The Mixed Role Stops for Controlling Risks

Test Results

Table 6-3 shows a 10-year optimization of trend speed versus percentage stop-loss for Chrysler, Siemens (for only 5 years), the Deutsche mark, and Eurodollars, ending June 1993. Only the adjusted rate of return is shown to allow comparisons (see in Chapter 4, “Choosing Between the Currency and Bond Portfolios,” for an explanation of adjusted rate of return). The far right column in Table 6-3, marked “None,” shows the results of the trend system without any stop-loss. The far left column, marked “.02,” shows a very small .02 percent stop-loss.

The conclusion is that improvements are inconsistent. The best results for this test set seem to be Siemens, which has higher adjusted returns for trends below 100 days, and scattered improvement in the middle of the table, centered near a stop-loss of .50 percent.

Because the major currencies are said to have more trends, we expected a stop-loss in the Deutsche mark to produce better results. Prices that reach the stop-loss level in the D-mark should continue in the same direction until it activates a new, reverse trend signal. That did not happen. The results from the smallest stops were uniformly worse than the use of no stops in the 10-year test. Improvement occurs in a small area in the center of the table.

Larger stops, or no stop, show a more uniform result. When using an optimization test to select the best trading rules, it is preferable to see smooth, consistent results, rather than alternating profits and losses. Both Chrysler and the D-mark have poor returns in the bottom left corner of the tables.

Another View with a Shorter Test Period

Table 6-4 compares the cash returns with risk-adjusted returns for the Deutsche mark and Eurodollars over the 4 years ending November 1992, using comparable stops. The Deutsche mark cash returns appear much better than Eurodollars but have higher, inconsistent risk. When adjusted for risk, the Eurodollar returns are clearly better.

Contour Map of Eurodollar Stop-Loss Tests. Figure 6-2 shows a contour map of the Eurodollar tests. The white areas have the highest profits and the black parts the worst losses. As in the 10-year tests, the use of small stops, seen at the left edge of the figure, is inconsistent, alternating between light and dark, with neither the best or worst results. As stops become larger toward the right, performance is more uniform and predictable. We can conclude that small stops are sensitive to specific price patterns and noise; therefore they are erratic.
Table 6-3. Stop-Losses: Results of Longer Term Tests
Values are annualized rate of return, adjusted to a 25% maximum drawdown.

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b. Siemens: 1452 Days (2/3/87 to 11/23/92)

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Pattern of Results. The size of the stop-loss must be based on the speed of the trend. A small stop with a slow system will usually be hit and rarely allows the trade to reach a profit. A large stop with a fast system will never be reached before the trend signal reverses the position. It should not be surprising that only a narrow band of stops applies to one trend speed.

Intraday Stops with a Daily System

It is tempting to react quickly to an adverse price move to keep losses small. Although the trend may be determined using daily closing prices, a stop could be activated when prices move badly during the
Table 6-3. Stop-Losses: Results of Longer Term Tests (Continued)

Values are annualized rate of return, adjusted to a 25% maximum drawdown.

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d. Eurodollars: 2556 Days (1/03/83 to 12/14/92)

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Results of Longer Term Tests: The table shows the risk-adjusted test results of a trending system. All annualized rates of return are based on a maximum drawdown adjusted to 25% of the initial investment, allowing results to be compared fairly. The far right column, marked “NONE,” had no stop-loss and therefore the largest risk. Results of using the smallest stops (0.2%) are in the far left column. Although stops improve performance in specific cases, there does not seem to be a consistent pattern. Smaller stops are especially erratic as the trends increase in length, often showing alternating better and worse performance.

trading session. Unfortunately, the market noise will cause many more stops to be reached. At the end of the day, you will have captured losses that would have disappeared had you waited for the closing price. The accumulation of intraday losses and the increased number of trades will be far worse than basing the stop-loss on the same daily data as the system trend calculations.
Table 6-4. Stop-Losses: 4-Year Test Results
Comparison of cash returns vs. risk-adjusting returns.
Deutsche Mark: 1030 Days (11/22/88 to 11/23/92)

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### Annualized Rate of Return (Adjusted to a 25% Drawdown)

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**Benefits of Being Out of the Market**

Being out of the market may reduce equity fluctuation, even though a smaller profit is taken at the end of the trade. If the use of a stop-loss neither helps or hurts profitability, then the time spent out of the market will avoid some erratic price movement and improve the reward/risk ratio of trading performance. Holding a position that alternates from a profit to a loss without ultimately ending up profitable does not benefit your trading.
Table 6-4. Stop-Losses: 4-Year Test Results (Continued)

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#### Annualized Rate of Return (Adjusted to a 25% Drawdown)

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**Comparison of 4-Year Results:** The pattern in the "NONE" column (indicating no stops) shows that the risk-adjusted results are, in general, more consistent than unadjusted returns. Risk-adjusted returns show some large improvements due to the use of stops, but the total picture is very inconsistent. The variation is especially apparent by comparing the smallest .02% stops in the far left column with no stops in the far right column. Large stops affect the longer-term trends first (seen along the bottom of the table) and slowly work their way to the faster trends as the size of the stop gets smaller. Deutsche mark returns are uniformly better with 2% stops but inconsistent when stops become small. Eurodollar returns are best with no stops, which confirms their strong trend character.
Figure 6-2. Contour map presentation of Eurodollar performance. Results using small stops, along the left part of the chart, are much more inconsistent than larger stops, or no stops, seen at the right.

Figure 6-3(a) shows the contour map test results of the 10-year Deutsche mark adjusted rate of return. The best performance is the small peak in the center bottom of the map. This corresponds to a slow trend and relatively large stop-loss of .50 percent. The darkening area as we move toward the top and left of the chart shows faster trends and smaller stops.
Figure 6-3. Contour map of 10-year Deutsche mark stop-loss tests. (a) Adjusted rate of return. Large stops and slower trends produce the best results, indicated by the peak at the center bottom of the map. A system must be finely tuned to capture this.

Figure 6-3(b) is the contour map of the return/risk ratio (annualized return divided by 1 standard deviation of equity changes) over the same 10-year period. The white area, showing the best performance, is larger than in the previous map and includes areas in the bottom left. This means that the use of a small stop with a slow trend does improve Deutsche mark performance by exiting trades that become volatile and unprofitable. The far left edge remains inconsistent, and the right side is very uniform.
Figure 8-3. (Continued) Contour map of 10-year Deutsche mark stop-loss tests. (b) Return/risk ratio. Smaller stops may not improve profits but can improve the return/risk ratio of longer-term trends in this contour map. A better return/risk ratio can be converted to a higher rate of return using leverage.

Viewing the results as a return/risk ratio shows a much clearer picture. For the Deutsche mark, considered a "trending" market, stops should improve performance by reducing risk more than it reduces profits for longer-term trends and for most stops except those that are very small. The noisier index markets and most stocks do not show this result.
A Stop-Loss May Conflict with the Strategy

The nature of a stop-loss order is often contrary to the system with which it is used; it may "fight" with a trend-following program. The purpose of a trend is to smooth out and ignore market noise; the trendline is substituted for prices to represent a better approximation of price direction. A stop-loss that is too close will be reached by an erratic price move, offsetting the value of the trend.

Trend Systems

When a stop is reached, the trend has not yet reversed. The system is saying that the trend is still intact. If that is true the trend will continue and the loss will turn into a profit, but you would not have a position because you were stopped out. If the stop works most of the time, then the trend changes whenever the stop is triggered. That is the same as saying the trend is too slow. A faster trend would catch the change of direction sooner. In either case, the solution does not seem to lie with the use of a stop-loss.

Countertrend Systems

Trading against the trend requires frequent small profits. To get more profits, it is necessary to hold larger losses, waiting for prices to move your way whether because of noise or good forecasting. A stop-loss will cause more frequent losses and prevent profits from developing. The two will not work together.

Apparent Improvement

Tests show that stop-losses improve results, either outright profits or reward/risk ratios. Usually, that is not the case. Tests of short intervals may not be representative of the long-term picture. The use of intraday stops can easily misrepresent the fill that is received from a stop. The lack of liquidity, or a price shock during the trading session cannot be seen by most computerized testing packages.

One event can appear to make the use of a stop-loss worthwhile. Reducing the loss from a major price shock to a reasonable level may be a good exchange for small give-ups. A trader must realistically assess whether a resting stop or visual stop would have offered the protection needed. It is difficult to design a system that continually gives up profits in expectation of possibly reducing risk in a single case.
Reentering a Stopped-Out Position

Once a trade has been stopped out, but the underlying trend or counter-trend position does not reverse or exit naturally, the trader faces another problem. Do you reenter the market and chance another loss in the same trade? Then the compounded risk would be much larger for each trade. If the decision is to reenter, what criteria should be used? Because the trend-following signal remains the same, there is no new signal to buy or sell; therefore, the trader must have additional rules for reentering the market. That makes the system much more complicated.

Managing Risk with and without Stops

If small stop-losses are not predictable, then the best choice for controlling risk is to deleverage, reducing the risk to acceptable levels. Deleveraging is always the safe alternative. It can be achieved with the following simple procedure:

1. Find the long-term risk level of the trading program, using a combination of maximum drawdown and standard deviation of equity changes (see Chapter 4).

2. Adjust the system risk to your acceptable level. You probably want less than a 1 percent chance of losing more than 10 percent of the invested capital during any year; therefore, set 3 standard deviations of the annualized risk equal to 10 percent of your investment.

3. Determine the investment size or the amount of capital to be traded, based on the adjusted risk in step 2.

4. To give protection from major price shocks, use a larger stop-loss that will not be easily reached due to noise.

For example, you have a trading program that returns 40 percent per year with a 95 percent chance that losses will be under 15 percent during the 10-year test period (1 standard deviation of the equity changes is equal to 7.5 percent). However, you want to keep the risk under 10 percent, which is two-thirds of the current level. If the required capitalization is US$1 million, then increase the investment by one-third to US$1.33 million.

Because control of risk is more important than higher profits, we accept a 20 percent expected return to keep the risk at 7.5 percent. By using a large stop-loss, the returns on the test optimization are more consistent, and we have greater confidence that the stop-loss will not interfere with the expected returns.
The Dilemma of Professional Traders

Institutions allocate their professional traders a specific amount of trading capital on which their performance will be judged. To maximize profits and minimize risk, they tend to use high leverage and small stop-losses. The result is often modest profits and larger risk.

As discussed earlier, the amount of noise in foreign exchange markets causes small stops to be triggered frequently, preventing traders from reaching their profit objectives. But small stops are seen to be necessary because of the high leverage and potential risk. Most foreign exchange traders would be under pressure to explain losses in excess of 10 percent of capital.

Therefore, the best performance profile is not achieved by using small stops. It is best when the program is deleveraged and only larger stops, or no stops are used. But deleveraging means using a smaller amount of capital. As was pointed out in Chapter 4, if you achieve better profits trading a smaller amount (which can be seen from the size of the positions taken in the market), the head of the Foreign Exchange Trading Division might say, "If you can produce 20 percent return using only half the money, then use all of it so that you can get a 40 percent profit!" Unfortunately, the reserve capital is needed for a period of unusually high risk. It does not occur often, but you must be prepared for it anyway.

What do you do? If you don't trade more of the capital, it might be taken away. If you do trade more and the market is hit with a price shock, you can lose an unacceptably large part of the capital. The answer is don't trade more. You must be able to explain that deleveraging to achieve risk control is safer for the investment portfolio and for the company. Artificial risk controls are counterproductive over the long term and often over the short term. It is a corporate problem that must be resolved. The trader must only produce returns with the best return/risk ratio.

Summary

It is difficult to trade without a clear idea of risk, and a stop-loss, or fixed-value limit, is the most agreeable to traders. A stop-loss based on the number of points you are willing to lose is not a good choice. But performance using a stop-loss is inconsistent and, during a fast market or a price shock, when risk protection is most important, a resting stop-loss could result in the worst fill. Stops based on logical price levels, such as support and resistance, or volatility, are much more likely to improve performance. Tests confirm that larger stops give better performance than small stops.
If a relatively small stop-loss consistently improves a trend-following system, the trader should see if a faster trend might work even better. If a larger stop-loss improves performance, it may have been the result of a single event—it would be difficult to build a system around one situation.

Reducing risk by increasing the investment size, or lowering leverage, is the safest method of all. With smaller exposure, risk is always proportionally less. If you increase the leverage of your system because of the perceived safety of a stop-loss, one price shock is enough to cause serious damage. A stop-loss does not guarantee risk protection. If you need to deleverage to avoid occasional large risk, then a stop-loss may no longer benefit performance.
Understanding Price Shocks

A price shock is the ultimate risk. It is an entirely unpredictable, large jump in price that is too fast to trade. Price shocks cause the ruin of more traders than any other problem. A price shock can be seen as a large opening gap, or a very volatile trading range, often three or four times the average size, sometimes bigger by a factor of 10. Because they occur infrequently but are so dramatic, price shocks are treated very differently by many analysts when they develop a trading system. Some analysts will make up special rules to be applied for specific past events; others will include shocks as a part of the normal price phenomena, to be resolved by strategy testing.

Trading Risk Is Higher Than Expectations

This chapter will show that price shocks, which are frequently small and only occasionally extreme, are the reason the risk of trading is always greater than expected. When you look back at historic price moves, especially with a computer charting or a test program, such as System Writer, TeleTrac, or MetaStock, it is easy to identify a price shock. The clear ones are seen as highly volatile days or large gaps.

How do you handle them? When you are testing or developing a strategy, you look for a trend or pattern that would have had the right position to take advantage of any major move. But is that really possible? Could you have known which direction the price would have moved? And what about all the small shocks? Many small price shocks are not obvious. Although they do not attract attention if their size does
Figure 7-1. Chart analysis with typical price shocks. The Deutsche mark chart shows eight clear price shocks. Those marked 1-5 are expected to have generated profits for a trend system; those marked A-C are most likely to have produced losses. The Gorbachev abduction first appears to be the obvious price shock, but closer study shows that there are surprisingly many gaps and volatile days. Unfortunately, some analysts choose their strategy by its ability to profit from these past moves.

not cause any serious problems, they are just as unpredictable as large shocks.

Figure 7-1 is a chart of the September 1991 Deutsche mark, traded on the IMM. It shows the Gorbachev abduction on August 19, which produced a large profit for many traders. Those profits disappeared two days later when the market abruptly reversed. A closer look at the chart shows that other shocks were nearly as large. The point marked A indicates an unexpected change of direction ending two days later and 300 points lower. The Moscow coup spanned only 250 points.
Other shocks can be seen by the gaps or the high volatility in a direction opposite to the previous day. The points marked 1 through 5 are price shocks that were likely to be profitable for a trend-follower; those marked A through C would probably have caused losses. We can see that there are many sudden changes and gaps in price movement, each representing an unexpected event and all adding risk.

If you assume that you could have profited from a large price shock, you have mistakenly reduced your assessment of market risk. You can eliminate a price shock from a chart analysis or computer test, but you cannot remove it from real trading. A price shock is not predictable. That means you cannot assume that you would have profited from the price move, nor do you have to say that all price shocks would have caused losses. You can assume that half the shocks will be in your favor, and the other half will be against you.

**Types of Price Shocks**

Price shocks have no rules or patterns that can be applied in advance. Because they are always unexpected, they can occur any time and during any market environment. However, there is a distinction between a price shock that is the result of a structural change and one that is temporary or ambiguous in its effects (see Figure 7-2).

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**Figure 7-2. Three patterns associated with price shocks.** (a) A sudden drop to A has a sound basis but was exaggerated. Prices partially correct to B. (b) A structural shock will continue in the same direction [B] after the initial move (A). (c) A “false” shock (A), without basis, reversed as news corrected the situation. After 3 days, the effect had disappeared.
A price jump based on an assassination or abduction, such as the Gorbachev coup on Sunday, August 18, 1991, is entirely speculative. How do you assess the importance of the death of a leader in terms of Swiss francs? Whether temporary, as in the case of Gorbachev, or permanent, as with the Kennedy assassination, the economy of a country often shows little long-term effect.

In general, wars, rumors, assassinations, and political coups have temporary effects on price (see Box 7-1). Weather could cause a structural change in supply but rarely does; it always results in an immediate overreaction. Lack of rain, too much rain at the wrong time, freezes, and monsoons all cause a nervous reaction. By harvest, it is clear that corn and soybeans are exceptionally healthy crops, and that Brazil is more than happy to supply the U.S. consumers with any orange juice shortfall at an agreeable price.

Price shocks based on surprise economic news are often structural; prices try to jump to a level that is a fair assessment of the news. The market may push prices a little too far, but overall a trader cannot expect to profit from a price reaction. When the Central Bank announces a rate cut of 0.5 percent, prices must move to the level dictated by that change. If a 0.25 percent cut was anticipated, then prices move down; if a 1 percent reduction was expected, then prices move up. With periodic economic and statistical releases, the difference between the news and the anticipation determines price reaction.

Many long, fast price moves are not price shocks. Weather-related news is often anticipated by the market. A freeze or hurricane does not occur without warning. As cold weather moves south to Florida, traders and growers become concerned about the increasing likelihood of a freeze. They start hedging by buying futures, or covering their shorts. The result is a market that starts drifting higher in advance of a freeze. A speculator using a simple moving average system may get a buy signal ahead of severe weather, the result of informed reaction to anticipated weather.

Similarly, a change of regulation that affects industry often has warning. A vote before Congress to change pollution control or standards has clear, sometimes measurable effects on a group of companies. A bill likely to pass finds its results already discounted in the stock price.

**Impact of a Price Shock on an Investment**

A price shock can cause a severe equity fluctuation in a fully funded account, but many traders use leverage whenever possible. Shocks can
vary from 3 percent to 30 percent of the value of the asset. If you hold a
conservative portfolio with 50 percent cash reserves and the rest allo-
cated to unleveraged stocks, or 50 percent cash and the rest leveraged at
5 percent margin in futures, then the impact of a price shock will be:

<table>
<thead>
<tr>
<th>Portfolio Portion Allocated to This Position</th>
<th>Size of Price Shock (Not Leveraged)</th>
<th>Corresponding Drop in Stock Portfolio</th>
<th>Corresponding Drop in Futures Portfolio (5% Margin)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50% (Maximum exposure)</td>
<td>3%</td>
<td>1.5%</td>
<td>30%</td>
</tr>
<tr>
<td>10%</td>
<td>30%</td>
<td>15.0%</td>
<td>300%</td>
</tr>
<tr>
<td></td>
<td>3%</td>
<td>3%</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>3.0%</td>
<td>60%</td>
</tr>
</tbody>
</table>

The stock portfolio has no problem absorbing a 3 percent equity drop in
a worst-case scenario when only 10 percent, or $\frac{1}{2}$ the available trading
capital, is exposed to one correlated group. Even the 15 percent loss is
unpleasant but not fatal. Futures is another story. Mostly traded with
high leverage, a portfolio is rarely prepared for a large adverse price
move. The most conservative futures portfolio, with 5 assets allocated
10 percent each, and 50 percent in reserves, still lost 6 percent on a 3 per-
cent price drop.

**Eliminating Price Shocks from System Performance**

During the testing of a new strategy, most traders and analysts elimi-
nate the losses due to price shocks, or gain from their moves, without
being aware of it. They can

- Select the most profitable system from an optimization test.
- Luckily miss being in the market during a shock.
- Test data that did not have significant shocks.

In the enthusiastic search for a great trading system, traders would
select the system that performed best over historic tests. They are not
critical of a system when there are profits. If a 25-day moving average
had resulted in a long S&P position on the Friday before Gorbachev was
abducted, it had large back-to-back losses over 3 days. A 5-day trend
might have just entered a new short or closed out a long that day, and
would have benefited from the shock.

Selection of the wrong system parameter can happen when you
choose only the best results (i.e., as is automatically entered using a
TeleTrac optimization). If the slower system netted a 5 percent return
Box 7-1. THREE CLASSIC PRICE SHOCKS

1. The Kuwait invasion in August 1990 found most traders long (Figure 7-3(a)). The possibility of sustained oil shortages moved prices steadily higher. The U.S. retaliation in January was still an unknown, and the sharp reversal proved that the market's reaction was a surprise to traders (see Figure 7-3(b)).

*Figure 7-3. Kuwait price shock. (a) Iraq invades Kuwait. (b) The U.S. retaliates with Desert Storm.*
Box 7-1. (Continued)

2. The markets were not expecting the conservatives to win the British election in January 1992 and posted large gains for the Sterling as a result (see Figure 7-4).

![Figure 7-4. Conservatives win the British election.]

with 20 percent risk, while the faster program returned 4 percent with a 6 percent risk (due to large losses during the Moscow coup), the numbers make clear that the faster program is more desirable. No one would immediately pick the system with lower profits and higher risk.

What really has happened? By picking the system that profited from the coup, you have unconsciously assumed that you could predict a price shock. But that’s impossible. Therefore, your conclusion is not valid. That is not to say that the slower system was better. At this point, we really do not have enough information to tell, because the test results are too distorted by incorrect assumptions.
Box 7-1. (Continued)

3. The political coup in Russia on Sunday, August 16, caused a uniform pattern in Forex, oil, and equity markets. The S&P (Figure 7-5(a)) moved opposite to a trend position, crude oil would have caused new longs to be set (Figure 7-5(b)), and the Deutsche mark (Figure 7-1) would have profited. However, they all would have posted large losses when markets reversed two days later, after Gorbachev’s release.

*Figure 7-5. Political coup in Russia.* (a) The Moscow coup causes a sharp drop in the S&P. (b) Oil prices rally on expected supply interruption in Russia.
Short Tests May Not See Shocks

Some systems are evaluated over recent data because older prices do not seem representative of current market conditions. The European Monetary System (EMS) has changed the spread relationship between the exchange rates of member currencies. By creating limits, prices are supported and patterns are different from pre-EMS data. Short amounts of data have the disadvantage of not having enough price patterns to develop a robust trading model. They may show only a bull market, or a few small price jumps. It would be unusual to see a large price shock in a small data sample.

Frequency of Price Shocks

You might think of every price change based on news as a price shock. Markets are filled with little jumps because of unexpected events such as periodic reports on unemployment claims, corporate earnings, an unexpected charge, Federal Reserve or Central Bank shifts in monetary policy (never announced in advance), trade balance, announcements of new government policy, crop estimates, daily marketing of livestock, amount of rain in the Midwest, or cold in the northern hemisphere. The difference between the market's anticipated assessment of a piece of information and the reality of the event causes a price shock.

Most price shocks are small. Often, the relative accuracy of market anticipation to the released information obviates a change in price. Sometimes, the difference between actual and expected is unimportant in light of other effects attracting the public's eye. After three years of prolonged recession (beginning in 1991) and steadily lower interest rates, a worse unemployment number is not as important to the market as a Consumer Price Index that signals possible inflation.

Only the bigger price shocks attract our attention, even though smaller jumps occur frequently. Being unpredictable and frequent, shocks occur in a pattern (or lack of pattern) very similar to a random distribution. There are many small shocks and a rapidly decreasing number of large shocks.

Gaps and Ranges. Figure 7-6 shows the frequency of opening gaps and daily trading ranges and compares the S&P with the Deutsche mark for the 10 years ending with 1993. The inset chart begins with gaps and ranges of 0.5 percent; however, the frequency drops off quickly and the smaller number of large percentage moves cannot be seen. The larger chart shows only those 1-day gaps and ranges above 3 percent of the current price. These values can be seen exactly in Table 7-1.
Figure 7-6. *Frequency of price shocks.* The comparison of S&P and Deutsche mark price shocks shows that the Deutsche mark has many more gap openings, while the S&P has much larger daily price ranges. The frequency of these larger gaps and ranges points out that price shocks and uncontrolled risk occur more often than we would expect.

Table 7-1. Frequency of Price Shocks (January 1983–June 1993)

<table>
<thead>
<tr>
<th>Size of Move (%)</th>
<th>S&amp;P No. of Gaps</th>
<th>S&amp;P No. of Ranges</th>
<th>DM No. of Gaps</th>
<th>DM No. of Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>2963</td>
<td>118</td>
<td>2572</td>
<td>824</td>
</tr>
<tr>
<td>1.0</td>
<td>307</td>
<td>1273</td>
<td>622</td>
<td>1728</td>
</tr>
<tr>
<td>1.5</td>
<td>64</td>
<td>1069</td>
<td>133</td>
<td>581</td>
</tr>
<tr>
<td>2.0</td>
<td>24</td>
<td>510</td>
<td>34</td>
<td>164</td>
</tr>
<tr>
<td>2.5</td>
<td>6</td>
<td>219</td>
<td>10</td>
<td>48</td>
</tr>
<tr>
<td>3.0</td>
<td>1</td>
<td>94</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>3.5</td>
<td>2</td>
<td>41</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>4.0</td>
<td>3</td>
<td>19</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>4.5</td>
<td>1</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.0</td>
<td>3</td>
<td>9</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>5.5</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6.5</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7.0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7.5</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8.0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8.5</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9.0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9.5</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10.0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>3375</td>
<td>3375</td>
<td>3376</td>
<td>3376</td>
</tr>
</tbody>
</table>
The patterns in Figure 7-6 are different for the two markets. The S&P, a U.S. domestic market, shows very few opening gaps compared with the Deutsche mark, which is actively traded 24 hours a day. (This is discussed in Chapter 11 in the section “Overnight Risk.”) The S&P also shows much larger risk, with one gap of 9.5 percent and 51 daily ranges above 4 percent; the Deutsche mark had only 5 for the same period. The S&P was 10 times more likely than the Deutsche mark to have a price shock greater than 4 percent.

The implications of this are important. There are 51 of 3375 days (on average, 4 days each year), in which a price shock in the S&P will occur. From experience, we know that these are likely to be clustered together; therefore, we can assume that once each year there will be a volatile period of 4 days. One year, that move might be profitable, and the next year it might generate a loss. In either case, a 4 percent range is a 40 percent swing in equity for futures traders, based on margin.

The chart shows that large gaps and ranges will occur periodically and will be large enough to represent a problem. Individually, the risks might be absorbed within a well-diversified portfolio, but in reality, price shocks often affect a broad range of markets and assets at the same time.

**Why All the Fuss?**

During testing, many trading program do not distinguish a price shock from other moves. By applying special combinations of rules, and selecting the best trend speed, the trading program can successfully be on the right side of the market whenever a major price jump occurs. It would be easy for a computer to scan stock market historic prices and identify a pattern of extreme drops. A system that sold stocks on every Friday, during the last half of October (from 1929 through 1993), covering the position on Monday afternoon, would have made a fortune. Although most trades produced a small profit or loss, a few major plunges overwhelmed the result.

What is wrong with this approach? You are collecting, classifying, and creating rules to take advantage of price shocks that are unpredictable. You are attributing special traits to events that, by definition, have no traits. In general, if you have developed a system that did not show a large loss, you have done something wrong.

**Using Stops for Risk Protection**

In addition to a reduction in expected profits, the inability to identify a historic price shock affects risk control. You cannot assume that a price
shock would produce a profit, and you cannot assume that a stop-loss
would have saved even part of a loss. Resting stop-loss orders tend to
be filled at the worst place, and visual stops are too slow to be effective.

- A stop cannot get you out of a short position that is limit bid, or a
stock that moves quickly after a news release.
- A stop will get you out at the worst price when the market begins to
trade.
- In historic testing, a stop cannot tell that an intraday shock caused
prices to jump through the risk level and that the order was at the
high of that interval. (It is always safe to assume that you were filled
on a buy at the high of a 15-minute range, or sold at the low of a 15-
minute range.) A computer system that assumes a fill during an
intraday shock presents unachievably good results.
- A “fast market” exists during a price shock and price quotes run late
on the screen. A visual stop could never cut losses because the event
could be over before it appears on the screen.

It would be comforting to place the stop in advance and expect that execu-
tion price, but an occasional shock is nasty, and a stop-loss rarely
improves risk control.

**Key Price Shock Concepts**

Risk is always higher than expectations because historic testing (either
computerized or manual) does not distinguish between data that can be
used to forecast profits and price shocks that cannot be predicted:

- You cannot know which shocks would have been in your favor, or
which would have resulted in losses.
- You cannot know which days contained intraday price moves that
would not have allowed a stop-loss or a new trade entry to be exe-
cuted at a reasonable price level.
- Many small price shocks that result in bad executions are much more
difficult to recognize when only historic price data is available.

**Handling Price Shocks**

So far, price shocks paint a dismal picture. They cannot be predicted,
many of them cannot be seen afterward, and they can generate devas-
tating losses. The comforting thought is that, when you accept the
uncertainty of price shocks and do not assume profit opportunities, you
know the worst case of risk. This is not necessarily good, but it is a safe
way to evaluate trading and investment returns. Believing that a system
has less risk will lead to more serious problems.

Guidelines for Assessing Risk

The following guidelines will help you avoid mistakes and assess risk
more accurately. These points will not identify every price shock, nor is
it likely that the final risk level will be as great as the real risk of trading,
but it should be very close:

- **More test data gives more realistic results.** Larger periods of test data con-
tain a greater variety of price patterns and more price shocks. Parameter
selection based on longer tests tends toward the longer-term forecasts and slower trends. These can better absorb the effects of price
shocks. Faster trading strategies must show profits from price shocks,
in order to prevent losses from appearing disproportionately large. The
expected profits of a longer-term system may be lower, and the risk
higher, than a faster trading method, but the real trading results are
more likely to be similar to the slower system, and may vary far from
expectations of a fast system.

- **Use less data for parameter selection and more data for risk evaluation.** If
older data is not representative of current market conditions, it may
be more reasonable to select parameters based on a short test period.
Once those parameters are fixed, test a longer set of old data to get a
better evaluation of risk. It is not possible to find all the risk from a
small test sample. Use the old data to show more patterns of volatility
and risk, and recent data for trend timing and profit patterns.

- **Find a worst case scenario in past prices.** It is not difficult to look at past
charts to see obvious price shocks. Look for the largest price moves,
then consider a worst-case scenario to evaluate the risk. It is safe to
assume that what has happened before will happen again.

Creating an Artificial Data Series

A valuable transformation of data can give realistic system test results.
It will be necessary to use a computer to do the following:

1. **Scan the historic daily data** and remove the data for the day a price
shock occurred, plus the next two days of data. The day of the shock
can be identified by a large opening gap or an unusually large trading
range. You can select different size shocks by requiring the opening
gap or trading range to be 3, 5, or even 10 times larger than the
average gap or range.
2. *Create an index* of prices without the 3 days of data associated with the price shock. This will close any gap created by the elimination of data and change all the prices to percentage changes.

3. *Test the trading strategy* using the gap-adjusted series. This will result in parameter selection that does not try to profit from price shocks, or assume that it could be stopped out at unrealistic levels. It will produce a system that works in a "pseudo-normal" market (although "normal" must really contain price shocks).

4. *Run the trading strategy* with the selected parameters through the original data series, including all price shocks. The results should be similar profits, but much larger risk. Half of the shocks should have generated profits, and the other half large losses. If you find that there were no shocks that caused losses, then use the profitable shocks to indicate the magnitude of the potential losses. It should be considered simply good fortune that a few shocks occurred in the direction of the current position; in real trading it could be reversed. You should manually evaluate the size of the past price shocks and assume that it represents future risk.

You now have a realistic set of return and risk values to decide the merits of the system and the investment necessary to trade it successfully. The parameters selected for "normal" markets should return more consistent profits, and the final risk figures will give a realistic idea of the effects and frequency of price shocks. By removing the price shock data, the optimization process will never be able to fit parameters so that they profit from an unpredictable price shock.

The clear identification of price shocks which was used to create a gap-adjusted series also allows you to automatically recognize the same shock as the system during actual trading. When the shock occurs, you can change rules and treat the situation as a special case. Box 7-2 gives the FORTRAN code for creating this series. More on adjusting data can be found in Chapter 10.

**Managing a Price Shock**

You are going to take a big profit or a big loss from a price shock. Because you cannot predict when it will happen, you must assume that you will be holding a position, either long or short. We have discussed the use of a stop-loss to reduce risk and believe that a resting Stop order is more likely to capture the worst possible price. Then what are the choices?

You could hold a trade or exit it after the shock with a large profit or loss, whichever occurs. Because you can automatically identify a price
Understanding Price Shocks

shock on a computer, you can also test special strategies. For example, if the price shock is up, set a long or short position on the close, depending on the type of shock, then exit one or two days later (see Table 7-2). You can determine which shocks tend to continue and which reverse. If there are enough cases you can develop a clear price shock strategy.

Qualifying the Shock

There is a logical, accepted strategy to managing a price shock even without computerized testing. First, you must qualify the situation. If the price shock was caused by a fundamental, structural change, then only a small reversal should be expected. An announcement to raise interest rates ¼ percent by the Central Bank means that bond prices will fall to the new level. If a ½ percent increase was expected, prices will rise. It is not an issue of anticipation, but of fact. Interest rates are more definitive than most other news. Putting a price on the Gorbachev coup, planting intentions, retail drug prices, or a new national health program is not as simple. While most price shocks move further than necessary, a structural change means a permanent price shift. Some correction is normal, but a continuation of the new direction is also possible. Opportunities for recovering losses from a structural change are small.

Political news, natural disasters, and rumors dominate most other prices shocks. Assassinations are tragic but do not necessarily affect the safety or economy of a nation. Hurricanes, droughts, floods, and freezes devastate small countries and regions but rarely cause a substantial change in total supply. In the past, a freeze in Florida caused orange juice prices to soar; now, any shortfall in supply is happily filled by Brazil. Price shocks that cannot be confirmed or cannot be translated clearly into a price change are likely to move too far, too fast. These moves allow traders to recover a substantial part of their losses.

The Shock Is in Your Favor

When a price shock gives you a windfall profit, the position should be closed out immediately. Even though a structural change is likely to show additional profits, the increase in risk is greater than the potential for further profits. If the shock causes a loss, the position can be managed to recover part of the loss.

Figure 7-7(a) shows a price shock with some fundamental basis. Prices move sharply higher, then start a volatile, erratic decline. A short-term and long-term trend are shown as (1) and (2). Because prices move fast, system (1) cannot exit. The short trend would have been stopped out at the high, reversed to long and been stopped out again in a few
Box 7-2. CREATING A "SHOCK-ADJUSTED" PRICE SERIES

The following code to create a gap-adjusted and shock-adjusted series cannot be done using TeleTrac, Easy Language, or spreadsheets because the new data series is shorter than the old one. The following code in FORTRAN reads the original data series OLD and creates an adjusted series NEW.

```
SUBROUTINE GAPADJ(PERIOD,GF,TRF,FDAYS)
C----- "GAPADJ" subprogram for removing price shocks
C----- PERIOD the number of days to determine normal price movement
C----- GF the relative size of the overnight shock versus normal
C----- TRF the relative size of the intraday shock versus normal
C----- FDAYS the number of days to remove including the day of shock

PARAMETER (max$ = 500)
INTEGER DATE(max$),FDAYS
REAL OPEN(max$),HIGH(max$),LOW(max$),CLOSE(max$),
+ TRANGE(max$),GAP(max$),INDEX

IF(FDAYS.LT.1)FDAYS = 1
C---- Open input and output files
OPEN(10,FILE = 'IN')
OPEN(11,FILE = 'OUT')
C---- Initialize output count
N = 1
C---- Read original input data
10 READ(10,1000,END=50)DATE(N),OPEN(N),HIGH(N),LOW(N),CLOSE(N)
1000 FORMAT(6,F8.2)
C---- Start output file on day of full period
IF(N.EQ.1)THEN
NX = 1
INDEX(NX) = 1000.
WRITE(11,1100)DATE(N),INDEX(NX)
1100 FORMAT(6,F8.2)
ENDIF
IF(N.GT.1)THEN
NX = NX + 1
INDEX(NX) = INDEX(NX) + ABS(CLOSE(N)-CLOSE(N-1))/CLOSE(N-1)
C---- True range
TOP = HIGH(N)
BOT = LOW(N)
IF(CLOSE(N-1).GT.TOP)TOP = CLOSE(N-1)
```

IF(CLOSE(N-1).LT.BOT)BOT = CLOSE(N-1)
TRANGE(N) = TOP - BOT
C---- Gaps
    GAP(N) = ABS(INDEX(N) - INDEX(N-1))
    ENDF
C---- Test for a price shock
    IF(N.GT.PERIOD + 1.AND.
        +(GAP(N).GT.AVGGAP*GFACT.OR.TRANGE(N).GT.AVGTR*TRFACT))THEN
C---- Skip RDAYS = 1
    DO 30 I = 1, RDAYS
        PRIOR = CLOSE(N)
        READ(10,1000,END = 50)DATE(N),OPEN(N),HIGH(N),LOW(N),CLOSE(N)
        30 CONTINUE
        INDEX(NX) = INDEX(NX) + (CLOSE(N) - PRIOR)/PRIOR
        WRITE(11,1100)DATE(N),INDEX(NX)
C---- If enough data, calculate average range and gap
    IF(N.GT.PERIOD)THEN
        SUMTR = 0
        SUMGAP = 0
        DO 20 I = N, N-PERIOD+1, -1
            SUMTR = SUMTR + TRANGE(I)
        20 SUMGAP = SUMGAP + GAP(I)
        AVGTR = SUMTR/PERIOD
        AVGGAP = SUMGAP/PERIOD
        IF(N.LT.max$)THEN
            N = N + 1
            GOTO 10
        ENDF
        STOP 'Data too big for array. Increase max$ and rerun.'
    50 CLOSE(10)
    CLOSE(11)
    RETURN
END

Identification of a price shock once the factor has been determined:

IF (open > @AVERAGE(@ABS(open-close[1])/close[1],period)*GapFactor
OR @TrueRange > @Average(@TrueRange,period)*RangeFactor) THEN
Table 7-2. Price Shock Characteristics

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Structural Change</th>
<th>Temporary Panic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Volatile, quieting quickly</td>
<td>• Continued volatile</td>
</tr>
<tr>
<td></td>
<td>• Likely to produce more profits, but incremental risk greater than profits</td>
<td>• Likely to reverse</td>
</tr>
<tr>
<td></td>
<td>• Small reversal</td>
<td>• Large reversal</td>
</tr>
<tr>
<td>If a profit</td>
<td>Close out the trade</td>
<td>Close out the trade</td>
</tr>
<tr>
<td>If a loss</td>
<td>Wait for a small reversal to exit</td>
<td>Wait for a 25% to 50% reversal or add to the position to recover more than 50% of the loss</td>
</tr>
</tbody>
</table>

...days. The slower trend gets a windfall profit but gives back one-third before getting a trend reversal signal.

After the price shock, both fast and slow trends are catching up to the price jump while in Figure 7-7(a) prices have actually reversed direction. It is difficult to say that we are “following the trend” when the trend ended with the shock. This was exactly the situation following the 1987 stock market drop. Sensible management requires that trend positions be closed out after a windfall profit. If the change is structural, the position may be reset, but in most cases it is best to wait for a new trend signal to re-enter.

Figure 7-7(b) depicts a structural change. Although prices continue higher, the faster trend system is stopped in and out because of higher volatility. The slower trend would have increased profits before encountering the same sideways period. Both strategies, however, would have been improved by taking profits immediately after the price shock.

**Risk Reduction**

Price shocks are accompanied by high volatility. By taking profits as soon as possible, you would not be holding a position during the period of increased risk following the first price peak. Even though a structural change produced more profits when the trade was held, the risk (measured by the volatility) was far greater than the marginal profit gained. Once this equity fluctuation is part of performance, it cannot be erased. Focusing on low risk translates into higher leverage and greater profits.

**The Shock Produces a Large Loss**

Once the price shock hits, and you are on the wrong side, risk is no longer an issue. The most important concern is to find the best chance for
Figure 7.7. Trading price shocks. (1) Trend-following where the shock is a loss, and (2) Trend-following where the shock is a profit.
recovering part of the loss. If the change is structural, you can expect only a small recovery, and the risk of further loss may be just as high. Timing is important. A professional trader can monitor the market, waiting for a sign that trading is quieting and the surge of orders has been filled. Whatever correction is likely will come at this time. Afterward, prices may again move in the direction of the shock. A longer-term trader, who may have seen the shock only after the close, would do best to get out as soon as possible, as long as the market is actively trading.

A temporary event that is likely to reverse can be managed in two ways. A conservative trader may hold the original position and wait for a reversal to exit, expecting a 10 percent to 30 percent recovery. It may be closed out after one day if proved wrong and prices reach new ground, or if the reason for the shock appears to become structural. A more aggressive trader may double the original position, looking to recover 20 percent to 60 percent of the losses. In neither case should you expect to turn a loss into a profit. This is entirely a defensive management strategy.

**Management Obligations**

Traders often feel that they have an obligation to follow their system no matter what the circumstances. It is true that, if the rules are strictly followed, it is easy to explain why things went wrong. Deviating from the plan, and subsequently losing more, will be embarrassing to explain.

Offsetting the rigid systematic approach is the concern that it is not reasonable to follow a "trend" when prices are moving in the opposite direction after a price shock. To resolve this dilemma, record the following list of clear rules to use when a "price shock day" is identified:

1. **Identify the shock.** A price shock occurs when a gap or trading range is greater than a threshold value.
2. **If profitable,** then take profits and wait for a new trend signal.
3. **If losing,** then hold losses for one day after market trades. Exit if a new extreme price, a 50 percent reversal, or a contrary trend signal occurs.

Using two clear sets of rules, a manager can justify the proper response to a price shock.

**Long-Term Systems Are More Predictable Than Short-Term Systems**

When choosing a trading strategy, remember that the longer-term, slower systems are more likely have returns similar to their historic test-
Understanding Price Shocks

ing and expectation. Because the tests cover a long time period, they include more price shocks, more patterns, and more risk. They generate larger profits by holding the trade for longer periods; therefore, a price shock does not seem as important or disruptive to performance. The relative size gives it a chance to absorb the shocks. It is difficult to add a short-term rule to a long-term system for the purpose of eliminating a price shock. Short-term rules tend to change a slow trading system to a fast one, including large periods of being out of the market.

Summary

We prefer to trade a system which we perceive as having low risk, but we often create larger risks by unrealistically assuming that we can profit from price shocks. This leads to undercapitalized accounts and unpleasant results. A price shock affects all trading the same way, whether you are a short-term or long-term trader, a trend-follower or a countertrend trader. If a government report causes the yen to jump 300 points, all trades will be affected. It only matters whether you are long or short when the price shock hits. However, in the total performance profile or in a fully diversified portfolio, the effects of a shock on a longer-term view will be less dramatic.

By accepting the uncertainty of price shocks, you can implement alternate trading rules to limit further risk and possibly recover some loss. Once the price shock hits, it triggers a new plan. Trend-following systems do not apply to a market that has just experienced a structural change, no matter which direction prices move.

Understanding the real risk of trading is the most important part of system testing and performance evaluation. The business of trading is expected to return a profit for an acceptance of risk. Without clearly understanding the risks of each strategy, you cannot intelligently choose the best system and decide how much capital will be required to trade.
If you could achieve only one goal in price analysis, it should be identifying the price direction, or trend. If you take positions in the direction of the trend, then you should capture the biggest price moves and have reasonable control over risk. When you use a trend to select trades or set hedge positions by confirming the correct trend direction, your trading performance must improve.

**Forecasting and Following**

**Finding the Trend**

There are two ways to find the trend. By analyzing major economic factors, you can conclude that prices should go higher. Greater demand, good management, better technology, and cheaper money may all contribute to long-term growth, higher dividends, and higher share prices. Energy prices may be pushed up by greater consumption, a unified OPEC position to cut production, or supply disruption in Siberia. But basic fundamental evaluation is difficult and dependent on reliable information. The conclusion may change if new factors are introduced. Changes must be constantly monitored and weighed.

Many traders supplement or substitute a moving average to identify the trend. There may seem to be no relationship between a simple mathematical formula and the result of events that drive prices, but that is not the case. A moving average creates a trend by smoothing erratic price movement. Because it is an average of past prices, it reduces the effects of outliers that appear to have been extreme reactions to news.
Averaging longer periods of data gives smoother trends. The result is often a good representation of long-term market direction, and a valid parallel to government monetary or interest rate policy. Moving averages are also used in econometrics to remove known seasonal or cyclic effects. For many years, stock market analysts have used a 200-day moving average as their benchmark.

A moving average is exactly what it seems to be: the average value of a prior data period. A 3-day moving average is simply

$$\text{average} = \frac{\text{price} + \text{price}[1] + \text{price}[2]}{3}$$

Most computer trading software, even spreadsheets, will have the moving average formulas preprogrammed, so that it is only necessary to enter

@average(price, n)

where price is the data to be averaged, and n is the number of periods (e.g., days or hours). There are many variations on a moving average:

- A weighted average may assign different importance to each data item. A 3-day weighted average typically values 60 percent of the most recent price and 30 percent of each prior day:

@weighted_average(price, 3) = .60 \times \text{price} + .30 \times \text{price}[1] + .30 \times \text{price}[2]

- An exponential moving average (called an "exponential") is a special type of weighted average, in which each data item is reduced in value by a constant percentage as it becomes older:

$$\text{exponential} = \text{exponential}[1] + \text{percentage} \times (\text{price} - \text{exponential}[1])$$

which may also be entered

@exp_ma(price, smoothing_constant)

where smoothing_constant is the percentage weighting.

In most of this book, whenever a moving average is needed, an exponential moving average ("exponential") will be used. It is the simplest calculation because it does not require all the past data, and the results are nearly identical to other moving averages.

Fundamental Analysis and Trend Following

Economic or fundamental analysis forecasts, and trend evaluation follows. Fundamental analysis attempts to anticipate events by assessing the
reaction to current factors and weighing the impact of probable events. Trend calculations look at past data, reduce price movement to a net direction, and assume that prices will continue to do the same as in the past. Trend-following systems respond to events, rather than anticipate them.

Both fundamental analysis and trend following are good methods, but neither are simple nor are they foolproof. This chapter is concerned with trend-following methods and computer applications. New, high-powered graphics equipment has made looking backward much easier, and computerized strategy testing packages have made searching for successful systems painless. But it is not that easy. What worked in the past does not seem to work in the future—at least not as well, or not all the time.

**Trend Trading**

**Noise**

Trading in the direction of the trend is a safe, conservative approach. An important feature of trending systems is that they let profits run and cut losses short. Financial analysts call this “conservation of capital.” The most reliable trends are slower ones, capturing the long-term direction of interest rates or the decline of the U.S. dollar. Long-term trends should reflect the same direction as government policy.

Trend systems should not be expected to work with data periods shorter than 1 hour. As you look at prices over intervals such as 5 minutes, you see mostly “noise.” Noise is caused by buy and sell orders from all over the world entering the market for different reasons. Liquidation of stocks for personal reasons, trading objectives that focus on different time periods, currency transactions that hedge international business exposure, all come in a steady flow into the marketplace. Orders vary in size, and some larger orders find periods of low volume. This results in price gaps and short, fast moves that may appear to be a new price direction.

The level of volatility that occurs during a sustained sideways, directionless period is a convenient measure of intrinsic noise. A price trend will be unreliable if it is signaled by a move that is no greater than the intrinsic level of market noise (see Figure 8-1).

**Slow Trends and Lags**

Although longer-term trends are the most dependable, they respond very slowly to changing market conditions. A 200-day moving average
Figure 8-1. Intrinsic noise in the Dow Jones Industrial Average. (a) Intrinsic noise can be seen as the lowest normal level of volatility. In the year before the October 1987 plunge, the DOW showed remarkably uniform volatility. The daily trading range of about 25 points makes a stop-loss of 25 points likely to be executed without any expectation that prices would continue in one direction. (b) Because of noise, small changes in the daily closing price cannot be considered important. Price changes, from close to close, show that over 2 to 3 days, prices could move up or down 30 points. A trend system that buys when prices move up by only 20 DOW points will be unreliable. (Charts courtesy TeleTrac.)

barely reacts to a 10-day burst of energy in a stock issue. If the price of IBM ran from $50 to $70 per share in 20 days, a 200-day moving average would have moved up by no more than $2. It is difficult to consider a method as "trend-following" when a moving average is catching up to a price move that is already over.
Adaptive Approach

To avoid false signals due to noise, yet eliminate some of the lag inherent in long-term trends, an adaptive method is needed—a moving average that will speed up when markets move and do nothing when there is no direction. “Adaptive” is the term given to techniques that self-adjust to market conditions. But again, it is not always clear what patterns will signal the moving average to change speeds.

The Traditional Solution

The most popular way of finding the “best” moving average speed is simply to test all possible trend speeds using historical data. The answer given by the computer depends on the amount of data tested. If you use a long data history, the best choice will be a very slow moving average. If short time periods are tested, the computer will find a number of highly profitable fast and slow solutions; often it will hone in on a single large price move to capture all its profits. Because these patterns do not continue, faster trends rarely succeed.

Typically, the more data tested, the more likely the results will be a very slow trend-following system. And that solution is correct. Short-term price bursts are erratic and unpredictable, but the long-term trend is stable. Unfortunately, large equity swings are associated with holding a trade for weeks or months. Everyone wants a short-term, fast-trading trend that works without large losses. That combination does not exist.

Another popular solution is using a computer frequently to retest the speed of the trend. By including the most recent data, the trend speed is always expected to be the best. This still requires decisions such as how often to retest and how much data to use for retesting. Jumping from one fast trend speed to another creates two additional problems. The computer may want you to get into a trade that it entered some time ago and is already highly profitable. That should worry you. It may also result in “overfitting,” isolating a very short-term pattern that does not work anymore. If the “best” choice changes frequently, it is because the last choice was not the best.

Adapting to Different Market Traits

A trend-following method is needed that adapts to different market conditions. It must be slow when prices are drifting aimlessly and fast when it is necessary to capture profits. Frequent retesting cannot find
this trend because an emerging pattern is only a small piece of the total data.

A solution can be found by remembering how certain market patterns affect trends. To begin, what do we know about price movement that would help an analysis?

- Fast-moving averages are best when the market is moving quickly in one direction.
- Slow-moving averages are best when prices are going nowhere in choppy markets.

Therefore, the system would be “smart” if it changed speeds according to a combination of market direction and speed. Figure 8-2 shows four cases that explain the transition.

Another important principle to remember is that analyzing a lot of data produces robust results. It may give less profitable solutions, but these tend to be more dependable. Analyzing small amounts of data results in many solutions that appear to be good but rarely work.

**Moving from Specific Cases to a General Solution**

The best choice for a moving average will be the fastest one that can be used for a situation. What, then, do these four cases have in common? Each one shows that the fastest trend that can be used is limited by the amount of noise, or unpredictable price movements. As the market pattern goes from ideally smooth to very noisy (from (a) to (c) in Figure 8-3) the trend speed must get slower to avoid whipsaw losses.

When prices move faster in one direction, the market speed makes the noise less important. Therefore, the choice of a trend speed is based on both noise and direction. A price move that is either cleaner or faster can use a faster trend. What is needed is a mechanism to sense market speed and choppiness; this information can then be fed back into the moving average to adjust the speed of its smoothing.

The Efficiency Ratio combines these features. This ratio divides the net price movement by the total price movement (the sum of each of the individual moves taken as a positive number). It can also be considered a ratio of the price direction to its volatility. The more efficient, the faster the trend. A safety factor is built in to the selection of the right trend. If there is any uncertainty, a slower trend is picked. Some readers will recognize the Efficiency Ratio as being what has been recently named generalized fractal efficiency.
(a) Runaway markets: Very fast. Markets that break out and never look back can be traded using the fastest practical speed.

(b) Fast markets: Fast speeds. Fast markets may have some sharp reversals within a prolonged directional move. A moving average must lag enough to avoid getting caught by the short reversals. The faster the market is rising (falling), the less impact the reversals have on the speed of the trend.

(c) Congested markets: Very slow. Markets that enter, or are already in, a sideways pattern, cannot be actively traded. A slow trend speed with a large trend change criteria will hold the same position, therefore it will avoid getting whipsawed.

(d) Middle-trends with some volatility: Slightly faster sometimes. As markets start to trend after a sideways period, the speed of the trend can increase. This only works if the level of noise declines; otherwise, a slow speed is still necessary.

Figure 8.2. Observing price patterns and trends.

The Efficiency Ratio has values ranging from 0, when markets are very noisy for the current amount of direction, to +1 when prices are highly directional. This notation is convenient because it fits perfectly as an exponential smoothing constant. A small transformation scales the value and increases stability (see Box 8-1).
Defining the Range of Trend Speeds

The range of the Efficiency Ratio (ER), from 0 to 1, can be mapped onto a range of trend speeds using a simple formula. Let $ER = 0$ be the slowest speed and let $ER = 1$ be the fastest speed. Then the ratio itself can be used as a percentage that moves between the slowest and the fastest. If the trend speed, in days, is converted to a smoothing constant approximation using $sc = 2/(N + 1)$, then the slowest speeds have the smallest values. The formula for scaling the smoothing constant becomes

$$\text{Scaled smoothing constant} = ER \times (\text{fast } sc - \text{ slow } sc) + \text{ slow } sc$$

The range of fast to slow is selected as 2 to 30 days, which is the same as the smoothing constants .6667 and .0645. The scaled speed formula is then
Box 8-1. VOLATILITY MEASUREMENT

There are three popular ways to measure volatility. The method chosen may differ for specific applications. Figure 8-4 (a)–(c) shows the three approaches. The first (a) is simply the net change in price from the first to the last point. This tends to be the most conservative measurement, because it smooths any price movement that occurs between the beginning and end. The high-low range (b) is more descriptive of any extremes that might have occurred within the period. The sum of all changes (c) is the most encompassing measurement because it distinguishes the number of times a price moves from high to low. The Efficiency Ratio uses the last method because a low value of this sum is consistent with the strictest idea of “efficiency.”

(b) 

Figure 8-4. Volatility measurement. (a) Positive change in price. (b) High-low range. (c) Sum of all positive changes.
Scaled smoothing constant: \[ sc = ER \times (.6667 - .0645) + .0645 \]
\[ = ER \times .6022 + .0645 \]

One last step is necessary because the longer-term 30-day moving average will still move slowly up and down, even in a sideways market. The Adaptive Moving Average will be best if it can stop moving when the direction of the market is uncertain. To accomplish this, the final speed is the result of squaring the scaled speed value.

\[ c = sc \times sc = sc^2 \]

**The Adaptive Moving Average**

The smoothing constant \( c \) is calculated every day and used in the exponential moving average formula. This becomes an *Adaptive Moving Average*:

Adaptive Moving Average:

\[ AMA = AMA[1] + \text{smoothing}\_\text{constant} \times (\text{price} - AMA[1]) \]

The complete calculation of the AMA can be found in Box 8-2. This trendline has special features:

- It uses a small number of days (always fixed at 10 in this book) to assign a trend range from very fast to very slow.
- The AMA trendline appears to stop when markets have no direction.
- When prices make a significant move, the AMA trendline catches up, resulting in a very small lag.
- Only one parameter may be changed. The Efficiency Ratio can be based on a 10-day calculation, and that time period may be used for all markets. The filter size (discussed later) allows some flexibility for different trading speeds.
- The AMA was based on analysis rather than testing.

**Stock and Forex Examples**

Castril is used to compare the Adaptive Moving Average with a 30-day standard and a 30-day exponential moving average. Comments on trading are also included. The Deutsche mark is used to show how the AMA
can produce a smooth trendline through a period of changing market patterns and speed. They also show the adaptability of the AMA, independent of the market selected.

**Castrol**

The Castrol chart (Figure 8-5) shows that the three trendlines come together at key points. The AMA does not necessarily turn up or down ahead of the others, but it shows much less lag. Notice the two periods, December 1992 and March 1993. In the first case, the AMA moves up in a few days, then sideways for the next 1 1/2 months until the other trendlines catch up. A similar situation occurs in March, although the AMA continues to move slowly lower, based on a slightly directional market.

**Trending versus Lagging.** During December 1992, the Castrol chart shows that the standard trendlines successfully stayed in the upward move until after the peak near the end of February. But during the month of December, there was no trend. December was highly volatile. Had the market continued lower in mid-December, the standard and exponential moving averages would have lost all their profits.

A serious problem with any trend that is fixed at one speed is that it spends most of the time catching up to a price move that has ended. In December and March, the price moves took only a few days, but the trendlines needed another month to catch up. When a trending indicator tells you that the trend is down, it really means that the trendline is going down, even though prices may be going up.

**Profit-Taking.** The selection of the fastest AMA trend speeds, seen during the sharp rise and fall of the trendline in December and March, precede the end of a significant price move. For reasons discussed in detail in Chapter 5, this becomes an excellent point to exit the position. The December peak above 1000, and the first March low at 800 are near, or better, than the exit price that would have been achieved by waiting for the end of the trend. Combined with better executions and lower volatility, covered later, profit-taking is strongly recommended based on a high value of the Efficiency Ratio.

**Deutsche Mark: Efficiency Ratio and AMA Trendline**

Figure 8-6 uses an arbitrary period for the Deutsche mark to show the Efficiency Ratio and the corresponding AMA trendline. In the middle of November 1992, the Efficiency Ratio declines to 0, indicating a period of
Box 8-2. A SMARTER MOVING AVERAGE USING THE EFFICIENCY RATIO

To create the Adaptive Moving Average, it is first necessary to calculate an Efficiency Ratio, then convert that ratio to a trend speed.

Step 1: Price Direction

Price direction is expressed as the net price change over time. For example, using the time interval of n-days (or n-hours):

\[ \text{direction} = \text{price} - \text{price}[n] \]

or

\[ \text{direction} = \text{@momentum(price, n)} \]

where direction is the current price difference, or directional value
price is current price (daily close or hourly price)
price[n] is the close n-days ago (or n-periods ago)

Step 2: Volatility

Volatility is the amount of market "noise." It can be defined a number of different ways, but this calculation uses the sum of all the day-to-day or hour-to-hour price changes (each taken as a positive number), over the same n periods. It is expressed as

\[ \text{volatility} = \text{@sum(@abs(price – price[1]), n)} \]

where volatility is today's volatility value
@abs is the absolute value (positive value of any number)
@sum(value, n) is the sum of "value" over n periods

Step 3: Efficiency Ratio

These two components are combined to express the ratio of directional movement to noise, called the Efficiency Ratio, ER:

\[ \text{Efficiency Ratio} = \text{direction}/\text{volatility} \]

By dividing the directionality by the noise, the ratio varies from 0 to 1. When the market moves in the same direction for all n-days, then direction = volatility and Efficiency Ratio = 1. If volatility increases for the same price move, volatility gets larger and the ratio ER moves away from 1. If prices go nowhere, then direction = 0 and ER = 0.
This result is convenient as an exponential smoothing constant, which changes the trendline by a percentage each day. ER = 1 is equivalent to 100 percent, the fastest moving average, which should work because prices moved in one direction without a retracement. When ER = 0, a very slow moving average is best to avoid getting stopped out while the market goes nowhere.

**Step 4: Transforming the Ratio into the Trend Speed**

The ratio will be changed into a smoothing constant c, for use in an exponential moving average. By using this formula, the trend speed can change each day by simply changing the smoothing constant. It becomes *adaptive*. The formula for this is

$$\text{@exp\_ma} = \text{@exp\_ma}[1] + c \times (\text{price} - \text{@exp\_ma}[1])$$

which shows that the exponential moving average gets closer to today’s close by a percentage, c, of yesterday’s gap. The constant c relates closely to the number of days in a standard moving average by the relationship $2/(n - 1)$, where n is the number of days.

Tests show that squaring the value of the smoothing constant greatly improves the results by virtually stopping the trendline from moving during a sideways market. This process selects very slow trends during sideways markets, and speeds up to a very fast trend (but not 100%) during highly trending periods. The smoothing constant is then

- fastest = $2/(N + 1) = 2/(2 + 1) = .6667$
- slowest = $2/(N + 1) = 2/(30 + 1) = .0645$
- smooth = ER $\times$ (fastest $-$ slowest) + slowest

$$c = \text{smooth} \times \text{smooth} = \text{smooth}^2$$

Squaring smooth forces the value of c toward zero. This means that slower moving averages will be used more often than fast ones. That is the same as being more conservative when you are uncertain.

$$\text{AMA} = \text{AMA}[1] + c \times \text{(price} - \text{AMA}[1])$$
more noise relative to trend direction. The AMA trendline becomes nearly horizontal for this period (see Figure 8-6(a)), indicating a sideways period and allowing the system to hold its long position, or to stand aside, depending on your rules.

During the months of October 1992 and June 1993, clear trends cause the AMA trendline to begin slowly, then increase its speed as the trend develops. In both cases, the Efficiency Ratio peaks over .80 (see Figure 8-6(b)). The Efficiency Ratio may vary from 0 to .40 without the speed of the trendline changing by much. The period from March through May
1993 shows a relatively noisy but low level for the Efficiency Ratio, resulting in a very slow trend for the AMA.

Figure 8-6(c) shows the moving average days corresponding to the smoothing constant. The days appear upside down relative to the Efficiency Ratio because the trendline slows as the days increase. The days also move in a more extreme manner than the Efficiency Ratio, remaining at its peak level (the program cuts the tops off at 40 days) longer but moving from fast to slow quickly. This is due to the squaring of the smoothing constant after all other calculations are done.

Trading Rules

A basic trend-following system should not be confused with a complete trading strategy. There are no subtleties in the selection of entry and exit timing, nor are there special techniques for entering multiple positions, taking profits, or using other risk controls. Those features must be analyzed separately to maintain their integrity in a lateral solution. To know if one trend-following method is better than another, it is necessary to simply enter and hold a long position when the trendline moves up, and reverse to a short position when the trendline turns down.

Basic Buy and Sell Signals

The trading rules for the Adaptive Moving Average are:

- Buy when the Adaptive Moving Average turns up.
- Sell when the Adaptive Moving Average turns down.

Because the trendline is the result of netting all the price moves, it should represent the best evaluation of the trend. Therefore, the buy and sell signals are based on the direction of the trendline, rather than the price penetration of the trendline.

When exponential smoothing is used, the trendline always turns up and down at the same time the price penetrates the line. The benefit of using the trendline for the Adaptive Moving Average signal is that the formula limits the amount of change in the trendline, making it easy to increase reliability by using a small entry filter.

A Filter for False Signals

A filter is needed for any trending system to avoid false signals caused by noise when prices are moving sideways. During a nondirectional
period, prices will move back and forth through the smoothed trendline value. This affects all moving average systems in the same way, but it is more obvious with faster trends. The trendline must move higher or lower by the amount of the filter to qualify for a trading signal.

The Adaptive Moving Average produces a very slow trend during noisy market periods. The 30-day maximum, or .0645 smoothing constant, becomes .0041 when squared, equivalent to a 486-day moving average. When prices move through the AMA, the trendline makes only a very small change. Therefore, only a small filter is needed to avoid most whipsaws.

**Self-Adjusting Filter.** To be consistent with the adaptive nature of the system, the filter will be also get larger and smaller when prices become more or less volatile. To accomplish this, the filter is defined as a small percentage of the changes in the AMA trendline:

\[ \text{filter} = \text{percentage} \times \text{std dev}(\text{AMA} - \text{AMA}[1],n) \]

where percentage is the percentage of 1 standard deviation,

\[ \text{std dev}(\text{series},n) \]

is the standard deviation of series over n periods, and

\[ \text{AMA} - \text{AMA}[1] \]

is the 1-day change in the AMA trendline.

The smallest filter percentages of .01 can be used for faster trading, while the larger percentages of 1.0 select those trades that have had a more significant price move. Typically, forex and futures markets trade faster, stock and interest rate markets trade slower. Normally, the filter is calculated over a period of 20 days.

**Adding the Filter to the Rules.** Using the filter, the one-period change in the AMA trendline must be bigger or smaller than the filter size to get a buy or sell signal. This works well for selecting trades and eliminating false signals. One problem occurs, however, when the trendline very gradually changes direction. The change in the AMA trendline may not be greater than the filter on the first or the second or the third day. That may be good, because a slow trend change may reverse to be a continuation of the opposite trend direction. But if those small changes continue, the trend could have reversed without giving a new trading signal.

If the new buy and sell signals are based on comparing the one-period changes in the AMA trendline with the filter, a signal could occur well after the new trend begins. To eliminate this possibility, the most recent lowest and highest points on the AMA are recorded. Instead of comparing the one-period changes with the filter, the total change in the AMA since its recent high and low is compared against the filter.