 \). The rest of the process is

\[
\begin{align*}
E_{1t} &= E_{1t-1} + s \times (\ln p_t - E_{1t-1}) \\
E_{2t} &= E_{2t-1} + s \times (E_{1t} - E_{2t-1}) \\
E_{3t} &= E_{3t-1} + s \times (E_{2t} - E_{3t-1}) \\
TRIX &= (E_{3t} - E_{3t-1}) \times 10000
\end{align*}
\]

This original approach has seen some variations over the years. The most significant is not using the log of prices, but changing the final step to a percentage change. The percentage change at the end speeds up the process. In all cases, the smoothing constant should represent a short time period, less than 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

\[
\begin{align*}
E_{1t} &= E_{1t-1} + s \times (p_t - E_{1t-1}) \\
E_{2t} &= E_{2t-1} + s \times (E_{1t} - E_{2t-1}) \\
E_{3t} &= E_{3t-1} + s \times (E_{2t} - E_{3t-1}) \\
TRIX &= (E_{3t} - E_{3t-1}) / E_{t-1}
\end{align*}
\]

A signal line is created by taking the 3-day moving average of the most recent 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.

A 9-day TRIX is shown in the lower part of Figure 8.11 corresponding to the price of the EURUSD (euro currency). The final step that takes the difference between the current and previous TRIX value shifts the indicator so that it does not have the lag that would be expected, yet it is still smooth. The effect of the weighting on price data caused by double and triple smoothing was discussed in Chapter 7. Readers that are interested in similar methods should refer to Blau’s *True Strength Index* and *True Directional Movement*.

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Although we usually trade a trend from the beginning to end based on some smoothing method, Linda Bradford Raschke has shown that a selected piece of the trend move can be a very reliable trade. It is also necessary to introduce the idea of momentum, which will be the subject of the next chapter. Her First Cross system enters a trend trade on the first pullback after an initial trend signal based on a faster momentum indicator. Momentum will be used here as the difference between two trends. To create this strategy we need

\[
\text{osc} = \text{fastMA} - \text{slowMA}
\]

A buy or sell entry signal is a 3-step process (comments on right):

- **B1.** \( osc_{t-1} > \text{trend}_i \) and \( osc_t <= \text{trend}_i \)  
  \( osc \) crosses trend moving down

- **B2.** \( low_t > low_{t-1} \)  
  low of the current bar is rising

- **B3.** \( \text{Buy} \)  
  \( buy \) signal

- **S1.** \( osc_{t-1} < \text{trend}_i \) and \( osc_t <= \text{trend}_i \)  
  \( osc \) crosses trend moving up

- **S2.** \( high_t < high_{t-1} \)  
  high of the current bar is declining

- **S3.** \( \text{Sell} \)  
  \( sell \) short signal

Although Raschke does not discuss exits, a likely exit rule for the First Cross system should maintain its short-term nature. You might use this method to time an entry into

**FIGURE 8.11** A 9-day TRIX based on euro futures shows that a triple smoothing does not create the lag that would be expected.
a longer-term trend using the first pullback. Or, you might want to trade only the short period isolated by the first pullback until this initial impulse is exhausted. If you choose the second method, you might try the following sequence for an exit condition:

X1. \( close_{t-1} > close_{t-2} \) previous close turns up (confirms trend)
X2. \( close_t < close_{t-1} \) the current close turns down
X3. Exit long

Raschke’s idea is an excellent example of selectivity. First, you recognize that the beginning of a trend is unique event. As traders recognize a change of direction, the move strengthens. Because most systems lag the market, they are often too late in capturing initial profits. As an alternative, this technique waits for the first move to be exhausted and then enters in anticipation of another surge as the new trend reasserts itself. Once these early moves are over, the general trend move may not be as easy to work with, and you may find yourself trying to enter as the trend comes to an end.

**COMPARISON OF MAJOR TREND SYSTEMS**

Trend strategies dominate the world of algorithm trading and managed futures in particular. But which method is the best? As we will see later in this book, 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 returns 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 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 time period and a selection of calculation periods, we can understand how the major trending methods differ. The most popular approaches, two event-driven (discussed in Chapter 5) and four time-driven are:

1. \( M, N \)-day momentum
2. \( MA, N \)-day moving average
3. \( EXP, N \)-day exponential smoothing
4. \( NDB, N \)-day breakout
5. \( SWG, N \)-day swing breakout
6. \( LRS, N \)-day linear regression slope

The markets used will be IBM, Ford, and Bank of America representing the equities, and Eurodollar interest rates, the S&P 500, the euro currency (EURUSD), and crude oil.
futures markets. The data for equities has been adjusted for splits, and the futures are continuous, back-adjusted. Neither of these data adjustments affects the trend calculations or trading signals. The time period will be the most recent 20 years. For the time-based systems, the calculation periods will begin at 5 and test every 5-day interval up to 160. If it wasn’t so easy to do this in a test platform, we could get a representative sample by starting at 5 and doubling in order to keep the percentage change the same, such as 5, 10, 20, 40, 80, and 160. That would also remove the distortion if we were to look at average results, because the longer calculation periods, which are very similar, would outweigh the shorter periods. For the swing method, a varying percentage swing size will be used, starting at 0.25% and doubling to 4%. The data used was from CSI and the testing was done using TradeStation. All tests begin trading on the same date, even though the 5-day test needs less data to start the calculations than the 160-day test.

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. That is, once they enter a long or short position, they always reverse on a new signal, going from long to short, or short to long. 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 closing price. A $20 transaction charge was applied to each futures trade, and $0.01 per share for each stock trade to cover commissions and slippage. Without a transaction charge, the very fast trading systems will show much better results than they can achieve in real trading. 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 $\text{close}_t > \text{close}_{t-n}$
   b. Sell when $\text{close}_t < \text{close}_{t-n}$

2. MA, Simple moving average
   a. Buy when $\text{MA}_t > \text{MA}_{t-1}$
   b. Sell when $\text{MA}_t < \text{MA}_{t-1}$

3. EXP, Exponential smoothing.
   a. Buy when $\text{Exp}_t > \text{Exp}_{t-1}$
   b. Sell when $\text{Exp}_t < \text{Exp}_{t-1}$

4. $NDB$, $N$-day breakout
   a. Buy when $\text{high}_t > \text{highest} (\text{high}, t-1, n)$ and $\text{close}_t > \text{close}_{t-1}$
   b. Sell when $\text{low}_t < \text{lowest}(\text{low}, t-1, n)$ and $\text{close}_t < \text{close}_{t-1}$
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** 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 Example**

A spreadsheet is an easy way of seeing 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 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,−$F$3,0). Calculations begin in row 163 because there will be a maximum of 160 days allowed.
5. **Column G** is the moving average= AVERAGE(E163:OFFSET(E163,−$F$3,0)).
6. **Column H** is the exponential smoothing, =H162+$H$3*(E163−H162). Cell $H$3=2/(F2+1), the standard conversion from days to smoothing constant.
7. **Column I** is the regression slope=SLOPE(E163:OFFSET(E163,−$F$3,0),A163:OFFSET(A163,−$F$3,0)).
8. **Column J** records if the most recent breakout is up (+1) or down (−1)=IF(E162>MAX(E162:OFFSET(E162,−$F$3,0)),1,IF(E162<MIN(E162:OFFSET(E162,−$F$3,0)),−1,“”)).

The next five columns, K–O, show the continuous trend direction (+1 or −1) based on the calculations in F–J. 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. For the Eurodollar interest rates, the futures market conversion is $2500 per big point, making a move from 97.00 to 98.00 worth $2,500. No commissions are used, although those costs could significantly affect the comparison. Results for Eurodollars, the S&P, and IBM can be found in three spreadsheets, TSM Trend Systems Comparisons ED/SP/IBM, available on the Companion Website.
**Spreadsheet Results of Eurodollars, the S&P, and IBM**

Figure 8.12 shows the cumulative returns of the Eurodollar futures using the 160-day calculation period, the longest to be tested. Over the 20-year test period, the moving average performed the best, with the n-day breakout second and the n-day momentum at the bottom. The best returned about 26 points and the worst about 11 points. In dollars, that would range from a simple return of $3250 to $1375 per year. For an investment of three times the typical initial margin of $1500, that gives a return of 72% and 30% per annum. Of course, there is no commission and no slippage used, and Eurodollars have the most trending characteristics, so this should not be taken as representative of all performance. A more complete review will follow in the next section.

By observing the performance pattern of the five 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.
- 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.

**S&P**

The S&P is a much noisier market than Eurodollars, which shows in the Figure 8.13 performance. Again, the moving average leads with the momentum showing the only outright loss over the test period. The jump in the moving average performance was the result of entering a short sale on April 24, 2007, and holding it until October 16, 2008. While this shows the advantage of the long-term trend, most traders would find it difficult to watch the weekly and monthly fluctuations in their equity over this holding period.
IBM
The last example in Figure 8.14 is IBM, which should bear some relationship to the S&P, given that it is a high-cap stock and must also be a relatively noisy market. In fact, these results show that all returns are worse than the S&P index, with the moving average the only profitable method. It is likely that the index smoothes out the erratic moves of individual stocks. But a brief look at the results using only one calculation period doesn’t show the whole picture.

Comparative Results
For comparison, four futures markets will be used, Eurodollar interest rates (ED), euro currency (CU), the S&P (SP), and crude oil (CL), and three stocks, IBM, Bank of America

**FIGURE 8.13** Comparative trend results for the S&P emini futures.

![S&P emini Trend Comparison, 160-day period](replace with new figure)

**FIGURE 8.14** Comparative trend results for IBM from August 1998 through February 2011.

![IBM Trend Comparison, 160-day period](replace with new figure)
The first comparison is net profit because everyone wants to know how much each system and each market will return. Looking only at the moving average tests (Figure 8.15b), Eurodollars, the euro, and crude oil are profitable to different degrees across most of the calculation periods, but tend to lose in the very short-term. The S&P generates mostly losses but more in the short-term.

The three stocks show losses for nearly all periods (see Figure 8.15a). In terms of consistency, the Eurodollar interest rates stand out as very stable from 25 to 160 days compared to the other six tests. This can be attributed to its relatively low noise compared to all other markets, as discussed in Chapter 2. Because equity markets are at the other end of the noise spectrum, trends are more likely to fail. Is this conclusion the same over all trending methods, or is one better than another for specific markets?
Different Trend Philosophies

The moving average, exponential, and linear regression are traditional time-series processes, that is, the price of one day is a small part of the total calculation. This can make it very difficult for a single large price jump to cause a change in the direction of the trend and, consequently, the trading signal. It also introduces a lag. For very fast trends, each price will have more importance than for slower trends.

The n-day breakout and swing breakout systems are triggered on new highs and lows; therefore, a single big price move often causes a new signal. Breakout systems can be considered event-driven, while a moving average system requires a trend to evolve. Because an event-driven system gives a signal at the moment prices make new highs or lows, there is no lag.

Different Risk Profiles

The biggest difference in the trend methods is in their risk profiles. Even when the returns are similar, the risk of the moving average technique is remarkably different from the breakout methods. While the information ratio (annualized return divided by annualized risk) is the best way to distinguish one system from another, the profit factor (gross profits divided by gross losses) was the only measurement available for these tests; however, the results will still give a good idea of the relative difference in performance. Figure 8.16a shows the profit factors for the Eurodollar interest rate futures for 5 of the 6 methods, all based on the same calculation periods. Data is for 20 years through 2011. Figure 8.16b shows the profit factors for the swing method, which varies the percentage swing size.

Even though we recognize the Eurodollar as a highly trending market, the similarity in the profit factors is remarkable. The n-day breakout seems to be slightly better than the other methods, but all of them are clustered together, improving at the same rate as the calculation period increases. This brings up the question “Does it really matter which trend method we use?” Are trend profits the result of a clever formula, or is it the market that controls the result?

The swing method has a problem for interest rates because tests are based on varying the percentage swing. But rates are quoted in prices, not yields, so volatility goes down as prices go up. Figure 8.16b shows that, using the range of percentage swings that work for other markets, the results using prices had no trades when the swing was above 1.375%. Using the yield, by subtracting the price from 100, gave trades everywhere but had poor returns. This example is included here to point out that any analysis of interest rate futures prices that use percentages will be a problem.

Based on the profit factor, five of the systems look the same for the Eurodollar interest rates. Other markets are not as consistent. The euro currency, Figures 8.17a and b, show that the n-day breakout is quite different for long calculation periods. The rules of the breakout only change positions on new highs and lows, and a calculation period over 125 days is equal to 6 months. Then a new long is set on a high above the highest price of the past 6 months and not exiting until a new low of the past 6 months. That can create a lot of risk. The same is true, to some degree, of the swing method. A swing of 5% in crude oil at $30/bbl is $1.50, but at $100/bbl it’s $5.00. Even though a percentage swing is somewhat self-adjusting in sensitivity, the risk continues to increase (see Figures 8.18a and b).
The S&P, along with the euro and crude oil, shows similar profit factors for all trend methods from the fastest calculation periods through about 85 days (see Figures 8.19a and b). After that returns begin to diverge and become more erratic. The n-day breakout is consistently the best for longer periods, but also highly variable.

But that’s still not the whole story. The frequency of trades, the percentage of profitable trades, and the average profit highlight the differences in the methods. Using only the euro currency as an example because it seems most representative, Figure 8.20a shows the number of trades for each calculation period, Figure 8.20b the percentage of profitable
trades, and Figure 8.20c the average profit per trade. Again, the breakout system stands out as having less than half the number of trades of the other trend methods. If we use the moving average as an example, prices can move up and down at the time of the trend change causing frequent buy and sell signals until a new trend is decided. These losses are small, but there can be many of them. The risk of a trade in the breakout system is the difference between the n-day high and n-day low, which can be very large but not likely to be reached often. Then we would expect fewer trades and larger losses for the breakout system.

The percentage of profitable trades, also called reliability, varies considerably for each method with the moving average and momentum results showing the lowest reliability at about 34% (results are almost identical) and the breakout system at the top with just under 50%. The slope and exponential smoothing are both about 43%. This chart tells...
us that, although the breakout system holds trades longer and has greater risk, it is more likely to end with a profit.

The last chart, average profit per trade, reflects the holding period of the methods. The longer you hold a trade, the larger the average profit, although the average risk will also get larger. The moving average, exponential smoothing, and momentum are all similar and almost indistinguishable on the chart. The regression slope has much larger profits. But the breakout stands alone as having very large profits at all calculation periods.

The initial results that we saw, using the simplified spreadsheet and a calculation period of 160 days, are not as clear as when we see more of the system profile. The moving average is still a consistent top performer, but the breakout often has higher returns at the same time it has higher risk. One thing is clear—all of these trend systems are profitable in the long term.
When trying to decide how fast or slow to trade, it is important to recognize that shorter calculation periods result in more trades, smaller profits per trade, and more sensitivity to transaction costs, slippage, and commission. Even for the euro currency, which is a moderately trending market, fast trading lowers the profits per trade to a marginal amount, which tends to lower the profit factor as well. In Figure 8.21 the five systems are all shown in terms of the number of trades (frequency of trading) and the resulting profit factors. The chart shows that calculation periods that produced more than 200 trades in 20 years were not as good as slower choices.

**Viewing the Big Picture**

When trying to decide how fast or slow to trade, it is important to recognize that shorter calculation periods result in more trades, smaller profits per trade, and more sensitivity to transaction costs, slippage, and commission. Even for the euro currency, which is a moderately trending market, fast trading lowers the profits per trade to a marginal amount, which tends to lower the profit factor as well. In Figure 8.21 the five systems are all shown in terms of the number of trades (frequency of trading) and the resulting profit factors. The chart shows that calculation periods that produced more than 200 trades in 20 years were not as good as slower choices.

**Expectations**

Expectations help us recognize when test results are wrong and, even more important, when actual trading varies too far from test results. Common sense goes a long way toward
**FIGURE 8.20a** Euro currency futures, 20 years through 2011, number of trades.

**FIGURE 8.20b** Percentage of profitable trades.

**FIGURE 8.20c** Average profit per trade.
keeping your work correct. Consider an engineer who is building a bridge over a large river. The data entry clerk incorrectly enters a value with the decimal shifted to the left one place. The final plans show a 10-foot bridge over a 100-foot river. Fortunately, the engineer had estimated the results and expected an answer between 80 and 120. When different systems are tested for different calculation periods, we should have a good idea of the expected results. Fast and slow trading each has its own patterns; breakout and moving averages have distinct risk profiles. Understanding these differences is important to success.

**Robust Testing**

To get the most value from these tests, there needs to be as much consistency as possible between tests. The following standards were used:

1. *Test periods.* All markets and all tests used the same 20-year period, ending February 2011. More data are always better, and data that include bull markets, bear markets, and sideways markets are necessary to get the best idea of how a system performs.

2. *Tests start on the same date regardless of the calculation period.* All tests should begin on the same date as the test with the longest wind-up period, in this case 160 days.

3. *Range of trend speeds.* The calculation periods should produce tests that range from only a few trades to many. It should not be necessary to fall below two or three trades per year, or more than 100 per year. Those combinations are unlikely to be traded.

4. *Use realistic costs.* Costs matter because you cannot trade for free. If your costs are too high, then you might turn a profitable system into a loss, and if the costs are too...
low, then you will have unrealistically optimistic results. Try to use costs that represent actual trading.

5. Type of results. In the previous sections, the results were shown as net profits, profit factor, number of trades, average trade profit, and the percentage of profitable trades. If you could only choose one, then the profit factor, or information ratio, is the most important. Those statistics give you the returns relative to the risk and allow you to compare trading strategies on an equal basis.

The complete testing process is discussed in Chapter 21.

Which System Is Best?

We come back to the question that started this study of various trend-following strategies, “Which system is best?” Of the sample of markets and methods, the moving average and the n-day breakout seem to be the best choices but with two completely different profiles. The moving average has many more trades and many losses, with a few large profits. It is considered a conservation-of-capital approach. The breakout system tends to be more reliable and has much larger profits per trade but does it by taking very large risk. The linear regression slope seems to be somewhere in between.

Many traders prefer the returns of the breakout system but find the risk too high and the time holding the trade too long. You might think of trading a 100-day breakout as investing rather than trading. Although a moving average takes losses sooner, it holds the biggest winners for even longer. Traders are always looking for a way to take advantage of the long-term trend but not hold the trade as long and not take as much risk. This will be discussed in the next section.

The answer is “There is no best system, only trade-offs.” Every investor has a different risk tolerance. Some traders need to trade a system that has a high percentage of profitable trades, and others want only small losses. It is important to start building a strategy using an underlying method that satisfies your goals.

Programs for the Six Systems

In addition to the spreadsheet that gives comparative performance of 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
- TSM Swing

The moving average program gets signals from the trendline rather than a price penetration. Each program has useful options.
There are many situations where two trends of different calculation periods can solve a problem better than one. 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 successful. 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. Most 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 final 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 method. In this section, we will use the same trending techniques previously discussed to create a system. The longer calculation period will represent the major trend and the shorter period will be used for timing. Consider the idea that a good entry point is when there is a recent short-term surge of prices in the direction of the major trend. To implement this plan, select two moving averages, one noticeably faster than the other, and apply one of the following sets of rules (also shown in Figure 8.22).

1. **Buy** when the faster moving average crosses the slower moving average going up. **Sell short** when the faster moving average crosses the slower moving average going down.

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 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 price move based on price, while Rule 3 looks for both trends 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.

To further reduce the problem of whipsaws caused by erratic penetration of the trendlines in Rule 2, yet maintain a faster response to price change than Rule 3, 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 in proportion to the size of the band. With this technique you would want the band to be small; otherwise, you will interfere with the natural process that is the benefit of the two trendlines.
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. In 1961, when moving averages were considered state-of-the-art, there was less noise, and agricultural markets were the most liquid. The equivalent of a 1- and 4-week moving average would have worked well. Even now, the use of calendar 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, and also respond 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, but with some added complication. 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 be calculated as the average true range over one or more days.

The 5-day moving average serves as a liquidation criterion (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. The combination of different factors was the result of refinement over 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

These three calculations are then used with the rules

- If position is not long and \( \text{Close}_t > \text{MA5}_{t-1} + 1\text{ATR}_{t-1} \) and \( \text{close}_t > \text{MA20}_{t-1} + 1\text{ATR}_{t-1} \) then buy
- If position is not short and \( \text{Close}_t < \text{MA5}_{t-1} - 1\text{ATR}_{t-1} \) and \( \text{close}_t < \text{MA20}_{t-1} - 1\text{ATR}_{t-1} \) then sell short
- If position is long and (\( \text{Close}_t < \text{MA5}_{t-1} - 1\text{ATR}_{t-1} \) or \( \text{close}_t < \text{MA20}_{t-1} - 1\text{ATR}_{t-1} \)) then exit long position
- If position is short and (\( \text{Close}_t > \text{MA5}_{t-1} + 1\text{ATR}_{t-1} \) or \( \text{close}_t > \text{MA20}_{t-1} + 1\text{ATR}_{t-1} \)) then cover short position

---

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

\[
\text{Position size} = \frac{\text{Investment}}{(\text{ATR} \times \text{Big Point Value})}
\]

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 $1000 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 without costs (which were much higher until the mid-1990s), the cumulative profits are shown in Figure 8.23. Although the rate of return has slowed, it seems remarkable that a simple method could have been consistently profitable for 50 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 rather than using 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 Turtle’s 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, 100, and 200 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 8.24, the results of Golden Cross are compared to the passive returns of the S&P index (SPX) and continuous futures, remembering that SPX cannot be traded. When the trend signal indicates a short sale, the 1-day returns of the 3-month T-bill rate are used for the daily returns. A spreadsheet named TSM Golden Cross can be found on the Companion Website.

For the 11 years beginning mid-1999, the passive return of the stock market was a loss of 7.8%. During the same period, the Golden Cross returned 66.7% using SPX and 36.7% using futures. While the cash index can be traded as the ETF SPY, the futures contract is reasonable alternative. In addition, futures can be leveraged considerably, increasing the returns (and the risk).

All the calculations are shown in the Golden Cross spreadsheet, but the way in which the returns of continuous futures are matched to SPX needs some explanation. While the daily returns of SPX are calculated as \( \ln(p_t/p_{t-1}) \), continuous futures are back adjusted and values can become negative. The annualized volatility of SPX was calculated in the classic way (see Chapter 2), but the annualized volatility of the futures was calculated based on the daily change in dollar value of the futures contract.

![Golden Cross graph](image)

**FIGURE 8.24** The Golden Cross applied to the S&P index (SPX) and continuous futures compared to the passive returns of SPX.
1. Begin with an arbitrary, but large, investment size
2. Calculate the daily returns based on the initial investment size
3. Calculate the rolling 20-day annualized volatility of the returns
4. Find the factor needed to make the annualized volatility 12%
5. Multiply the current returns by the previous volatility factor
6. Create the NAVs from the volatility-adjusted returns

In Figure 8.24 the annualized volatility of SPX is 11.5%, and the volatility of the futures returns is 10.9%. The process of adjusting the portfolio volatility is discussed in detail in Chapters 23 and 24.

**ROC Method**

Another classic method for trading the major index is *Woodshedder’s long-term indicator.* The rules are

- *Buy* when the 5-day ROC (rate-of-change) 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.
- When there is no position, the system earns one-half of the cash 3-month T-bill rate.

In Figure 8.25, the results are compared to the Golden Cross, both using SPY as the basis for trading, from April 15, 1994 (the first available data for SPY plus the 252-day windup), through September 2011. No costs were charged although SPY has administrative cost included. The ROC method far outperformed the Golden Cross even with an annualized volatility of 14.1% compared to the Golden Cross volatility of 10.5%. Note that trading the SPY gave better returns than SP futures, shown in Figure 8.25.

**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 \( \text{fastperiod} = 8 \) and \( \text{slowperiod} = 18 \). The \( \text{differenceperiod} = 9 \).

\[
\text{FasterAverage} = \text{Average}(\text{close}, \text{fastperiod}) \\
\text{SlowerAverage} = \text{Average}(\text{close}, \text{slowperiod})
\]

---

9The *Woodshedder* blog can be found at www.ibankcoin.com/woodshedderblog 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.
**TRADING SYSTEMS AND METHODS**

**FIGURE 8.25** Comparison of Golden Cross and ROC Method using SPY.

\[
\begin{align*}
\text{TrendDifference} &= \text{FasterAverage} - \text{SlowerAverage} \\
\text{DifferenceAverage} &= \text{Average}(\text{TrendDifference, differenceperiod})
\end{align*}
\]

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 can give 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.

**MULTIPLE TRENDS AND COMMON SENSE**

If two trendlines can improve trading, it should follow that three or more are even better—but there may be more problems than benefits. Many analysts subscribe to the idea that simpler is better. A single moving average may not have a high percentage of profitable trades but the longer-term periods work because they capture the fat tail.

With the use of two trends, the number of combinations expands rapidly. Is there a best relationship between the slower speed and the faster one, that is, should the faster trend period be $\frac{1}{4}$ of the slower? Certainly, a 38- and 40-day combination will not offer much value, but is a 10-day and 40-day the right combination?

Consider something else. If a 10-day trend is not profitable, and a 20-day trend is not profitable, each taken on their own, but the combination is profitable, would you trade...
“Trend Systems”

**TABLE 8.7** Comparison of 1 and 2 Trend Systems, Eurodollar Interest Rate Futures, 1990–2011

<table>
<thead>
<tr>
<th>Trend</th>
<th>Number of Trades</th>
<th>Days Held</th>
<th>Total Profit</th>
<th>Avg Trade Profit</th>
<th>% Profit Trades</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>164</td>
<td>31</td>
<td>16537</td>
<td>1.65</td>
<td>22.5</td>
</tr>
<tr>
<td>20</td>
<td>350</td>
<td>16</td>
<td>21737</td>
<td>1.44</td>
<td>31.0</td>
</tr>
<tr>
<td>Both</td>
<td>254</td>
<td>16</td>
<td>15310</td>
<td>1.50</td>
<td>34.6</td>
</tr>
</tbody>
</table>

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? Not likely, unless a very large percentage of the combinations were profitable or each trend served a particular purpose and had a calculation period that reflected that purpose.

For example, 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 trends. But those trades can be held for months, and you don’t like that profile, so you want a shorter trend to tell you when to get in and out of that trade, always holding a position in the direction of the long-term trend. Using Eurodollars with 60-day and 20-day trends over the past 20 years, with a $40 round-turn cost, Table 8.7 shows the change in performance. Both single trends do very well, but the 60-day holds trades for an average of 31 days, about 1½ months. The 20-day trend would be better, but the average profit per trade is only $62. By combining the two trends and trading only in the direction of the long-term trend, the profits per trade jump to $92, and the days held remain the same as the 20-day trend. Overall, you get slightly worse performance than the long-term trend but hold the trade for half the time. That makes sense because you are only trading the longs rather than both longs and shorts.

Another benefit of the two-trend method is that you are in the market only 50% of the time. That reduces your risk, especially the risk of a price shock. That is a benefit not to be taken lightly.

**Three Trends**

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 using for entry timing. The third trend could be very fast, perhaps 3 days.

Gerald Appel\(^\text{10}\) adds three rate-of-change (ROC) indicators together (actually momentum, 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 upwards bias in the S&P, the 4% threshold may not be arbitrary.

**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 may happen if the trading signal is generated when the two moving average lines cross, rather than when price move through the averages. The slope of a third, faster moving average, \( MA_{3} \), can be used as a confirmation of direction to 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 new long (or short) position unless the slope of the confirming moving average (the change in the moving average value from the prior day to today) was up (or down).*

The speed of this third, confirming moving average only makes sense if it is equal to or faster than the fastest of the trends used in the Crossover System. A program to test the three-trend model is *TSM Modified 3MA Cross*, available on the Companion Website.

In earlier tests of the 3-Crossover method compared to the 2-Crossover, results showed that the added timing in the 3-Crossover reduced the number of trades and increased the size of the returns per contract. Overall, the profitability remained about the same.

**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. It is also likely to have been the outcome of the first computerized testing. 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.

To get an idea of how three trends compare to either one or two trends, a small test was run using Eurobund futures from 1990 to mid-2011. Granted this is a trending market, and one test does not reflect the big picture; nevertheless, the results, shown in Table 8.8, were unexpected. Because we already know that faster trends are not performing as well in recent years as they did in the 1970s, the test of Eurobunds compared a 40-day and an 80-day calculation period with a 40-80-day crossover and a 20-40-80-day combination. The 3-crossover method outperformed all others but also reduced the number of trades by emphasizing the trend direction.
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, both of which show results in a standard form and make 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 tests of single-trend strategies are compared for a standard set of 17 futures markets. In addition, a 2-trend crossover strategy is compared to the single trend methods. An objective of the testing process is to find parameters that succeed over time; this discussion can also be found in Chapter 21.

### SELECTING THE RIGHT TREND METHOD AND SPEED

Up to now, the selection of the right 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 addition, the best moving average speed for institutional or commercial participants may be very different from that of an active trader.\(^\text{11}\) 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. A 3-day moving average might generate 5 to 10 buy and sell signals in one month, each the result of a 2-day price move—an ineffective tool for either participant.

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looking for just one place to enter the market. A calculation period of 10 days may come
closer to generating the one buy signal needed for the fund or one sell signal that is
best for the hedger. The noncommercial trader is not concerned about the frequency of
trades, only the returns and risk.

For the trader or speculator, the right moving average speed is the one that produces
the best performance profile. This 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 necessary.

Computer testing of a trend system or other trading strategies sometimes leads to
solutions that are highly fitted. The computer may find that a 3-day moving average was
slightly more profitable and had lower risk than a 20-day average. Our common sense
tells us that the results of the 3-day system will be more difficult to attain in real trading
because execution costs will have a larger impact. An occasional fast market may cause
the execution price to be far off from the price indicated by the system signal. A slower
trend selection with fewer trades is less affected by poor executions.

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 by a strong trend in the overall market, as
measured by the S&P 500. In fact, the arbitraging of the S&P 500 futures with the actual
stocks has significantly changed the patterns of the many stocks, forcing many of them to
have higher correlations. However, a grain trader knows that the price pattern has a clear
cycle each year. At best, we can expect one long upwards move followed by a shorter,
faster decline. Not all trend speeds can capture the profits in this pattern. For example, if
the uptrend lasts for 6 months, a 6-month moving average will not see any of it; therefore,
it is necessary to use a moving average with a period less than one quarter of the length of
the trend. If computerized testing of a large range of moving average calculation periods
results in a “best” moving average period of six months or more, that choice should be
interpreted as a failure to capture the seasonal move.

We also discussed the “right” trend method earlier in this chapter. Tests over many
years and many diverse markets will show that the differences in net returns using dif-
ferent trend strategies are small. Those differences will be larger when the trend speeds
are faster. The most important differences are not in the profits but in the frequency of
trades, the size of the individual returns, and the risk of each trade. Experience shows
that the primary reason why trend-following systems work is because sustained price
moves exist, driven mostly by government interest rate policy. Every trend-following sys-
tem can capture these moves.

**Selecting the Trend Speed**

Chapter 21 will discuss the systematic ways to find the “best” trend, and that is the most
likely way that traders make their choice. But you can find a reasonable choice by simply
looking at a price chart. The trends that two traders see are often different. Some traders
immediately focus on long-term price trends; others see much shorter movements. To find your own best trend speed without the use of a computer, mark on a chart the beginning and end of each price move that you would like to capture. These trends may occur every few days, or only three or four times each year.

Using a daily price chart of IBM from July 2000 through May 2002 (Figure 8.26), the tops and bottoms of the major price swings that we would like to capture were circled. Noting that each gridline on the chart represents one month, there were eight tops and bottoms over a total period of 22 months. The average price swing was then $2\frac{3}{4}$ months, nearly one calendar quarter. Because it is so close to a quarterly value, which is the period of earnings reports, we will choose three months as the average swing period. Applying the rule of thumb that the trend can be isolated using a calculation period of one-quarter of the swing period, the moving average period becomes 16 days.

Applying a 16-day moving average system to the two years of IBM price data, buying and selling whenever the trendline changes direction, the trade results are shown in Table 8.9. There are a total of 36 trades, of which 20 were profitable (no transaction costs were used)—a very high percentage for a trend-following system. Total profits were better than $114 per share, on an average share price of about $100, showing that it is not necessary to optimize using a computer to create a successful trading program. Of course, there is no assurance that this pattern of swings will continue, but basing the decision on quarterly swings, which corresponds to earnings reports, is a hopeful sign.
Another approach to finding the trend period is to consider the worst price retrace-
ment. In the IBM chart, the move from $87 to $105, beginning in November 2000 and last-
ing about two months, is the one to avoid. Remembering that a trend is neutralized with
regard to a price move when the trend period is the same length as the total move, we
apply a moving average of 42 days. This method successfully avoids the price correction
and holds the downtrend, but the much slower trend nets a significant loss over the 2-year period. It is best to accept the frequent small losses that are natural in a trend-following system than attempt to remove them.

### 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 19-day and 21-day moving averages did not get sell signals. This means that the day that was dropped off the calculation 20 days ago caused a slight shift not seen by the other 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 time. It is most fallible when prices are changing direction or going sideways. Any information that clears up the problem is helpful. For any trend system, it is best to see a steady progression of trend changes from the short term to the long term. This is seen in the following tables, where $u$ is an uptrend and $d$ is a downtrend associated with the calculation period above those letters.

In Table 8.10, prices have turned up in such a way that the trend calculation periods 1 through 19 show up trends, while calculation periods from 20 and higher have not yet turned. 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 Table 8.11). This is easily explained because adding and subtracting one day 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, and in reality, it does not happen often. Yet when it does, the trend change is not to be trusted.

There are also cases where the longer trend begins to reassert itself and the results appear the same as in Table 8.10; 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 Table 8.12. 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
Erratic Trend Change for the Short Calculation Periods

<table>
<thead>
<tr>
<th>Moving Average Period in Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>Trend</td>
</tr>
</tbody>
</table>

shadow turn in the 20-day range. 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 in the second line of Table 8.12. Here, the smooth trend change 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.

An example of this process is shown in Figure 8.27. Moving average calculation periods of 5 to 50 days are shown in increments of five days for a total of 44 consecutive days. This illustration points out how the long-term uptrend (X) is breached by shorter-term, less consistent trends. Perhaps the best trend is the one with the majority of Xs or Os on the same line.

### Averaging the Sequences

The idea of requiring consistency in a range of trends can be automated by selecting a range of calculation periods preceding a target period, finding the trend signal (an up-trend or downtrend), and then deciding according to one of two rules:

1. Average the final trend values to get the average trend result. Compare the previous average result with the current value to determine the direction of the trend.

2. Scan the trend directions for consistent progression.

When selecting the range of calculation periods, start from 1 if the target period is small (e.g., your intended trend is 15 days). If you are looking at an intermediate trend period, for example, 30 days, you may want to include the range from 20 to 30, or 20 to 32. A few up-and-down price moves that make the short-end erratic should not alter the medium-term trend direction. By extending the calculation periods slightly past the target period, you gain confirmation at the cost of a small lag.

Progression of Trend Changes

<table>
<thead>
<tr>
<th>Moving Average Period in Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>Trend</td>
</tr>
<tr>
<td>Day</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
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<td>3</td>
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<td>42</td>
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<tr>
<td>43</td>
</tr>
<tr>
<td>44</td>
</tr>
</tbody>
</table>

**FIGURE 8.27**  Sequences of moving averages.
The idea that trends are sensitive to small price changes and the drop-off effect is not a surprise. An alternative to examining sequences is simply to select a number of calculation periods and net out the trends looking for a consensus. That would remove any dependence on a single selection.

**EARLY EXITS FROM A TREND**

By now we know that capturing the fat tail is necessary for the success of trend-following systems. However, there are always practical exceptions if you are allowed to add discretion to your trading decisions. 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 have declined for nearly all of the 30 years from 1981 through 2011. 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 varying maturity 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, 50 days. If the yield on interest rates had steadily dropped a total of 2% during the past year, then the trendline would be lagging about 1% behind current yields. That can translate into a large loss in unrealized gains.

One advantage of macrotrends 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. If the Fed were now to raise interest rates (or strongly hint that a rate hike is likely), it would signal a shift in policy. You can reasonably conclude that basis for the long-term uptrend in prices is over and that the trendline is due to 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 six months before the trendline actually signals a change of position. This will occur after a large part of your profits has been given back to the market. Exiting the trade when the fundamentals change would be a safe way of capturing more profits and being exposed to less market risk. Often, these decisions are clear only after the fact. In 2010 it seemed that Fed policy was going to change, yet 2011 was one of the strongest trend years in history, with yields reaching record lows.

**MOVING AVERAGE PROJECTED CROSSES**

If moving averages can successfully be used to identify the trend direction, it follows that a projection of the moving average will be valuable in anticipating when the trends
Trend Systems

will change. If a moving average trading strategy uses a single trend, the forecasted price \((CP_1)\) at which the standard \(n\)-day moving average line would cross is

\[
CP_1 = \frac{\text{Sum of last } N-1 \text{ prices}}{N-1} = \frac{\sum_{t=K+2}^{t} P_t}{(N-1)}
\]

That is, an \(n\)-day moving average would cross the next price at the value equal to the \(n-1\)-day moving average.

The price \((CP_2)\) needed to cause two moving averages, of periods \(m\) and \(n\), to cross is\(^{12}\)

\[
CP_2 = m \times \left( \frac{\sum \text{most recent } m-1 \text{ prices}}{m} - \frac{\sum \text{most recent } n-1 \text{ prices}}{n} \right)
\]

The projected crossover price is most useful when it is likely that a trend change will occur within a few days, that is, when the two moving averages begin converging and become close in value. Acting on the expected price would give the trader a great advantage in order execution. A chart of this, however, may not appear to be much different from a simple relative strength indicator. The difference between the price and the moving average line constitutes the relative strength.

The change in the projected crossover is considered a more valuable tool by Lambert.\(^{13}\) He creates a Market Direction Indicator (MDI) with the following formula:

\[
MDI = \frac{100 \times (\text{Crossover price}_{\text{potential}} - \text{Crossover price}_{\text{today}})}{\text{Average of past 2 day’s prices}}
\]

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.

**Forecasting When the Moving Average Will Turn**

There are two basic rules for generating a moving average signal, when the price penetrates the moving average trendline and when the moving average trendline changes up or down. In the previous section, the forecast was based on when the price crosses the moving average, which is a very common way of generating a trading signal.

Tests often show that results are better when the trendline itself is used to generate the signal rather than the penetration. This was discussed earlier in the chapter, but the rationale goes that once prices have been included in the moving average, then it is the moving average that tells you the correct direction, and that the price penetration takes

\(^{12}\) Calculation courtesy of Alexander Solodukhin, Mizuho Alternative Investments, New York.

away from the value of the trendline. There are two reasons for this. The trendline is smoother than price movement, so the results are more uniform, and the price penetrations generate many more trades and additional costs.

Having decided to use the trendline, then how do you forecast when that line will change direction? It is simply whether today’s price is greater or less than the price that is dropped off the end of the moving average period, \( n \) days ago. And, that being the case, using the moving average trendline is exactly the same as using the \( n \)-day momentum which states that you go long when today’s price is greater than the price \( n \) days ago. It seems too simple, but in most cases the results are better than using the price penetration of a moving average.