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Beyond Technical Analysis: How to Develop and Implement a Winning Trading System

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Preface

This is a book about designing, testing, and implementing trading systems for the futures and equities markets. The book begins by developing trading systems and ends by defining a system for trading. It focuses exclusively on trading systems. Hence, I have assumed that the reader has at least a working knowledge of technical analysis and is familiar with software for developing technical trading systems

The book is broadly divided into two parts. The first half deals with development and testing—how the system worked on past data—and discusses basic rules, key issues, and many new systems. The second half explores how the system might do in the future, with a focus on equity curves, risk control, and money management. A key contribution is a new method called "data scrambling," which allows unlimited amounts of synthetic data to be generated for true out-of-sample testing. The last chapter brings all of the material together by offering solutions to practical problems encountered in implementing a trading system.

This book goes beyond technical analysis—it bridges the gap between analysis and trading. It provides a comprehensive treatment of trading systems, and offers a stimulating mix of new ideas, timeless principles, and practical guidelines to help you develop trading systems that work.

Acknowledgments

I thank Nelson F. Freeburg for twice reading this manuscript. Nelson's meticulous attention to detail, outstanding grasp of the subject, sharp eye for inconsistencies, and love of the language have helped to improve this book immeasurably. Nelson edits a monthly newsletter, *Formula Research,* which is "must-reading" for serious students of the financial markets.

A good editor is essential to guide a book to completion. I want to thank Pamela Van Giessen of John Wiley & Sons for being the accessible, cheerful, and resourceful editor every author loves.

Beyond Technical Analysis

Chapter

Developing and Implementing Trading Systems

Nothing is easier than developing a trading system by the •usual process of trial and terror.

Introduction

Хорошая система торговли удовлетворяет вашу индивидуальность. К счастью, самый быстрый способ находить каждый - через процесс испытания(суда) и ужаса(террора). Любое проверяющее система программное обеспечение на быстром компьютере поможет Вам произвести в большом количестве тысячу розовых сценариев. Рынки безошибочно покажут любые недостатки в вашем проекте. Они выдвинут(подтолкнут) Вас, чтобы определить то, чему Вы верно верите. В конечном счете, если Вы выживаете, Вы обнаружите ваши веры торговли. Рынки будут вести Вас к системе, которая лучше всего удовлетворяет Вас.

Эта книга показывает Вам, как создавать, проверять, и осуществить системы, которые удовлетворяют вашу индивидуальность. Вы разовьете не только системы торговли, но и систему для торговли. Этот подход увеличит разницу(разногласия), что Вы выживете и будете процветать на рынках.

Эти книжные центры исключительно на творческом проекте системы, полном испытании, заметном(разумном) управлении денег, благоразумном контроле(управлении) риска, и осторожном внимании к выполнению. Эти факторы отличают эту книгу от других

РАЗВИТИЕ И ВНЕДРЕНИЕ ТОРГОВЫХ СИСТЕМ

На предмете. Привлекательная особенность - то большинство материала, первоначальное или новое. Эта книга разделена на две половины по четыре главы каждая. Первая часть посвящена проектированию торговых систем. Вторая половина обсуждает, как внедрить системы торговли. Первая половина охватывает следующие темы:

1. Принципы проектирования торговой системы, которая охватывает шесть кардинальных правил

2. Основы проекта системы, который представляет десять главных проблем проекта
3. Развитие новых систем торговли, который подробно описывает семь новых систем
4. Development of trading system variations, which discusses eight variations of known ideas

Once you have read the first half, you will be eager to explore questions about system implementation. The second half of the book is organized as follows:

5. Equity curve analysis, which explores what influences equity curve smoothness
6. Ideas for money management, which is the starting point for risk control
7. Data scrambling, which offers all the synthetic data you will ever need
8. A system for trading, which presents solutions to practical problems

After reading this volume, you should be able to take your ideas and convert them into useful trading systems. This book develops deterministic trading systems, which means that all the rules can be explicitly evaluated. The book does not discuss trading systems based on expert systems, neural networks, or fuzzy logic for two simple but important reasons: (1) More users understand and easily implement deterministic systems than any other type of system. (2) The software for testing deterministic systems is widely available at an economical price. Put the two together, and this book becomes immediately accessible to a large audience.

The Usual Disclaimer

Throughout the book, a number of trading systems are explored as examples of the art of designing and testing trading systems. This is not a recommendation that you trade these systems. I do not claim that these systems will be profitable in the future, nor that profits or losses will be similar to those shown in the calculations. In fact, there is no guarantee that these calculations are defect free. I urge you to review the section in chapter 3 called a reality check. That section points out the inherent limitations of developing systems with the benefit of hindsight. You should use the examples in this book as an inspiration to develop your own trading systems. Do not forget that there is risk of loss in futures trading.

What Is a Trading System?

A trading system is a set of rules that defines conditions required to initiate and exit a trade. Usually, most trading systems have many parts, such as entry, exit, risk control, and money management rules.

The rules of a trading system can be implicit or explicit, simple or complex. A system can be as simple as "buy sweaters in summer," or "buy when she sells." By definition, the system must be feasible. Ideally, the system accounts for "all" trading issues, from signal generation, to order placement, to risk control. A good way to visualize effective system design is to stipulate that someone who is not a trader must be able to implement the system.

In practice, every trader uses a system. For most traders, a system could really be many systems. It could be discretionary, partly discretionary, or folly mechanical. The systems could use different types of data, such as 5-minute bars or weekly data. The systems may be neither consistent nor easy to test; the rules could have many exceptions. A system could have many variables and parameters. You can trade different combinations of parameters on the same market. You can trade different parameter sets on different markets. You can even trade the same parameter set on all markets.

It should be clear by now that there is no single universal trading system. Every trader adapts a "system" to *his* or her style of trading. However, it is possible to draw a distinction between a discretionary trader and a 100% mechanical system trader, as compared in the next section.

Comparison: Discretionary versus Mechanical System Trader

Table 1.1 compares two extremes in trading: a discretionary trader and a 100% mechanical system trader. Discretionary traders use all inputs that seem relevant to the trade: fundamental data, technical analysis, news, trade press, phases of the moon—their imagination is the limit. System traders, on the other hand, slavishly follow a mechanical system without any deviations. Their entire focus is on implementing the system "as is," with no variations, exceptions, modifications, or adaptations of any kind.

Exceptional traders are discretionary traders, and they can probably outperform all mechanical system traders. Their biggest advantage is that they can change the key variable driving each trade, and therefore vary bet size more intelligently than in a mechanical system. Discretionary traders can change the relative importance of their trading variables so they can easily switch between trend-following and anti-trend modes. They can instantly switch between time frames of analysis, going from 5-minute bars to weekly bars as their assessment of the trading opportunity changes.

Discretionary traders can make better use of market information other than price. For example, they can react to news or fundamental information to change bet size. Discretionary traders can adjust their perceived risk constantly, so they can increase or decrease positions more intelligently than mechanical traders. These infrequent "home runs" often make all the difference between good and great trading performance. However, for the average trader, being a mechanical system trader probably maximizes the chances of success.

The goals of a mechanical system trader are to pick a time frame (for example, hourly, daily, weekly), identify the trend status, and anticipate the direction of the future trend. The system trader must then trade the anticipated trend, control losses, and take profits. The rules

Table 1.1 Comparison of trading styles: Discretionary versus mechanical

Discretionary Trader	100% Mechanical System Trader
Subjective	Objective
Many rules	Few rules
Emotional	Unemotional
Varies "key" indicator from trade to trade	"Key" indicators are always the same
Few markets	Many markets

must be specific, and cover every aspect of trading. For example, the rules must specify how to calculate the number of contracts to trade and what type of entry order to use. The rules must indicate where to place the initial money management stop. The trader must execute the system "automatically," without any ambiguity about the implementation.

Mechanical system traders are objective, use relatively few rules, and must remain unemotional as they take their losses or profits. The most prominent feature of a mechanical system is that its rules are constant. The system always calculates its key variables in the same way regardless of market action. Even though some indicators vary their effective length based on volatility, all the rules of the system are fixed, and known a priori. Thus, mechanical system traders have no opportunity to vary the rules based on background events, nor to adjust position size to match the markets more effectively. This is at once a strength and a weakness. A major benefit for system traders is that they can trade many more markets than can discretionary traders, and achieve a level of diversification that may not otherwise be possible.

You can create different flavors of trading systems that use a small or limited amount of discretion. *You.* could, for example, have specific criteria to increase position size. This could include fundamental and technical information. *You* can be consistent only if you are specific. This discussion really begs the question of why to use trading systems, answered in the next section.

Why Should You Use a Trading System?

The most important reason to use a trading system is to gain a "statistical edge." This often-used term simply means that you have tested the system, and the profit of the average trade—including all losing and winning trades—is a positive number. This average trade profit is large enough to make this system worth trading—it covers trading costs, slippage, and is, on average, likely to perform better than competing systems. Later in the book, I discuss all of these criteria in greater detail.

The statistical edge is relevant to another statistical quantity called the probability of ruin. The smaller this number, the more likely you are, on paper, to survive and prosper. For example, if you have a probability of ruin less than, say, 1 percent, your risk control measures and other measures of system performance are typically sufficient to prevent instant destruction of your account equity.

My biggest source of concern about these statistical numbers is they assume you will trade the system exactly as you have tested it, with not one deviation. This is difficult to achieve in practice. Thus, your risk of ruin—and it is only a risk until it becomes a fact—could be higher than your calculations. Despite this concern, you should develop systems that meet sound statistical criteria, for that greatly enhances your odds of success. As usual, there are no guarantees, but at least the odds, if not the gods, will be on your side.

Another reason to use a trading system is to gain objectivity. If you are steadfastly objective, you can resist the siren call of news events, hot tips, gossip, or boredom. Suppose you are a chart trader and you enjoy some flexibility in interpreting a given chart formation. It is very easy to identify a pattern after the fact, but it is rather difficult to do so as the pattern evolves in real time. Hence, analysis can paralyze you, and you may never make an executable trading decision. Being objective frees you to follow the dictates of your analysis.

Consistency is another vital reason to use a trading system. Since the few rules in a trading system are applied in precisely the same way each time, you are assured of a rare consistency in your trading. In many ways, objectivity and consistency go together. Although consistency is known as the hobgoblin of little minds, it is certainly a useful trait when you are not quite a champion trader.

A trading system gives another crucial advantage: diversification, particularly across trading models, markets, and time frames. No one can be certain when the markets will have their big move, and diversification is another way to increase your odds of being in the right place at the right time.

In summary, you can use a trading system to gain a statistical edge, objectivity, consistency, and diversification across models and markets. A key assumption underlying this section is that the system you are using is well designed and robust. The next section discusses examples of a robust trading system.

Robust Trading Systems: TOPS COLA

A robust trading system is one that can withstand a variety of market conditions across many markets and time frames. A robust system is not overly sensitive to the actual values of the parameters it uses. It is not likely to be the worst or best performer, when traded over a "long" time (perhaps 2 years or more). Such a system is usually a trend-following

system, which cuts losses immediately and lets profits run. This philosophy, called TOPS COLA, merely says "take our profits slowly" and "cut off losses at once."

Two examples of robust systems are a moving-average cross-over system and a price-range breakout system. Both systems are well known, and are widely traded in some form or another. The trades from these systems typically last more than 20 days. Hence I classify them as intermediate-term systems. They are trend-following in nature, in that they make money in trending markets and lose money in nontrending markets. The typical system has a winning record of 35 to 45 percent, with an average trade of more than $200. I will discuss these systems in detail later.

The key feature to note is that, when systematically implemented over a "long" time and over many markets, robust systems tend to be, on the whole, profitable. If executed correctly, they guarantee entry in the direction of the intermediate trend, cut off losses quickly, and let profits run. Countless variations of these systems exist, and trend-following systems seem to account for a large percentage of professionally managed accounts.

Robust systems do not make many assumptions about market behavior, have relatively few variables or parameters, and do not change their parameters in response to market action. There is no sharp drop in performance due to small changes in the values of system variables. Such systems are worthy of consideration in most portfolios, and are reasonably reliable. In addition, they are easy to implement.

How Do You Implement a Trading System?

Begin with a trading system you trust. After sufficient testing, you can determine the risk control strategy necessary for that system. The risk control strategy specifies the number of contracts per signal and the initial dollar amount of the risk per contract. The risk control strategy may also specify how the initial stop changes after prices move favorably for many days.

The system must clarify portfolio issues such as the number and type of markets suitable for this account. The trading system must also specify when and how to put on initial positions in markets in which it has signaled a trade before commencement of trading for a particular account.

A trade plan is at the heart of system implementation. The trade plan specifies entry, exit, and risk control rules along with the statistical edge. *You* should record a diary of your feelings and the quality of your implementation, plus any deviations from the plan and the reasons for those deviations. You should monitor position risk and the status of all exit rules.

Last, take the long view: Imagine you are going to implement 100 trades with this plan, not just one. Thus, you can ignore the performance of any one trade, whether profitable or not, and focus on executing the trade plan. These and other implementation issues are discussed in detail in chapter 9.

Who Wins? Who Loses?

Tewles, Harlow, and Stone (1974) report a study by Blair Stewart of the complete trading accounts of 8,922 customers in the 1930s. That may seem like a long time ago, but the human psychology of fear, hope, and greed has changed little in the last 60 or so years. The results of the study are worth considering seriously.

Stewart reported three mistakes made by these customers. (1) Speculators showed a clear tendency to cut profits short, while letting their losses run. (2) Speculators were more likely to be long than short, even though prices generally declined during the nine years of the study. (3) Longs bought on weakness and shorts sold on strength, indicating they were price-level rather than price-movement traders.

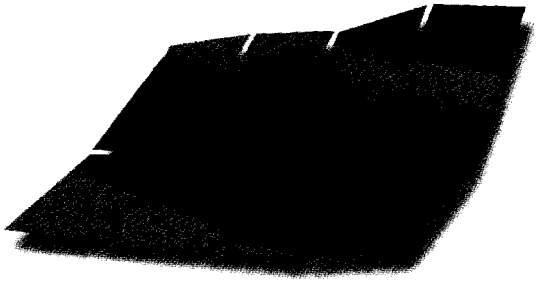
I should contrast this experience with the TOPS COLA philosophy discussed earlier. By taking profits slowly and cutting off losers at once, you will avoid the first mistake reported by Stewart. Second, by being a trend follower, you will avoid the next two mistakes. If you follow trends, you will be long or short per the intermediate trend, and avoid any tendency to be generally long. Third, if you follow trends, you will follow price movement, rather than being a price-level trader.

You will win in the trading business if you have a specific trade plan that contains all the necessary details. You should focus much of your effort and energy on implementing the trade plan as accurately and consistently as possible. Thus, you must go beyond technical analysis, deep into trade management and organized trading, to win.

Beyond Technical Analysis

The usual advice for technical traders is a collection of rules with many exceptions and exceptions to the exceptions. The trading rules are difficult to test and the observations are hard to quantify. I want you to go beyond technical analysis by converting an art form into a concrete trading system, and then focusing on implementing the system to the best of your ability. Trading is analysis in action. Thus, this book is an attempt to bridge the gap between the development and the implementation of a trading system.

Chapter



Principles of Trading System Design

If not the gods, put the odds on your side.

Introduction

This chapter presents some basic principles of system design. "You should try to understand these issues and adapt them to your preferences.

First, assess your trading beliefs—these beliefs are fundamental to your success and should be at the core of your trading system. You may have several strong beliefs, and they can all be used to formulate one or more trading systems. After you have a list of your core beliefs, you can build a trading system around them. Remember, it will not be easy to stick with a system that does not reflect your beliefs.

The six major rules of system design are covered in this chapter in considerable detail. The specific issues to be examined are why your system should have a positive expectation and why you should have a small number of robust rules. The focus in the later sections of this chapter is on money-management aspects such as trading multiple contracts, using risk control, and trading a portfolio of markets. The real difficulties lie in implementing a system, and hence, the chapter ends by explaining why a system should be mechanical.

By the end of this chapter, you should be able to tern design. write down your trading beliefs, as well as explain and apply the six basic principles of system design.

What Are Your Trading Beliefs?

You can trade only what you believe; therefore, your beliefs about price action must be at the core of your trading system. This will allow the trading system to reflect your personality, and you are more likely to succeed with such a system over the long run. If you hold many beliefs about price action, you can develop many systems, each reflecting one particular belief. As we will see later, trading multiple systems is one form of diversification that can reduce fluctuations in account equity.

The simplest way to understand your trading beliefs is to list them. Table 2.1 presents a brief checklist to help you get started.

You can expand the items in Table 2.1 to include many other items. For example, you can include beliefs about breakout systems, moving-average methods, or volatility systems. Your trading beliefs are also influenced by what you do. For example, you may be a market marker, with a very short term trading horizon. Or, you may be a proprietary trader for a big bank, trading currencies. You may wish to keep an eye on economic data as one ingredient in your decision process. As a former floor trader, you may like to read the commitment of traders report. Perhaps you were once a buyer of coffee beans for a major manufacturer, and you like to look at crop yield data as you trade coffee. The range of possible beliefs is as varied as individual traders.

You must ensure that your beliefs are consistent. For example, if you like fast action, you probably will not use weekly data, nor hold positions as long as necessary. Nor are you likely to use fundamental data in your analysis. Hence, a need for fast action is more consistent with day trading, and using cycles, patterns, and oscillators with intraday data. Similarly, if you like a trend-following approach, you are more likely to use daily and weekly data, hold positions for more than five days, trade a variable number of contracts, and trade a diversified portfolio. If you hold multiple beliefs, ensure that they are a consistent set and develop models that fit those beliefs. A set of consistent beliefs that can be used to build trading systems is listed below as an example.

1. I like to trade with the trend (5 to 50 days).
2. I like to trade with a system.

3. I like to hold positions as long as necessary (1 to 100 days).
4. I like to trade a variable number of shares or contracts.
5. I like to use stop orders to control my risk.

Pare down your list to just your top five beliefs. You can review and update this list periodically. When you design trading systems, check that they reflect your five most strongly held beliefs. The next section presents other rules your system must also follow.

Table 2.1 A checklist of your trading beliefs

Beliefs That Can Influence Your Trading Decisions	Yes,I Agree	No,I Disagree
1 like to trade using fundamentals only.	a	a
1 like to trade with technical analysis only.	a	a
1 like to trade with the trend (you define time	a	a
1 like to trade against the trend (you define time	a	a
1 like to buy dips (you define time frame).	D	a
1 like to sell rallies (you define time frame).	a	a
1 like to hold positions as long as necessary (1	a	a
I like to hold positions for a short time (1 to 5	a	a
I like to trade intraday only, closing out all	a	a
I like to trade a fixed number of shares or	a	a
I like to trade a variable number of shares or	a	a
I like to trade a small number of markets or	a	a
1 like to trade a diversified portfolio (more markets)	a	a
1 like to trade using cycles because 1 can	a	a
1 like to trade price patterns because 1 can	a	a
1 like to trade with price oscillators.	a	a
1 like to read the opinions of others on the	a	a
1 like to use only my own analysis of price	a	a
1 like to use daily data in my analysis.	a	a
1 like to use intraday data in my analysis.	a	a
1 like to use weekly data in my analysis.	a	a
1 like to trade with a system.	a	D
1 like to use discretion, matching wits with the	a	a
1 like lots of fast action in my trading.	a	a
1 like to use stop orders to control my risk.	a	a
1 like to trade with variable-length moving-	a	a

Six Cardinal Rules

Once you identify your strongly held trading beliefs, you can switch to the task of building a trading system around those beliefs. The six rules listed below are important considerations in trading system design. *You* should consider this list a starting point for your own trading system design. You may add other rules based on your experiences and preferences.

1. The trading system must have a positive expectation, so that it is "likely to be profitable."
2. The trading system must use a small number of rules, perhaps ten rules or less.
3. The trading system must have robust parameter values, usable ^ over many different time periods and markets.
4. The trading system must permit trading multiple contracts, if possible.
5. The trading system must use risk control, money management, and portfolio design.
6. The trading system must be fully mechanical.

There is a seventh, unwritten rule: you must believe in the trading principles governing the trading system. Even as the system reflects your trading beliefs, it must satisfy other rules to be workable. For example, if you want to day-trade, then your short-term, day-trading system must also follow the six rules.

You can easily modify this list. For example, rule 3 suggests that the system must be valid on many markets. You may modify this rule to say the system must work on related markets. For example, you may have a system that trades the currency markets. This system should "work" on all currency markets, such as the Japanese yen, deutsche mark, British pound, and Swiss franc. However, you will not mandate that the system must also work on the grain markets, such as wheat and soybeans. In general, such market-specific systems are more vulnerable to design failures. Hence, you should be careful when you relax the scope of any of the six cardinal rules.

Another way to modify the rules is to look at rule 6, which says that the system must be fully mechanical. For example, you may wish to put in a volatility-based rule that allows you to override the signals. Be as specific as possible in defining the conditions that will permit you to deviate from the system. You can likely test these exceptional situations on past market data, and then directly include the exception rules in your mechanical system design.

In summary, these rules should help you develop sound trading systems. You can add more rules, or modify the existing ones, to build a consistent framework for system design. The following sections discuss these rules in greater detail.

Rule 1: Positive Expectation

A trading system that has a positive expectation is likely to be profitable in the future. The expectation here refers to the dollar profit of the average trade, including all available winning and losing trades. The data may be derived from actual trading or system testing. Some analysts call this your mathematical edge, or simply your "edge" in the markets.

The terms "average trade" and "expectation" represent the same object, so they are freely interchanged in the following discussion. Expectation can be written in many different ways. The following formulations are identical:

Expectation($) = Average Trade($), Expectation($) = Net

profit($)/(Tbtal number of trades),

Expectation($) = [(Pwin) x (Average win($))] - (1 - Pwin)
x (Average loss($))].

The expectation, measured in dollars, is the profit of the average trade. The net profit, measured in dollars, is the gross profit minus the gross loss over the entire test period. Pwin is the fraction of winning trades, or the probability of winning. The probability of losing trades is given by (1-Pwin). The average win is the average dollar profit of all winning trades. Similarly, the average loss is the average dollar loss of all losing trades.

The expectation must be positive because, on balance, we want the trading system to be profitable. If the expectation is negative, this is a losing system, and money management or risk control cannot overcome its inherent limitations.

Assume that you are using system test results to estimate your average trade. Note that your estimate of the expectation is limited by the available data. If you test your system on another data set, you will get a different estimate of the average trade. If you test your system on different subsets of the same data set, you will find that each subset gives a different result for the average trade. Thus, the expectation of a trading system is not a "hard and fixed" constant. Rather, the expectation changes over time, markets, and data sets. Hence, you should use as long a time period as possible to calculate your expectation.

Since the expectation is not constant, you should stipulate a minimum acceptable value for the average trade. For example, the minimum value should cover your trading costs and provide a "risk premium" to make it attractive. Hence, a value such as $250 for the expectation could be used as a threshold for accepting a system. In general, the larger the value of the average trade, the easier it is to tolerate its fluctuations.

Note that the expectation does not provide any measure of the variability of returns. The standard deviation of the profits of all trades is a good measure of system variability, system volatility, or system risk. Thus, the expectation does not fully quantify the amount of risk (read volatility) that must be absorbed to benefit from its profitability.

The expectation is also related to your risk of ruin. *You* can use statistical theory to calculate the probability that your starting capital will diminish to some small value. These calculations require assumptions about the probability of winning, the payoff ratio, and the bet size. The payoff ratio can be defined as the ratio of the average winning trades to the average losing trades. As your payoff ratio increases, and your Pwin increases, your risk of ruin decreases. The risk of ruin is also governed by bet size, that is, percentage of capital risked on every trade. The smaller your bet size, the lower the risk of ruin. Detailed calculations of risk of ruin are presented in chapter 7.

In summary, it is essential that your system have a positive expectation, that is, a profitable average trade. The value of the average trade is not fixed, but changes over time. Hence, you can specify a threshold value, such as $250, before you will accept a trading system. The expectation is also important because it affects your risk of ruin. Avoid trading systems that have a negative expectation when tested over a long time.

The expectation of your system is determined by its trading rules. The next section examines how the number of trading rules affects your system design.

Rule 2: A Small Number of Rules

This book deals with deterministic trading systems using a small number of rules or variables. These trading systems are similar to systems people have developed for tasks such as controlling a chemical process. Their experience suggests that robust, reliable control systems have as few variables as possible.

Consider two well-known trend-following systems. The common dual moving-average system has just two rules. One says to buy the upside crossover, and the other says to sell the downside crossover. Similarly, the popular 20-bar breakout system has at least four rules, two each for entries and exits. You can show with testing software that these systems are profitable over many markets across multiyear time frames.

You can contrast this approach with an expert system-based trading system that may have hundreds of rules. For example, one commercially available system apparently has more than 400 rules. However, it turns out that only one rule is the actual trigger for the trades. The deterministic systems differ from neural-net-based systems that may have an unknown number of rules.

The statistical theory of design of experiments says that even complex processes are controllable using five to seven "main" variables. It is rare for a process to depend on more than ten main variables, and it is quite difficult to reliably control a process that depends on 20 or more variables. It is also rare to find processes that depend on the interactions of four or more variables. Thus, the effect of higher-order interactions is usually insignificant. The goal is to keep the overall number of rules and variables as small as possible.

There are many hazards in designing trading systems with a large number of rules. First, the relative importance of rules decreases as the number of rules increases. Second, the degrees of freedom decrease as the number of rules or variables increases. This means larger amounts of test data are needed to get valid results as the number of rules or variables increases.

A third problem is the danger of curve-fitting the data in the test sample. For example, given a data set, a simple linear regression with just

two variables may fit the data adequately. As the number of variables in the regression increases to, say, seven, the line fits the data more closely. Therefore, we can pick up nuances in the data when we curve-fit our trading system, only to pick up patterns that may never repeat in the future. The total degrees of freedom decrease by two for the simple linear regression, but will decrease by seven for the polynomial regression.

These ideas can be illustrated by using regression fits of daily closing data for the December 1995 Standard and Poors 500 (S&P-500) futures contract. The data set covers 95 days from August 1, 1995, through December 13, 1995. Two regression lines are fitted to the same data: Figure 2.1 presents a simple linear regression; Figure 2.2 fits higher-order polynomial terms, going out to the fifth power. As higher-order terms are added, the regression line becomes a curve, and we pick up more nuances in the data.

For simplicity, the daily closes are numbered 1 through 95 and denoted by D. All numbers represented by C (such as Ci) are constants. Est Close is the closing price estimated from the regression.

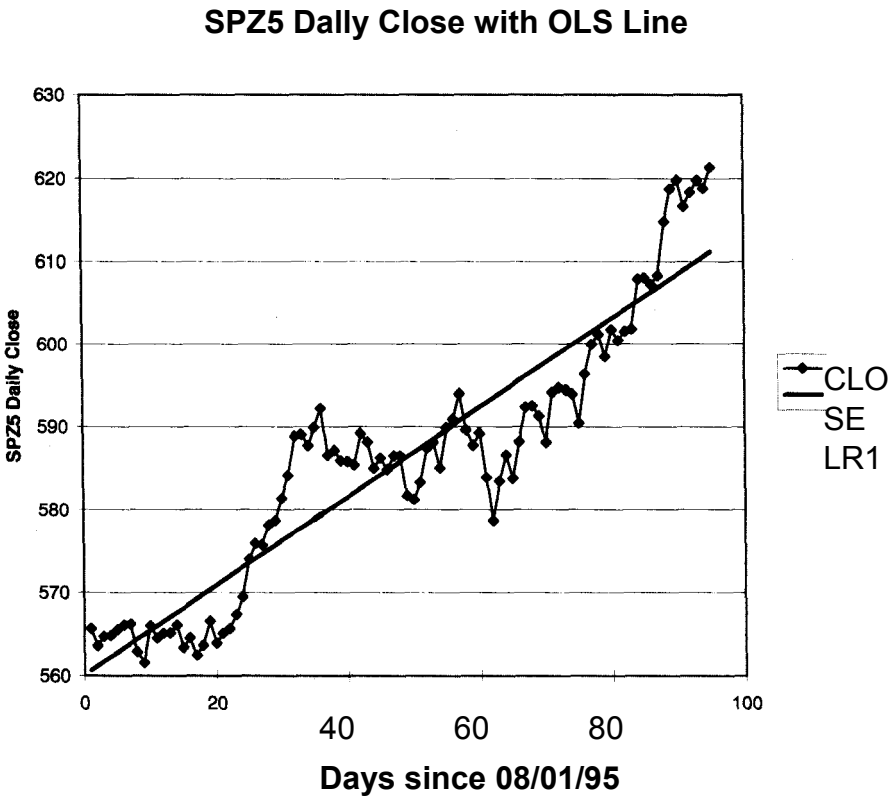


Figure 2.1 SScP-500 closing data with simple linear regression straight line.

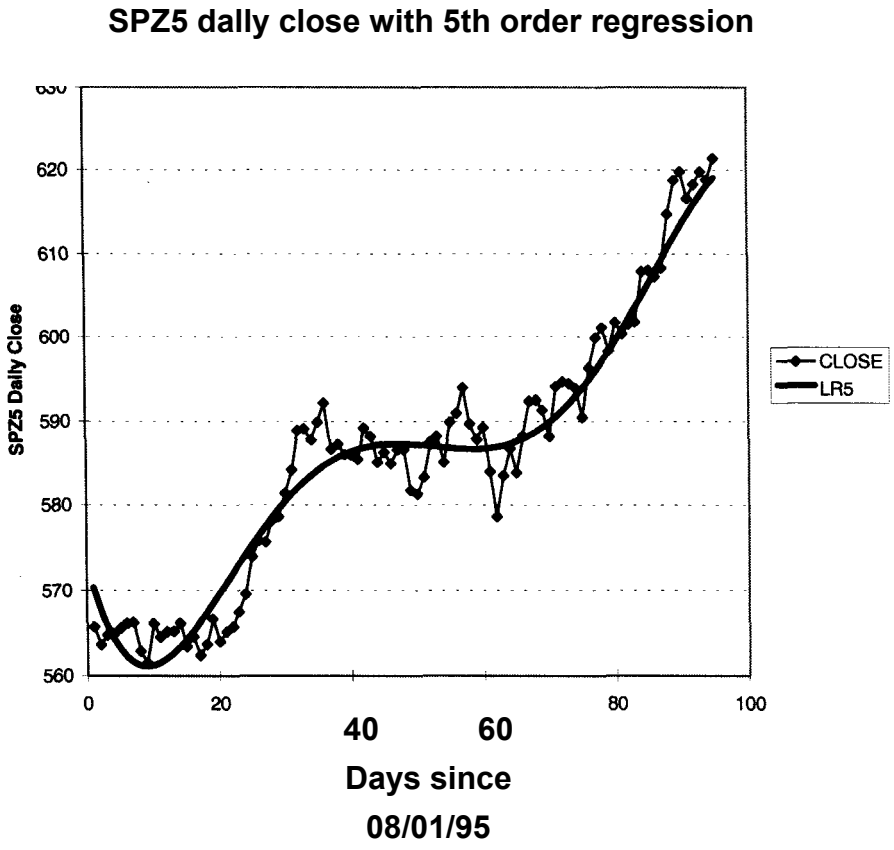


Figure 2.2 SScP-500 closing data with regression using terms raised to the fifth power.

$$\text{Est Close} = Co + (Ci \times D) \tag{2.1}$$

$$\text{Est Close} = Co + (Ci \times D) + (C^{\wedge} \times D^2) + (Cj \times D^3) + (C4 \times D^4) + C; \times D^5) \tag{2.2}$$

Table 2.2 illustrates several interesting features about curve-fitting a data set. First, observe that the value of the constant Co is approximately the same for each equation. This implies that the simplest model, the constant Co, captures a substantial amount of information in the data set.

Then, notice that the absolute value of the constants decreases as the order of the term increases. In other words, in absolute value, Co is greater than **Ci,** which is greater than C2 and on down the line. Therefore, the relative contribution of the higher-order polynomial terms becomes smaller and smaller. However, as you add the higher-order polynomial terms, the line takes on greater curvature and fits the data more closely, as seen in Figures 2.1 and 2.2.

Table 2.2 Comparison of linear regression coefficients

	Co	Ci	C2	C3	C4	Cs
Equation 2.1	560.0865	0.537870				
Equation 2.2	570.2379	-1.94509	0.131279	-0.00154	-0.00003	0.0000006

This exercise illustrates many important ideas. First, any model you build for the data should be as simple as possible. In this case, the simple linear regression, with a slope and intercept, captured essentially all the information in the data. Second, adding complexity by adding higher-order terms (read rules) does improve the fit with the data. Thus, we pick up nuances in the data as we build more complex models. The probability that these nuances will repeat exactly is very small. Third, the purpose of our models is to describe how prices have changed over the test period. We used our data to directly calculate the linear regression coefficients. Thus, our model is hostage to the data set. There is no reason why these coefficients should accurately describe any future data. This means that over-fitted trading systems are unlikely to perform as well in the future.

Another example, a variant of the moving-average crossover system, illustrates why it makes sense to limit the number of rules. In the usual case, the dual moving average system has just two rules. For example, for the long entry the 3-day average should cross over the 65-day average and vice versa.

Now, consider a variant that uses more than two averages. For example, buy on the close if both the 3-day and the 4-day moving averages are above the 65-day average. Since there are two "short" averages, this gives us four rules, two each for long and short trades. Using more and more "short" averages rapidly increases the number of rules. For example, if the 3-, 4-, 5-, 6-, and 7-day moving averages should all be above the 65-day average for the long entry, ten rules would apply.

Consider 10 years of Swiss franc continuous contract data, from January 1, 1985, through December 31, 1994, without any initial stop, but allowing $100 for slippage and commissions. The number of rules is varied from 2 to 128 to explore the effects of increasing the number of rules. As the number of rules increases, the number of trades decreases, as shown in Figure 2.3. This illustrates the fact that as you

increase the number of rules, you need more data to perform reliable tests.

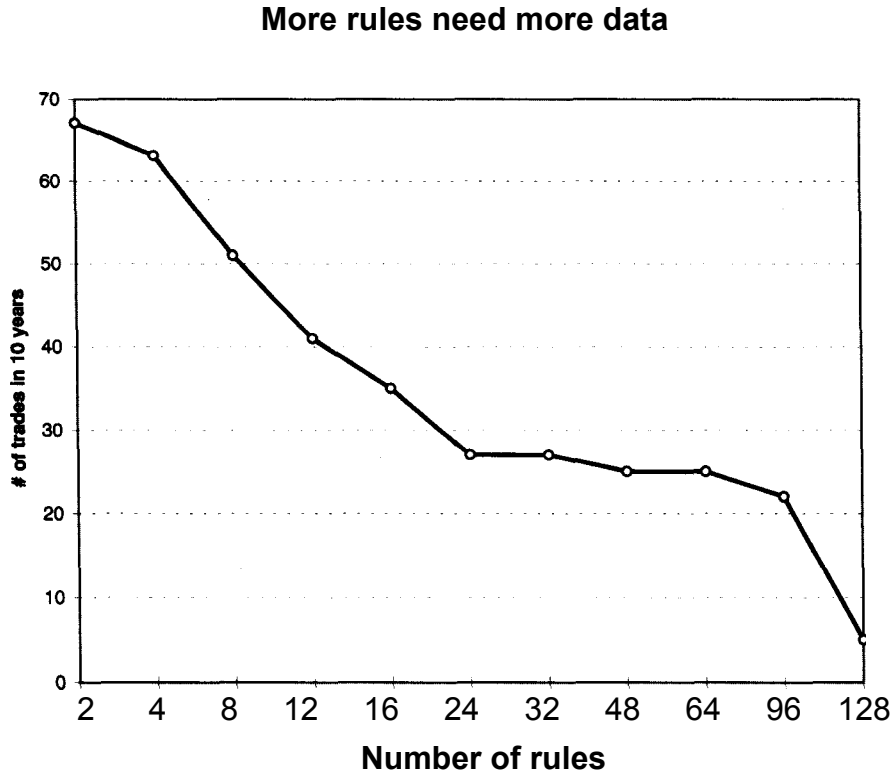


Figure 2.3 Adding rules reduced the number of trades generated over 10 years of Swiss franc data. Note that the horizontal scale is not linear.

Figure 2.4 shows that the profit initially increased as we added more rules. This means that the extra rules first act as filters and eliminate bad trades. As we add even more rules, however, they choke off profits and moreover increase equity curve roughness. Thus, you should be careful to not add dozens of rules.

As stated, this example did not include an initial stop. Hence, as we increase the number of rules, the maximum intraday drawdown should increase because both entries and exits are delayed. You can verify this by using Figure 2.5, page 23.

Calculations for the U.S. bond market from January 1, 1975, through June 30, 1995, illustrate that the general pattern still holds. Figure 2.6, page 24, shows that as the number of rules increases, the profits decrease. The exact patterns will depend on the test data. Data from other markets confirm that increasing rules decreases profits.

Thus, adding rules does not produce endless benefits. Not only do you need more data, but the rising complexity may lead to worsening system performance. A complex system with many rules merely captures

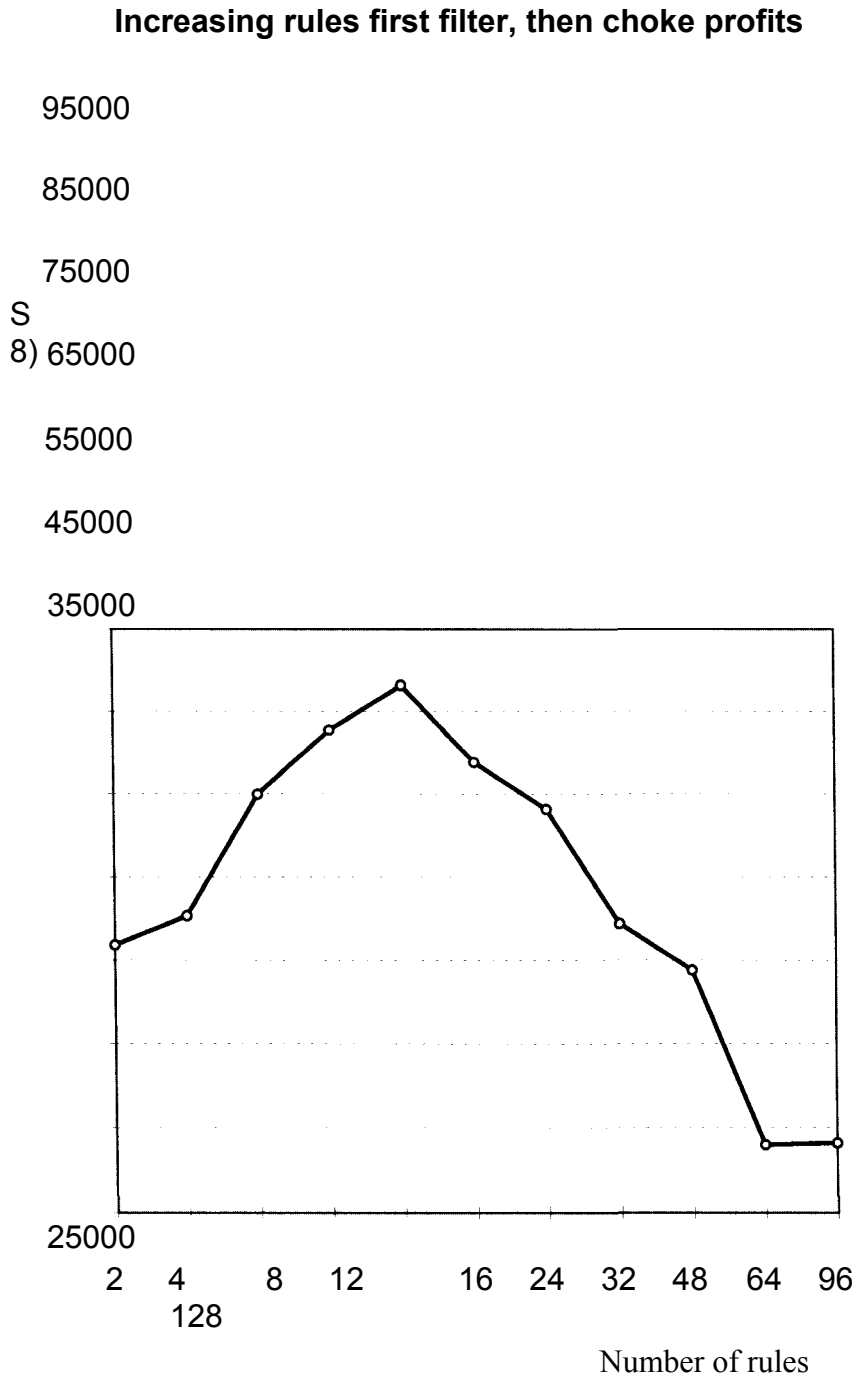


Figure 2.4 Adding rules increased profits moderately on 10-years of Swiss franc continuous contracts from January 1, 1985, through December 31, 1994. Note that the horizontal scale is not linear.

nuances within the test data, but these patterns may never repeat. Hence, relatively simple systems are likely to perform better in the future.

Rule 3: Robust Trading Rules

Robust trading rules can handle a variety of market conditions. The performance of such systems is not sensitive to small changes in parameter values. Usually, these rules are profitable over multiperiod testing, as well as over many different markets. Robust rules avoid curve-fitting, and are likely to work in the future.

An example of a system with delayed long entries illustrates the use of nonrobust parameters. The entry rule is as follows: if the crossover between 3- and 12-day simple moving averages (SMAs) occurred *x* days ago, and the low is greater than the parabolic, then buy tomorrow at the

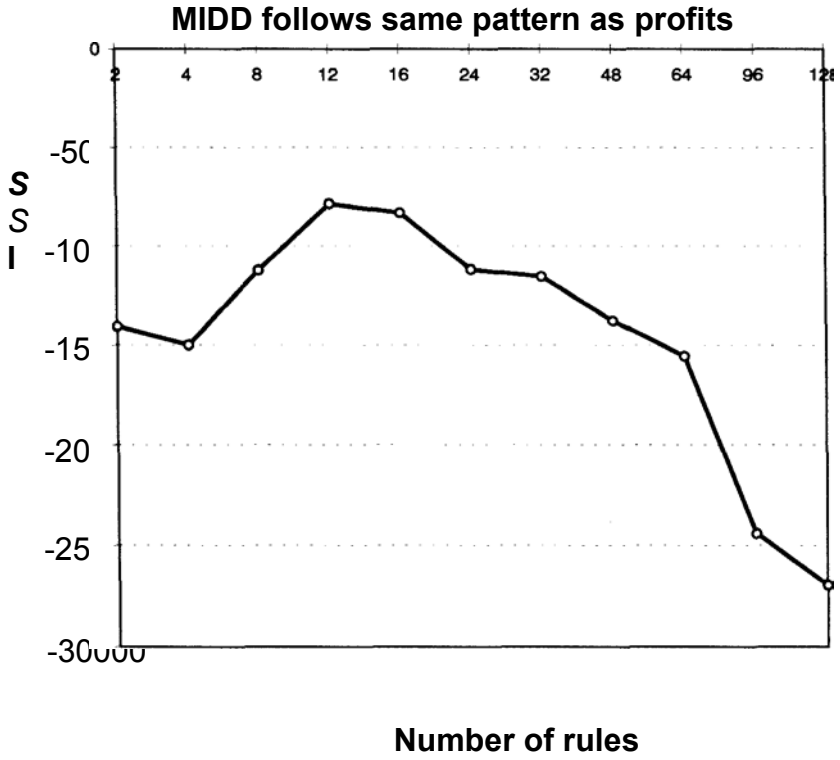


Figure 2.5 Adding more rules delayed entries and exits, increasing maximum intraday drawdown. Note that the horizontal scale is not linear.

today's high + 1 point on a buy stop. A $1,500 initial stop was used and $100 was charged for slippage and commissions.

The results above are for an IMM (International Monetary Market) Japanese yen futures continuous contract, from August 2, 1976 through June 30, 1995. The dollar profits are sensitive to the number of days of delay, and can vary widely due to small changes in parameter values. It also does not seem reasonable to wait 12 days after a crossover for such short-term moving averages. Hence, the flattening out of the curve after a 9-day delay is of little practical relevance. The delay parameter is not robust because a small change in the value of this parameter can make system performance vary widely with markets and time frames.

Next consider the effect of nonrobust, curve-fitted rules, illustrated by the August 1995 N.Y. light crude oil futures contract (Figure 2.8, page 26). The market was in a narrow trading range during February and March, and then broke out above the $18.00 per barrel price level. The market moved up quickly, reaching the $20 level by May. A volatile consolidation period ensued through June, before prices broke down toward the $17 per barrel level by July.

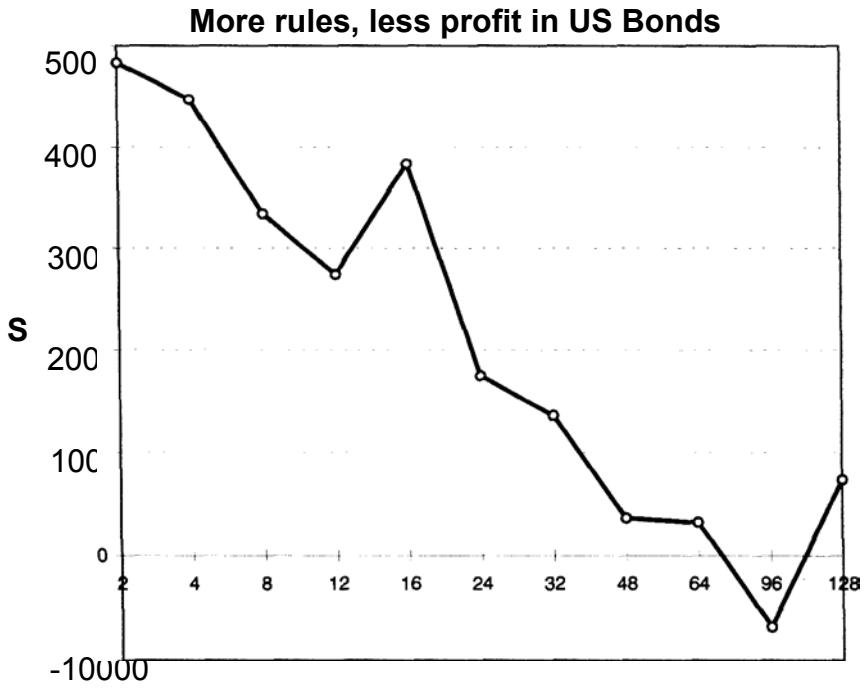


Figure 2.6 Increasing the number of rules decreased profits in the U.S. bond market from January 1, 1975 through June 30, 1995. Note that the horizontal scale is not linear.

The following trading rules were derived simply by visual inspection of the price chart in an attempt to develop a curve-fitted system that picked up specific patterns in this contract.

Rule 1: Buy tomorrow at highest 50-day high + 5 points on a buy stop (breakout rule).

Rule 2: Sell tomorrow at low -2 x (h-1) - 5 points on a sell stop (downside range-expansion rule).

Rule 3: If this is the twenty-first day in the trade, then exit short trades on the close (time-based exit rule).

Rule 4: If Rule 3 is triggered, then buy two contracts on the close (countertrend entry rule).

Rule 5: If short, then sell tomorrow at the highest high of last 3 days +1 point limit (sell rallies rule).

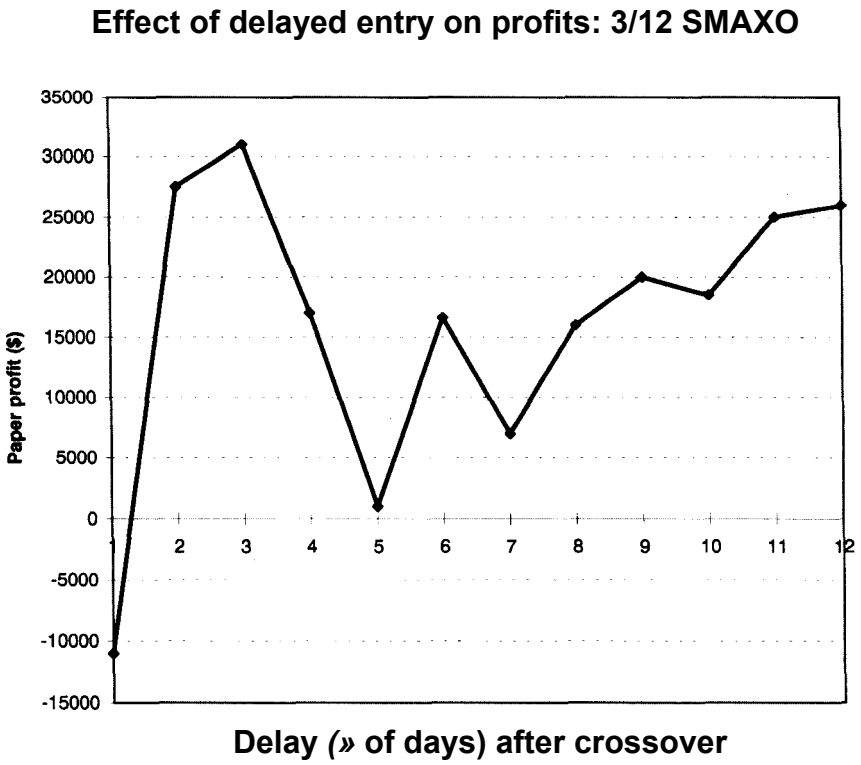


Figure 2.7 The effect on profits of changing the number of days of delay in accepting a crossover signal of a 3-day SMA by 12-day SMA system is highly dependent on the delay.

The first rule is a typical breakout system entry rule, albeit for a breakout over prior 50-bar trading range. The second rule is a volatility-inspired sell rule. The idea was to sell at a point five ticks below twice the previous day's trading range subtracted from the previous low. This will typically be triggered after a narrow-range day, if the daily range expands on die downside due to selling near an intermediate high. The third rule is a time-dependent exit rule, optimized by visual inspection over the August contract. The idea behind time-based exits is that one expects a reaction opposite the intermediate trend after *x* days of trending prices. Rule 4 merely reinforces rule 3 by not only exiting the short position but putting on a two-contract long position at the close. Rule 5 is a conscious attempt to sell rallies during downtrends. In this case, limit orders were used to sell, to avoid slippage. These rules assumed diat as many as nine contracts could be traded at one time, using a $1,000 initial money-management stop.

The results of the testing are summarized in Table 2.3, page 27. The first clue that this may be a curve-fitted system is the number of

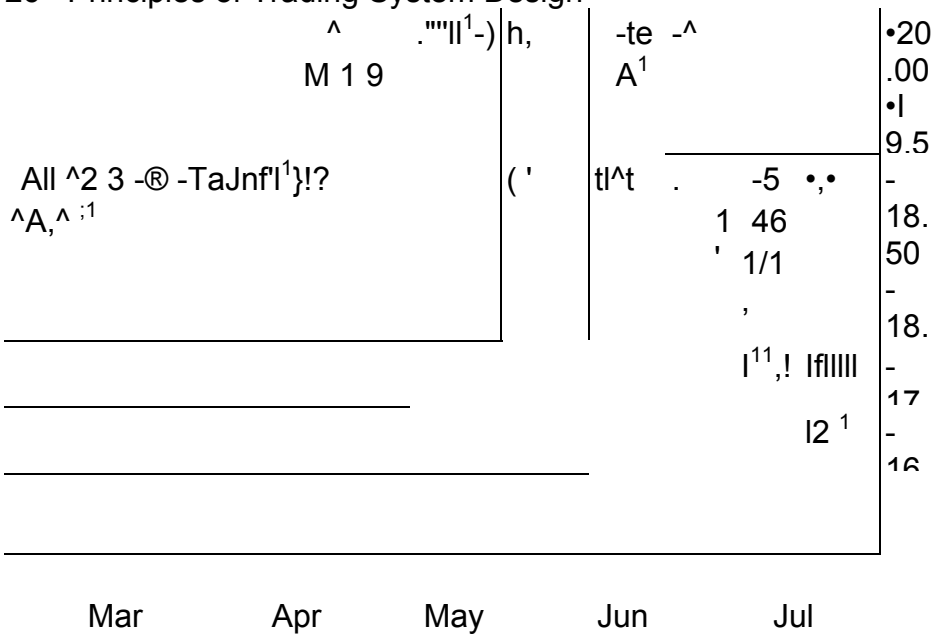


Figure 2.8 The August 1995 crude oil contract with curve-fitted system

profitable trades. As many as 87 percent of all trades (20 out of 23) were profitable. A second clue was in the 14 consecutive profitable trades. A third clue was in a suspiciously large profit factor (= gross profit/gross loss) of 13.49. These results are what you might see in curve-fitted systems tested over a relatively short time period. The computer-generated buy and sell signals are shown in Figure 2.8.

This curve-fitted system was tested by using a continuous contract of crude oil futures data from January 3, 1989, through June 30, 1995. Not surprisingly, this system would have lost $107,870 on paper, as shown in Table 2.4. Note how only 32 percent of the trades would have been profitable. There would have been as many as 48 consecutive losing trades, requiring quite an act of faith to continue trading this system. Also, the profit factor was a less impressive 0.61, a sharp drop from the 13.49 value in Table 2.3. These calculations show that curve-fitted systems may not work over long periods of time.

Interestingly, this system has its merits. When tested over 12 other markets to check if these rules were robust enough to use across many

Table 2.3 Results of testing August 1995 crude oil curve-fitted system N.Y. Light Crude Oil 08/95-Daily 12/01 /94 - 07/20/95

Total net profit ($)	12,990.00	Open position profit/loss ($)	520.00
Gross profit ($)	14,030.00	Gross loss ($)	-1,040.00
Total number of trades	23	Percent profitable	87
Number of winning trades	20	Number of losing trades	3
Largest winning trade ($)	1,370.00	Largest losing trade ($)	-860.00
Average winning trade ($)	701.50	Average losing trade ($)	-346.67
		Average trade ($)	564.78
Maximum consecutive winners	14	Maximum consecutive losers	2
Average number of bars in winners	20	Average number of bars in losers	1
Maximum intraday drawdown ($)	-1,670.00	Maximum number of contracts held	
Profit factor	13.49		

markets (Table 2.5), the results were better than expected; on some markets the system tested very well. This result was surprising because (1) this particular combination of rules had never been tested on these markets and were derived by inspection of just one chart; and (2) the

Table 2.4 Results of testing crude oil curve-fitted system over a long time period

Performance	Summary: All Trades 01/03/89 - 06/30/95		
Total net profit ($)	-		
Total number of	538	Percent profitable	32
Number of winning	173	Number of losing trades	365
Largest winning trade	7.160	Largest losing trade ($)	-3.670
Average winning	983	Average losing trade ($)	-761
		Average trade ($)	-200
Maximum winners	9	Maximum consecutive losers	48
Average number of winners	12	Average number of bars losers	6
Maximum intraday	-		

drawdown ($)			
Profit factor	0.61	Maximum number of contracts held	9

Table 2.5 A check for robustness: crude oil curve-fitted system over 12 markets (test period: 1 /3/89-6/30/95, using continuous contracts, $100 slippage, and commission charge)

Market	Paper Profit (S)	Average Trade ($)
Coffee	132,908	445
S&P-500	145.545	547
Cotton	84.925	284
U.S. bond	84.319	324
Japanese yen	67.975	176
Swiss franc	1 7.975	51
10-vear T-note	1 3.538	48
Gold. Comex	-1 3.270	-33
Copper. high-grade	-22.167	-49
Soybeans	^1.656	-117
Heating oil	-45.868	-80
Sugar #11	-56,394	-136

long entries and short entries are asymmetric. A symmetrical trading system uses identical rules for entries and exits, except that the signs of the required changes are reversed. For example, a moving average system would require an upside crossover or a downside crossunder for signals.

A closer look at the rules shows that they do follow some sound principles. For example, during an uptrend, each successive 50-bar breakout adds a contract until nine contracts are acquired. Thus, market exposure is increased during strong uptrends. The sell rule tends to lock in profits close to intermediate highs. As we sell rallies in downtrends, we are increasing exposure in the direction of the intermediate term trend. Also, a relatively tight $1,000 initial money management stop was used. Thus, even though these rules were derived by inspection, they followed sound principles of following the trend, adding to with-the-trend positions, letting profits run, and cutting losses quickly.

In summary, it is easy to develop a curve-fitted system over a short test sample. If these rules are not robust, they will not be profitable over many different market conditions. Hence, they will not be profitable over long time periods and many markets. Such rules are unlikely to be consistently profitable in the future. Hence, you should try to develop robust trading systems.

Multiple contracts allow you to make larger profits when you are right. However, the drawdowns are larger if you are wrong. *You* are betting that with good risk control, the overall profits will be greater than the drawdowns. An essential requirement is that your account equity must be sufficiently large to permit trading multiple contracts. Your risk control guidelines must permit multiple contracts to benefit from this approach. If your account permits you to trade just one contract at a time, then this approach must be deferred until your equity has increased.

Multiple contracts also allow you to add a nonlinear element to your system design. This means the results of trading, say, five contracts using this nonlinear logic are better than trading five contracts using the usual linear logic. The linear logic trades one contract per signal. The nonlinear logic uses a price-based criterion such as volatility. The volatility rule buys more contracts when volatility is low. Markets often have low volatility after they have consolidated for many weeks. If a strong trend develops as the market emerges from the consolidation, then the nonlinear effect is to boost profits significantly.

A simple example illustrates these ideas. Assume that your account is so large that trading up to 15 contracts in the 10-year T-note market is well within your risk control guidelines. For example, with a 1 percent risk per position and a $1,000 initial money management stop, you would need $1,500,000 in equity to trade 15 T-note contracts. This assumes that the 15-lot margin is also within your money-management guidelines.

Consider a simple moving average crossover system using 5-day and 50-day simple moving averages. The trade day is one day after the crossover day. You will buy or sell on the next day's open if you get a 5/50 crossover tonight after the close. Use a $1,000 initial stop on each contract and allow $100 for slippage and commissions.

Let us compare system performance with one contract versus variable contracts, rising to a maximum of 15 contracts. The test period is from January 3, 1989, through June 30, 1995, using a continuous contract. Table 2.6 compares four variations of the 5/50 crossover system. The column labeled "fixed 1 contract" shows the results over the test period for always trading one contract per trade. The next column, "fixed 15 contracts" shows the calculated results for always trading 15 contracts per trade. The column, "variable #1" trades a maximum of

Table 2.6 Performance comparison using variable number of contracts

Item	Fixed 1 Contract	Fixed 15	Variable #1 Maximum 15	Variable #2 Maximum 15
Net profit ($)	24,018.75	360,281	339,774	294,869
Maximum intra-day drawdown (MIDD) ($)	-6,918.75	-103,781	-66,650	-62,763
Net profit /MIDD	3.47	3.47	5.10	4.70
Largest losing trade	-1,100	-16,500	-1,350	-13,200
Total number of	48	48	594	48
Number of	15	15	215	15
Number of winning trades	500.39	2,448	7,506	572
Average trade ($)	0.09	340	36,721	5,836
Standard deviation of trades ($)			0.20	0.10
Average trade/ standard deviation			364	
Standard deviation: losing trades ($)			5,092	6,143
				0.24
				25,506
				3,362

15 contracts with the contracts added at the open on successive days. The "variable #2" trades a maximum of 15 contracts with all the contracts bought on the same day. The volatility in dollars here is four times the average 20-day true range. The volatility divided into $15,000 gives the number of contracts. Thus, variable #2 uses a volatility-based criterion for calculating the number of contracts, always trading 15 or less.

Let us compare the net profit produced by the four strategies. It should come as no surprise that the absolute amount of profit increases as we trade more contracts. However, as the next row of Table 2.6 shows, the maximum intraday drawdown also increases as we trade more contracts. The ratio of net profits to maximum intraday drawdown shows whether we gain anything by trading multiple contracts. This ratio is 3.47 for fixed contract trading strategy. The ratio increases to 4.7 or 5.1 for the variable contracts strategies. This is a 39 to 47 percent improvement, a strong reason to consider multiple contracts. Hence, profits can increase without proportionately increasing drawdowns.

Observe from Table 2.6 that the largest losing trade for variable #1 is considerably less than simply trading a fixed number of 15 contracts.

Similarly, the largest losing trade in variable #2 is less than always trading 15 contracts. This too confirms the benefits of going to the multiple-contract strategy.

The total number of trades remains the same for the fixed-1, fixed-15 and variable #2 strategies, since all the contracts are bought on the same day. The number of trades increases for variable #1 since not all the contracts are bought on the same day.

The average trade for each strategy is relatively high, suggesting that this simple model seems to catch significant trends. The average trade is higher when all the contracts are bought at the same time. This is merely an artifact of system design. As pointed out before, the average trade does not provide a measure of variability in system results.

The standard deviation per trade is naturally smaller when we trade one contract at a time rather than all at once. The standard deviation in trade returns increases as the number of contracts increases. As Table 2.6 shows, there is a higher volatility in trade returns ($36,721) for fixed 15-contract trading than either of the variable contract strategies. This means volatility can be reduced by trading a variable number of multiple contracts, rather than a fixed number of multiple contracts. This is another desirable design goal.

Dividing the average trade profit by the standard deviation in trade profitability yields a composite picture of model performance. The higher this number, the more desirable the system. For the fixed 1-contract strategy, this reward to risk ratio is only 0.09, and it increases to 0.24 for the variable #2 strategy. Remember, however, that the volatility in trading profits increases significantly with multiple contracts.

The last line of Table 2.6, the downside volatility, explains that the increased volatility occurs due to rising profits of winning trades. Note that the fixed 15-contract downside volatility is the highest, followed by the variable #2 and variable #1 strategies. There is not a large difference in downside volatility between the fixed 1-contract strategy and variable #1 strategy, which buys one contract at a time but on multiple days. Note also that the standard deviation of all trades (including winning trades) is much greater than the downside volatility. Thus, rather than all volatility being undesirable, note that adding multiple contracts increases upside volatility more than downside volatility. Increasing upside volatility is easier to cope with than sharply rising downside volatility.

In summary, if your account equity and mental makeup permit, consider the benefits of a multiple contract strategy.

Rule 5: Risk Control, Money Management, and Portfolio Design

All traders have accounts of finite size as well as written or unwritten guidelines for expected performance over the immediate future. These performance guidelines have a great influence over the existence and longevity of an account. For example, consider a trading system that produces a 30 percent loss over five months. The same trading system then goes on to perform extremely well. One person may close the account after the 30 percent drawdown. Another may go on to reap excellent returns. Your money management rules could cause you to close out an account too soon, or keep it open too long. Thus, money management guidelines are crucial to trading success.

Given performance expectations and finite size of the trading account, it is essential to maintain good risk control, sensible money management, and good portfolio design. Risk control is the process of managing open trades with predefined exit orders. Money management rules determine how many contracts to trade in a given market and the amount of money to risk on particular positions. Portfolio-level issues must be considered to obtain a smoother equity curve.

Table 2.7 illustrates the effects of not using an initial money management stop versus adding an initial money management stop of $2,000. The trading system, a "canned" system using four consecutive up or down closes to initiate a trade, comes with the Omega Research's System Writer Plus™.

As expected, the largest losing trade can be horrifying, and most real-world accounts would probably close before swallowing such huge losses. Of course, recent headlines of billion-dollar plus losses in sophisticated trading firms illustrate that trading without adequate risk control is not uncommon.

Adding a money management stop constrains the worst initial loss to predictable levels. Even with slippage, the largest loss is usually lower than trading without any stop at all. Thus, your profitability is likely to improve with improved risk control. Observe that average net profits improved from a loss of -$5,085 with no stop to a loss of -$424 using risk control. The maximum drawdown also improved with the added risk control. The lesson from this comparison is clear. There is much to gain if you use proper risk control.

You can reduce swings in equity and improve account longevity if you combine risk control with sound money management ideas. Your money management guidelines will specify how much of your equity to

Table 2.7 Effect of adding an initial money management stop, May 1989-June 1995 (dollars)

Market	No Stop			$2000		
	Net Profit	Largest Loss	Maximum Drawdow	Net Profit	Largest Loss	Maximum
Coffee	-4,206	-50,868	-24,149	33,776	-2,594	-13,970
Copper	5.082	-3.542	-14.810	-5.455	-2.302	-20.430
Cotton	4.370	-4.620	-14.585	7.580	-3.025	-13.800
Crude	-14.350	-12.350	-20.760	-8.690	-2.870	-15.100
Gold, Comex	7,180	-2,250	-6,560	3,750	-2,340	-6,650
Heating	16,758	-4,174	-16,350	-378	-3,989	-16,334
Japane yen	-36.800	-6.550	-65.673	-23.675	-3.388	-50.300
Sugar	-9.770	-3.594	-14.428	-7.799	-2.194	-12.456
Swiss	8.225	-7.613	-16.438	15.688	-2.663	-15.263
10-year T note	-15,913	-4,413	-29,444	-8,788	-2,100	-21,881
U.S. bond	-16,506	-6,194	-28,969	-10,625	-2,100	-22,856
Worst	-36,800	-50,868	-65,673	-23,675	-3,989	-50,300
Best	16.758	-2.250	-6.560	33.776	-2.100	-6.650
Averag	-5,085	-9,652	-22,924	-424	-2,688	-19,004

risk on any trade. These guidelines convert the initial stop into a specific percentage of your equity. One common rule of thumb is to risk or "bet" just 2 percent of your account equity per trade.

The 2-percent rule converts into a $1,000 initial stop for a $50,000 account. This $1,000 initial stop is often called a "hard dollar stop," applied to the entire position. A position could have one or more contracts. Thus, if you had two contracts, you would protect the position with a stop loss order placed $500 away from the entry price. Chapter 7 discusses the bet size issue in detail.

Overtrading an account is a common problem cited by analysts for many account closures. For example, if you consistently bet more than 2 percent per trade, you are overtrading an account. If you do not use any initial money management stop, then the risk could be much greater than 2 percent of equity. In the worst case, you risk your entire account equity. Some extra risk, say up to 5 percent of equity, may be justified if the market presents an extraordinary market opportunity (see chapter 4). However, consistently exceeding the 2 percent limit can cause large and unforeseen swings in account equity.

As another rule of thumb, you are overtrading an account if the monthly equity swings are often greater than 20 percent. Again, there may be an occasional exception due to extraordinary market conditions.

You mast also consider the benefits and problems of diversification, that is, trading many different markets in a single account. The main advantage of trading many markets is that it increases the odds of participating in major moves. The main problem is that many of the markets respond to the same or similar fundamental forces, so their price moves are highly correlated in time. Therefore, trading many correlated markets is similar to trading multiple contracts in one market.

For example, the Swiss franc (SF) and deutsche mark (DM) often move together, and trading both these markets is equivalent to trading multiple contracts in either the franc or the mark. Let us look specifically at SF and DM continuous contracts from May 26, 1989, through June 30, 1995, with a dual moving average system using a $1,500 stop and $100 for slippage and commissions. The two moving averages were 7 and 65 days. As Figure 2.9 shows, the equity curves have a correlation of 83 percent. For example, you would have made $60,619 trading one

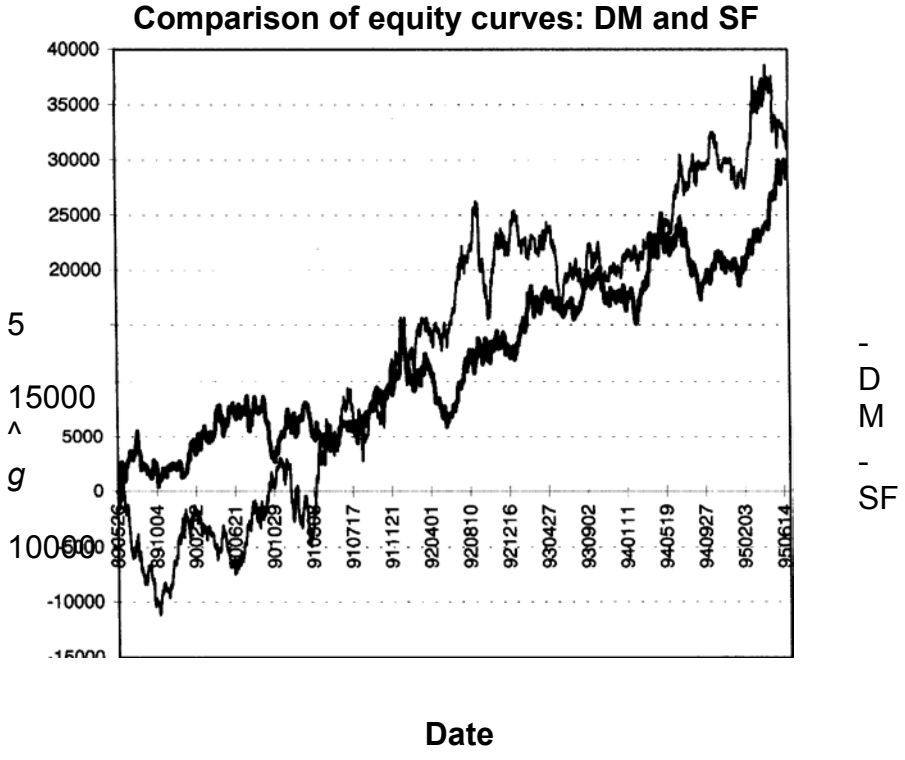


Figure 2.9 Swiss franc and deutsche mark equity curves are highly correlated at 83 percent.

contract each of SF and DM, but your profits would have been $63,850 trading two contracts of DM and $57,388 trading two contracts of SF.

Note one important difference between the two cases. Since the two markets may have negative correlation from time to time, the drawdown for both SF and DM together may be in between trading two contracts of just DM or SF. For example, the drawdown for SF and DM in this case was -$10,186 versus -$22,375 for two DM contracts and -$9,950 for two SF contracts. Hence, the benefits of trading correlated markets are relatively small. Thus, it may be better to trade uncorrelated or weakly correlated markets in the same portfolio.

The benefits of adding usually unrelated markets to a portfolio can be illustrated by an example of trading the Swiss franc (SF), cotton (CT) and 10-year Treasury note (TY) in a single account, using the same dual moving average system as above. The paper profits from trading three SF contracts add up to $86,801 versus $85,683 for SF plus TY and CT. The equity curve for the two combinations is shown in Figure 2.10. The smoothness of the two curves can be compared by using linear regression analysis to calculate the standard error (SE) of the daily equity

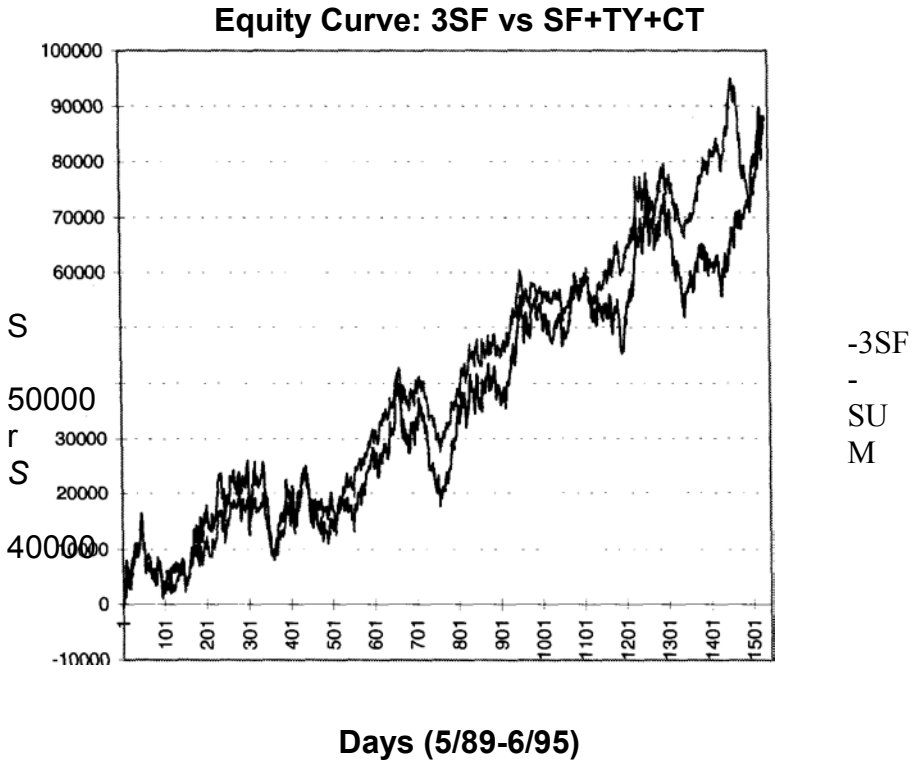


Figure 2.10 Adding 10-year T-note (TY) and cotton to the portfolio trading just Swiss francs provides a smoother equity curve versus trading three SF contracts.

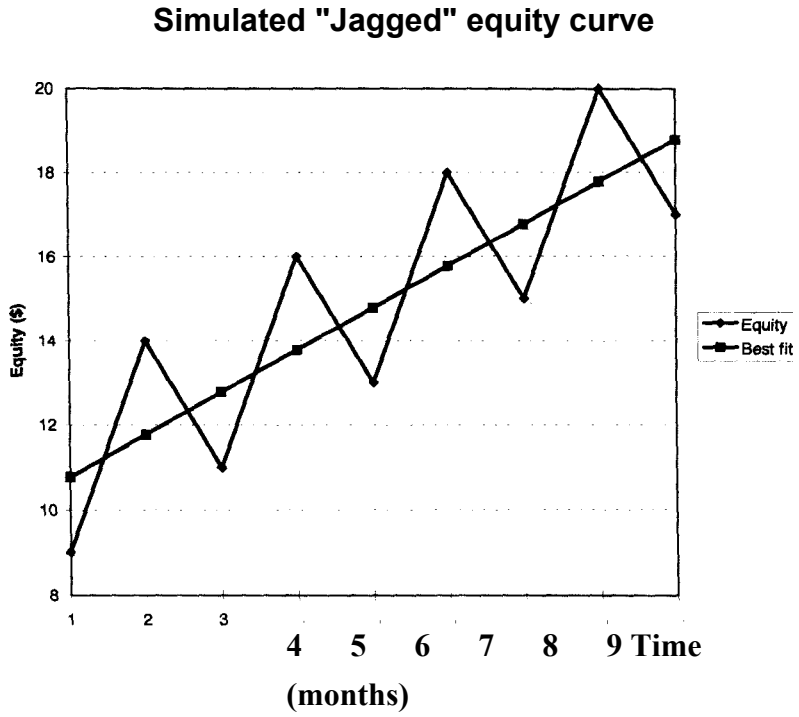


Figure 2.11 This contrived jagged equity curve has a standard error of 2.25. The perfectly smooth equity curve has an SE of zero. The standard deviation of monthly returns is 33 percent.

curve. The SE for trading three SF contracts in $6238, and the SE for SF and TY plus CT is just $4,902, a reduction of 21 percent. Thus, adding TY and CT to a portfolio of SF produced a smoother equity curve with essentially the same nominal profits.

The relevance of the standard error is illustrated in Figure 2.11, which shows a contrived equity curve. The SE for that curve was 2.25, since it was quite "jagged." A perfectly smooth equity would have an SE reading of zero.

Diversification can be more than just adding markets. *You* can also trade multiple trading systems and multiple time frames within a single account. *You* should try to use uncorrelated or weakly correlated systems. In summary, risk control, money management, and portfolio design are important issues in designing trading systems.

Rule 6: Fully Mechanical System

The simplest answer to why a system must be mechanical is that you cannot test a discretionary system over historical data. It is impossible to

forecast what market conditions you will face in future and how you will react to those conditions. Therefore, in this book, we will restrict ourselves to fully mechanical systems.

If you can define how you make discretionary decisions, then these rules could be formalized and tested. The process of formalization could itself provide many interesting ideas for further testing. Hence you are encouraged to move toward mechanical systems.

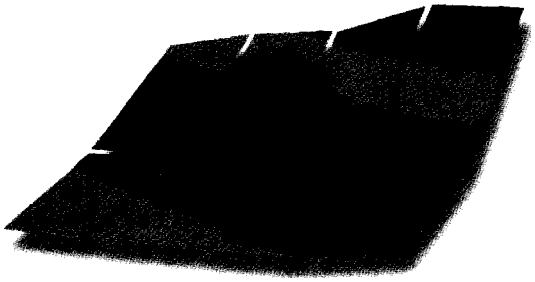
You are more likely to make consistent trading decisions if you use mechanical systems. The manner in which a mechanical system will process price data is predictable, and hence assures that you will make consistent trading decisions. However, there is no assurance that these logically consistent decisions will also be consistently profitable. Nor is there any assurance that these trading decisions will be implemented without modification by the trader.

Summary

This chapter developed a checklist for narrowing your trading beliefs. You should narrow your beliefs down to five or less to build effective trading systems around them.

This chapter also reviewed six major rules of the system design. A trading system with a positive expectation is likely to be profitable in the future. The number of rules in a system should be limited because increasing complexity often hurts performance. Relatively simple systems are likely to fare better in the future. The rules should be robust, so they will be profitable over long periods and over many markets. You should trade multiple contracts if possible because they allow you to make more profits when you are right. Risk control, money management, and portfolio design give you a smoother equity curve and are the keys to profitability. Lastly, a system should be mechanical to provide consistent, objective decision making. You should follow the six major rules to build superior systems that are consistent with your trading beliefs.

Chapter



Foundations of System Design

The best system provides instant gratification and constant satisfaction.

Introduction

This chapter examines many key system design issues. Now that you understand some basic principles of system design, you can consider more complex issues. And as you understand these issues, you can design more powerful systems.

We will begin by asking the question: Do markets trend? The answer to the next big question, whether you should trade with the trend or against the trend, is that you should trade with the trend. This chapter presents some test results to support this answer. *You* can then ask whether you should or should not optimize your trading system. We explore here how well you can predict future performance based on optimization of historical data.

The chapter begins the discussion on risk control issues by addressing whether the initial stop is a problem or a solution and discussing the different types of risk you may face in your trading. *You* should consider these issues early in your design process. We then look at the different types of data you can use for your testing and what difference, if any,

they make. Finally, the chapter explains what is found as well as what is lacking in the system performance summary.

At the end of this chapter, you will be able to:

1. Explain how you can diagnose trending markets.
2. Know whether to use a trend-following or countertrend strat-
^
3. Explain the benefits and pitfalls of optimization.
4. Understand the type of risks you may encounter.
5. Know how to select data for tests.
6. Effectively use the performance summary of system testing results.
7. Understand and explore what is not covered in the performance summary.
8. Explain why system design has its limits.

Diagnosing Market Trends

You can design a profitable trading strategy if you can correctly and consistently diagnose whether a market is trending. In simple terms, the market exists in two states: trending and ranging. A market is trending if it moves steadily in one direction. If the market is going back and forth within a relatively narrow price range, then it is ranging.

Longer-term strategies are likely to succeed in trending markets, and shorter-term strategies in ranging markets. As always, the market may not make a crisp transition from trending to ranging and back again. Sometimes the market begins to range only to break out into a trend, or vice versa.

There are many different ways to determine if a market is trending. Clearly, you must make a number of trade-offs, and these trade-offs largely define your answer. For example, one well-known measure is the average directional index (ADX) developed by Welles Wilder Jr. (see bibliography for references). This is usually a built-in function in most technical analysis software programs. The ADX describes double-smoothed, absolute market momentum. A rising ADX line usually indicates trend. You have to choose the number of days to calculate the ADX; the sensitivity of the indicator decreases as the time increases. A

value of 14 days is common, although 18 days works well. *You* must also define two reference levels to screen out false signals. An ADX value of 20 is useful as a reference level—that is to say a market is not trending unless the rising 18-day ADX is above 20. A second useful barrier level is 40, which says that when the ADX rises above 40 and then turns down, a consolidation is likely. You will find that in particularly strong trends, the "hook" from above 40 often signals just a brief consolidation phase. The trend then has a strong second "leg" toward higher highs or lower lows.

Sometimes you will find that the ADX will rise above 20 in markets that are in a broad trading range. Another quirk is that the ADX can head lower even though prices march steadily and smoothly in either direction. In short, this is not a perfect indicator. The main difficulty with the ADX is that it has two levels of smoothing, which produces disconcerting lags between price movement and indicator response. Chapter 5 shows that the absolute level of the ADX indicator is not as useful for system design as is its trend.

An indicator that is more directly based on market momentum, and that responds more predictably than the ADX, is the range action verification index (RAVI). This strategy, which focuses on identifying ranging markets, is different from the ADX, which looks at how much of today's price action is beyond yesterday's price bar.

To define RAVI, we begin by selecting the 13-week simple moving average, since it represents a quarter of a year. Because we want to use daily data, we convert the 13-week SMA into the equivalent 65-day SMA of the close. This is the long moving average. The short moving average is chosen as only 10 percent of the long moving average, which is 6.5 days, or, rounding up, 7 days. Thus, we use 7-day and 65-day simple moving averages. This choice of lengths is purely arbitrary. Next, the RAVI is defined as the absolute value of the percentage difference between the 7-day SMA (7-SMA) and the 65-day SMA (65-SMA):

RAVI = Absolute value (100 x (7-SMA-65-SMA)/65-SMA)

An arbitrary reference level of 3 percent means a market is ranging if the RAVI is less than 3 percent, and trending strongly if the RAVI is greater than 3 percent. In some markets, such as Eurodollars, this is too high a hurdle. Hence, you may want to experiment with a smaller level, such as 1 percent, or use a relative measure, such as a 65-day SMA of the

RAVI. You can also require that the RAVI be above 3 percent and rising for there to be a strong trend.

Note the following design features of the RAVI: (1) There is only one level of smoothing. (2) The 7-day moving average is relatively sensitive, so that the lags between price action and indicator action should be small. (3) Markets can still move more quickly than the RAVI indicates. You can verify this by looking at the currency markets. (4) Markets in a slowly drifting, choppy trend will pin the RAVI below 3 percent, indicating ranging action.

Figure 3.1 compares the 18-day ADX (bottom graph) to the RAVI (middle graph) with a horizontal line at the 3 percent RAVI level. There is a general similarity between the two indicators, with the RAVI responding more quickly than the ADX because it has only one level of smoothing versus two levels for the ADX. A double-smoothed RAVI indicator created by smoothing the RAVI with a 14-day SMA is very similar to the 18-day ADX, as shown in Figure 3.2. Thus the ADX closely describes double-smoothed momentum and can lag price movements.

We now compare the ADX and RAVI and use them both to measure how often trends occur. In this example, we use continuous contracts from January 1, 1989, through June 30, 1995, a rising 18-day ADX above 20, and a rising RAVI greater than 3 percent. The ADX and RAVI are considered to be rising if today's value is greater than the value 10 days ago. These choices of length and reference levels are arbitrary.

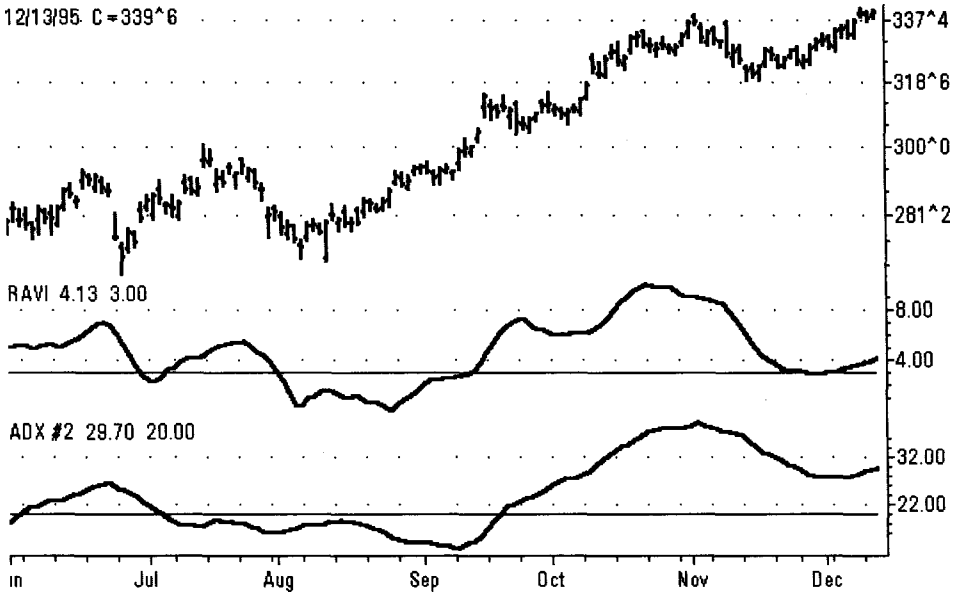


Figure 3.1 Comparison between the ADX (bottom) and RAVI (middle) to measure ranging behavior.

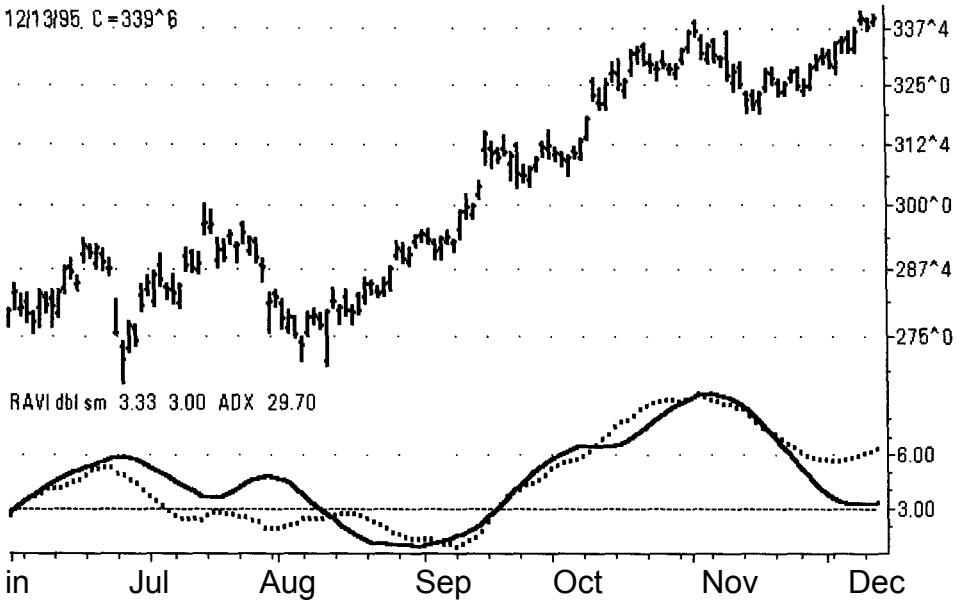


Figure 3.2 A double-smoothed RAVI (solid line) compared to the 18-day ADX (dotted line) shows that the two indicators are very similar.

The calculations shown in Table 3.1 suggest that markets seem to show some form oftrendiness about 20 to 40 percent of the time. Some markets, such as the 10-year T-note, have not shown very strong trends as measured by the RAVI. However, this may just be due to using a 3 percent barrier with the RAVI to measure trend strength. The "soft" markets, such as coffee and sugar, show the highest tendency to trend. Other fundamentals-driven markets, such as cotton, copper, and crude oil, also show a tendency to have strong trends, with a RAVI rating above 35 percent. The more mature markets, such as S&P-500 and U.S. bond markets, show fewer strong trends than the softs. RAVI calculations correctly tagged the prolonged sideways ranging action in gold with a low rating of 15.8.

A separate calculation showed that the average length of these trending intervals was about 15 to 18 days in most markets, with values ranging from as low as 1 to more than 30. Thus, the trending phase of these markets was long enough to allow profitable trading. These calculations show that markets have provided sufficient opportunities for trend-following systems in the "trendless nineties."

In summary, you can use momentum-based indicators to measure ranging or trending action. The calculations show that markets have trends lasting 15 to 18 days on average. Hence, trend-following strate-

Table 3.1 Proportion of market days showing definite trend, using ADX and RAVI

	Percentage of Days	Percentage of Days
ADX Rising, ADX>20	**RAVI Rising, Market (1/1/89-6/30/95) RAVI > 3**	
Coffee	30.2	43.3
Copper, high-grade	27.0	35.3
Cotton	29.2	39.4
Crude oil	30.2	39.9
Deutsche mark	32.6	25.7
Gold. Comex	25.0	15.8
Japanese yen	27.7	20.6
Soybeans	30.1	23.9
S&P-500	24.0	17.9
Sugar	31.3	41.7
Swiss franc	30.7	28.9
10-year T-note	32.8	6.0
U.S. bond	37.5	16.0

gies are worth considering for system design. The next section examines whether you should use trend-following strategies over the long run.

To Follow the Trend or Not?

If you are not a large hedger or an institutional trader, you can follow either of two basic strategies when you design a trading system. *You* can be a trend follower, or you can take antitrend positions. If you are a trend follower, you will typically take intermediate-term positions. In contrast, with a countertrend strategy, you take shorter-term positions that anticipate trends. This section explores both strategies and shows that a trend-following approach is more likely to be profitable over the long run than an antitrend approach.

Table 3.2 shows test results for a stochastic-oscillator-based antitrend trading system provided with System Writer Plus™ software from Omega Research. The stochastic oscillator is a range-location oscillator that shows where today's close is within its trading range over the last *x* days. If the close is near the top of the range, then oscillator values are greater than 80. The next move in prices will probably be toward the lower end of the range. Similarly, if the close is near the lower

Table 3.2 Stochastic-oscillator antitrend trading system results

Paper	Number Profits of ($)	Trades	Percent- age of Winners	Largest Intraday Winner ($)	Biggest Loser ($)	Consecu- tive Losers	Max imum Maximum Drawdown ($)
Coffee	1,837	276	32	27,065	-11,215	9	^4,931
Cotton	-98.725	296	24	4.955	-2.800	14	-102.205
Crude light	-61.940	301	29	5.210	-7.850	17	-63.180
Gold. Comex	-29.830	256	29	2.630	-2.920	21	-31.150
Japane ven	-47,713	309	32	8,633	-2,762	9	-60,81 3
Swiss	-55.350	285	32	9.175	-3.225	10	-63.51 3
U.S.	-49,313	310	28	4,400	-1,694	13	-61,469

end of the range, then oscillator values are below 20. We assume that the next move will take prices toward the top of the range. The "range" between the .r-day high and low changes continuously. Hence, this oscillator cannot predict the amplitude of the next move.

The system tested uses a 10-day period to calculate the so-called fast-K and fast-D moving averages. When the fast-K is above the fast-D line, the system buys on the open and vice versa. The System Writer Plus™ software guide gives the exact method for the calculations.

This example uses continuous contracts for seven unrelated markets, allows $100 for slippage and commissions, and uses a $1,500 initial money management stop. The test period was from May 26, 1989, through June 30, 1995. This simple system was a net loser over these markets. It also had substantial drawdowns, largely due to the many successive losing trades. Note the large number of trades and the relatively low proportion of winners.

The main implication of these calculations is that although markets may trend for short periods only, the profits during trending periods can far exceed the profits during trading ranges. The reason for this is that the amplitude of price moves during trends is many times the amplitude during trading ranges.

This example assumes that you pay the "discounted" trading commissions offered on the street. If your trading commissions are very low or negligible, then the antitrend strategy, with its high trading fre-

quency, takes on a different dimension.

Table 3.3 Impact of trading costs on profitability of antitrend trading strategies (dollars)

Market	Paper Profit $100SScC	Paper Profit noS&C
Coffee	1,837	29,438
Cotton	-98.725	-69.125
Crude oil. light	-61.940	-31.840
Gold. Comex	-29.830	*-A.230*
Japanese yen	^7.713	-16.813
Swiss franc	-55.350	-26.850
U.S. bond	-t9,313	-18,313

Table 3.3 compares paper profits with and without slippage and commissions (S&C). The difference in profitability is striking. The stochastic oscillator system performance improved significantly with low commissions. This result indicates that an antitrend strategy would not be attractive if you had to pay high commissions.

There are a number of "antitrend" strategies. Table 3.4 presents another set of calculations using a different trading strategy to illustrate this point. The moving average crossover (MAXO) system is the simplest trend-following strategy, but it can also be used as an antitrend strategy. For example, if the shorter moving average crosses over the longer moving average, you can go short in an antitrend strategy. Of course, this "upside" crossover would be a signal to buy long in a trend-following strategy.

Table 3.4 Comparison of trading systems using 5-day and 20-day simple MAXO tests, 5/89-6/95 (dollars)

	Antitrend Trading MAXO		Trend-Following MAXO	
	Paper Profit, $100SStC	Maximum Intraday Drawdown	Paper Profit, $100 S&C	Maximum Intraday Drawdown
Coffee	^2,719	-59,344	59,241	-17,216
Cotton	-14.670	-36.895	-6.845	-18.010
Crude oil.	2.580	-21.500	-30.730	-35.460
Gold.	-12.740	-21.780	-8.560	-12.950
Japanese	-34.650	-58.540	-9.025	-22.738
Swiss franc	-7.812	-45.688	-23.500	-40.175
U.S. bond	-28,119	-33,019	-9,643	-23,568
Average	-19,733	-39,538	-4,152	-24,302

Here we have arbitrarily picked 5-day and 20-day moving averages as examples of short- to intermediate-term averages. The test period was from May 26, 1989, through June 30, 1995, with $100 for slippage and commissions and a $1,500 initial stop. The antitrend strategy was a net loser on average, with significant potential for intraday drawdowns. The trend-following strategy cut the average loss by 79 percent and drawdown is lower by 39 percent—a better situation on both counts.

Table 3.5 presents another combination: the moving average antitrend and trend-following strategies with 7-day and 50-day simple moving averages. This combination is good for no-nonsense trend following. The assumptions are the same as before: $100 for slippage and commissions and a $1,500 initial stop with the calculations performed from May 26, 1989, through June 30, 1995.

Under antitrend trading, the 7/50-day SMA combination was also a net loser. On the other hand, it was a net winner with trend following, with profitability across all seven markets. The trend-following strategy had approximately one-fifth the drawdowns of the antitrend approach. Thus, the trend-following approach was the better choice on both counts.

These calculations show that a trend-following strategy is probably the better choice for the average position trader. However, the antitrend strategy may be attractive if you have low commission costs and little slippage.

The example tests in this chapter used arbitrary combinations of moving averages. However, you can test your system over historical data

Table 3.5 Comparison of performance for 7-day and 50-day simple MAXO tests, 5/89-6/95 (dollars)

Antitrend Trading MAXO			Trend-Following MAXO	
	Paper Profit $100 S&C	Maximum Intraday Drawdown	Paper Profit $100 SScC	Maximum Intraday Drawdown
Coffee	-22,716	-68,534	38,689	-27,615
Cotton	-44.375	-52.275	23.155	-9.795
Crude oil.	^t3.440	-47.570	20.430	-5.020
Gold.	-14.540	-20.980	4.560	-5.730
Japanese	-39.663	-71.225	23.662	-23.075
Swiss franc	-49.325	-70.800	32.988	-13.163
U.S. bond	-34,606	-36,756	18,131	-14,619
Average	-37,658	-49,934	20,488	-11,900

to find other combinations with better performance. Optimization is the process of finding the "best" performing variable set on historical data. The next section examines whether optimization is a good design strategy.

To Optimize or Not to Optimize?

If you have a computer, you can easily set up a search to find the "optimum" values for a system over historical data. The results can be truly astonishing. Imagine your profits if you could only have known ahead of time what the most profitable parameter combination was going to be. Therein lies the rub. The unfortunate fact is that parameters that work best on past data rarely provide similar performance in the future.

The term "optimization" is used rather loosely here to include all the activities affecting selection of parameter values in a trading system. We have already seen the difficulties of curve-fitting a model. You can also consider lower levels of optimization, in which you test variables over a broad range of values and markets, and try to select the one you like "best." But the real issue is not whether a particular set is the best. It is whether you believe sufficiently in the system to trade it without deviations. The primary benefit of optimization may be that you improve your comfort level with a particular system.

The problem with system optimization is that past price patterns do not repeat exactly in the future. The same is true of intermarket relationships. Although broad relationships follow from historical data, there can be differences in the time-lags between events and the relative magnitudes of the effects.

You must also resolve other conflicts. For example, you must choose the period you will use to optimize your trading system values. As you will quickly discover, the values you choose depend on the length of the test period. You must also determine how often you will reop-timize your system in the future. You must then prescribe the time for which the optimized values are valid.

For example, you may decide to use 3 years of data to optimize the values and recalculate them after 3 months. Thus, one solution may be to reoptimize after 3 months on the latest 3 years of data available. This is equivalent to retraining your favorite neural net. If you do reoptimize, you must determine how to treat trades that may be open from the previous period or values of the trading system.

You must also decide if you want to use the same values of your system parameters on all markets. If not, you will have to optimize the system on each market separately. In that case, you must keep up a program of reoptimization and recalibration for each of your systems over every market that you trade. Is all this effort worth the trouble? The results of deterministic testing do not support any attempts at finding the "best" or optimized variables.

Consider the following test using actual deutsche mark futures contracts. The rollover dates are the twenty-first day of the month before expiration. For simplicity, we will trade just one contract, allowing $100 for slippage and commissions, with a $1,500 initial money management stop. We will use a variation of the moving average crossover system, trading not the crossover, but a 5-day breakout in prices after the crossover. Thus, if the shorter moving average was above the longer moving average, then a 5-day breakout above the highs would trigger a long entry. Also included is a simple exit condition, ending the trade on the close of the twentieth day in the trade. One attractive feature of this arbitrary system is that the lengths of the short and long moving average can be optimized.

The calculations are simplified by fixing the length of the short average to a 3-day simple moving average of the close. The length of the longer simple moving average varies from 20 to 50 days, with an increment of 5 days. The test period was from November 14, 1983, through November 21, 1989. The performance of the various models was observed 3, 6, 9, and 12 months into the future. As Tables 3.6 and 3.7 show, there is no predicting how the model will do over a future period. The relative rankings change from period to period without any pattern or consistency.

Table 3.6 Data showing that past performance does not predict future performance

Length of mo. 1990 Profit	Optimized SMA (Days)	3 mo. 1990 Profit ($)	6mo.1990 Profit (S)	9 mo. 1990 Profit ($)	12 mo. 1990 Profit ($)	(S)
20	31,238	-2,200	-1,538	1,863	650	25
28,275	-2,475	-3,112	-488	-2,300	30	
24,175	338	-300	2,325	2,113	35	
18,088	338	63	2,175	1,963	40	
15,475	338	-525	2,625	4,000	45	
7,950	338	-4,363	2,038	3,600	50	
7,013	338	-4,363	-1,800	-238		

Table 3.7 Data showing that relative rankings from the past do not predict future relative ranks

Length of 12mo.1990 SMA Relative (days)	Optimized Relative Rank	3 mo. 1990 Relative Rank	6 mo. 1990 Relative Rank	9 mo. 1990 Relative Rank
20	1	6	4	5	5
25	2	7	6	6	7
30	3	1	2	2	3
35	4	1	1	3	4
40	5	1	3	1	1
45	6	1	6	4	2
50	7	1	6	7	6

We next test the hypothesis that if the optimization period were closer to the actual trading period, the predictions would be more reliable. However, as Tables 3.8 and 3.9 show, there is again no way to predict what the model will do in the succeeding periods. This should be expected because there is no cause-and-effect relationship between our optimized model and market forces. Since we are merely fitting a model to past data, we are not capturing all the fundamental and psychological forces driving the market. Our poor ability to predict the future based only on past price data is not surprising.

Let us carry our argument one step forward. Because we do not capture any cause-and-effect relationships, optimization on one market should have little or no benefit for trading other markets. Indeed, as Table 3.10 shows, optimizing a system on one market (here the deutsche mark) does little to improve performance in other markets.

Table 3.8 Data showing that bringing the optimization period closer to the trading period (11 /88-11 /89) does not predict future performance

Length of 12mo.1990 SMA (Pays)	Optimized Profit (S)	3 mo. 1990 Profit ($)	6mo.1990 Profit ($)	9mo.1990 Profit ($)	Profit ($)
20	3,525	-1,625	-1,000	2,650	2,438 25
5,225	-1,900	-2,575	400	-^13 30	4,250
5,338	4,713	7,688	8,475 35 '	513	5,338
4,713	7,213	8,000 40	63	5,338	4,437
6,213	8,813 45	-2,800	5,338	3,138	4,913
7,638 50	-1,525	5,338	913	2,688	5,413

Table 3.9 Data showing that relative rankings over recent past (11 /88-11 /89) do not predict future relative ranks

Length of SMA (Days)	Optimized Rank	3 mo. 1990 Rank	6 mo. 1990 Rank	9 mo. 1990 Rank	12mo. 1990 Rank
20	2	6	6	6	6
25	1	7	7	7	7
30	3	1	1	1	2
35	4	1	1	2	3
40	5	1	3	3	1
45	7	1	4	4	4
50	6	1	5	5	5

Any optimization exercise has many potential benefits. The first benefit is recognition of the type of market conditions under which the trading system is unprofitable. For any rules that you can construct, you can find market action that produces losses. This happens because the market triggers the signal, and then does just the opposite instead of following through.

The second benefit is verification of the general ideas underlying the model. For example, you can check to see if the model is profitable in trending markets or trendless markets. You have designed the rules to be profitable under certain market assumptions. The optimization exercise allows you to verify if your broad assumptions are correct.

A third benefit is understanding the effect of initial money management stops. *You* can quantify what level of initial stop allows you to

Table 3.10 Data showing that optimization over one market does not predict performance in other markets

Length of SMA (Days)	Deutsche Mark 11/88- ($)	Japanese Yen 11/90- (S)	Cold 11/90-7/95 (S)	Coffee 11/90-7/95 ($)	Heating Oil 11/90- (S)
20	3,525	8,188	-16,190	30,956	-26,771
25	5.225	7.838	-15.370	29.206	-21.938
30	4.250	8.938	-13.920	40.781	-21.230
35	513	7.013	-10.860	-5.013	-18.028
40	63	3.963	-11.400	-6.343	-14.316
45	-2.800	3.250	-7.940	6.188	-18.873
50	-1,525	11,245	-8,310	6,625	-13,773

capture the majority of potential profits. For example, if your stop is too wide, your losing trades will be relatively large. On the other hand, if your stop is too close to the starting position, you will be stopped out frequently. Your loss per trade will be small. However, the higher frequency of losing trades means your total drawdown could exceed a larger initial stop.

The biggest benefit of optimization is reinforcing your beliefs about a particular trading system. Ultimately, it is more important for you to implement the trading system exactly as planned. Hence, any testing you do that allows you to understand system performance and become more comfortable with its profit and loss characteristics will help you to execute it with greater confidence in actual trading.

The main point of this section is that you cannot assume your system is going to be as profitable in the future as it has been in the past. This raises the issue of how you control your risks to cope with uncertain future performance. The next section presents risk-control ideas.

Initial Stop: Solution or Problem?

Many traders have raised stop placement to an art form because it is not clear if the initial stop is a solution or a problem. The answer depends on your experiences. Often, the stop acts as a magnet for prices. It seems the market hits the stop, only to reverse and resume the previous trend. Thus, initial stops can easily test your patience. Even so, initial stops should be an essential part of managing trading risk. This section discusses some general issues related to selecting an initial stop. Detailed examples appear in the following chapters.

If you use an initial stop at all, use stops that follow money-management rules but are derived from system design and market volatility. A good idea is to use a 2 percent of equity initial stop, and then use maximum adverse excursion (MAE), a distribution of the worst loss in winning trades, to select the dollar value of the stop for a particular system. Relate the MAE to some measure of market volatility before calculating the number of contracts. Thus, the initial stop meets three criteria:
money management, MAE, and volatility.

Another issue involves whether you should place your stop loss order with your broker. Many traders will have a well-defined exit price, but will not place an order in the market. They like to monitor the market in real time, and will place the exit order themselves if needed. This is termed the "discretionary initial stop." If you have good discipline and

judgment, the discretionary initial stop could work well for you. However, if you cannot monitor the market continuously, it may be prudent to enter the exit order with your broker.

What values of the initial stop should you use during system testing? That depends on the type of data you have and the nature of the system design. The issue is whether to use a tight stop or a loose stop. A tight stop may have a dollar value less than $500 per contract. A loose stop could be as high as $5,000.

Let us assume you have only daily data. In this case, it is difficult to test a tight stop accurately because the exact track of prices during the day is unknown. Suppose you are trading the bond market, and the typical daily range is $1000. Now, say you want to test a $100 stop with daily data. Most system-testing software will stop you out on the day of entry because it does not know the exact track of prices. Of course, if you have intraday data, then you can more accurately test a $100 stop. Thus, if your stop is very tight, you need intraday data for accurate tests.

There are two broad types of systems, those that are self-correcting and those that are not self-correcting. Self-correcting systems have rules for long and short entries. Such systems will eventually generate a long signal for short trades and vice versa. Because these systems are self-correcting, the reverse signal will limit losses, even without an initial stop. Of course, the losses will depend on market volatility, and easily could be as large as -$10,000 per contract.

Systems that are not self-correcting include those that trade the long side or the short side only. Thus, you could get a false short signal and remain short through a long up trend. The losses in these systems can be unlimited, and hence must be protected by an initial stop. A onesided system with an exit strategy can become self-correcting. The exit strategy will limit losses in a one-sided system by closing out the trade at some preselected point. For example, a self-correcting, longside-only system has an exit stop at the most recent 14-day low.

You can get a better feel for the efficiency of entry rules if you test a self-correcting system without initial stops. However, if the system is not self-correcting, then you must test it with an initial stop. There is still the issue of how wide the stop should be. Relatively wide stops, defined as three times the 10-day average of the daily range, are a good choice. In this way the stop has a smaller influence on results than do the entry rules. If you like tight stops, then use intraday data, or use an amount larger than the recent daily trading range.

Your data set will strongly influence the results of your initial stop selection. If your data set has many trading range markets, then a

tight stop will produce whipsaw losses. Even though each loss may be small,

the sum of a series of losses can be large. A loose stop will prevent whip-saw losses in a trading range. If the market is trending, then the value of the initial stop is not critical. Thus, a trending market will rescue a system with tight stops, and you can get some astonishing results.

Relatively loose stops, between $1,500 and $5,000, work well. If the stops are relatively "loose" then there is little difference between nearby values. Conversely, if the stop is "tight," then small changes in the stop can produce big swings in equity. Hence, the system tests in this book use daily data and stops ranging from $1,000 to $5,000.

Often, the point of discussion in this book does not depend on the amount of the stop. Sometimes the loose stop is a necessary design feature. In such cases the reason for choosing the wider stop is stated. Ultimately, if you do not like my stop, you can retest the system to suit your preferences.

Some actual calculations will clarify this discussion. Here we use the standard 20-day channel breakout on the close (CHBOC) trading system. This system buys on the close if today's close is higher than the highest high of the last 20 days. The short sale condition is symmetrical.

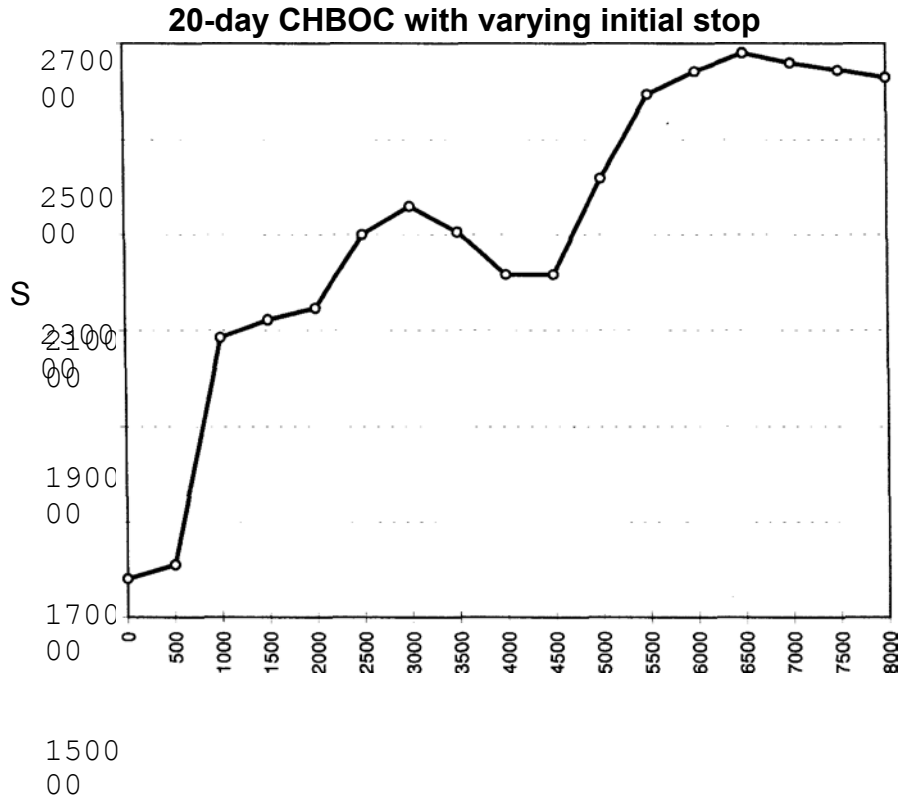


Figure 3.3 Profit increases steadily and then levelsoff as the

initial stop increases.

The system sells short on the close if today's close is lower than the lowest low of the past 20 days. We will test this system on the coffee market, which has seen much volatility as well as strong trends. We will vary the initial stop from $0 to $8,000 in $500 increments and allow $100 for slippage and commissions.

Consider for a moment what the $0 initial stop means. The system goes long or short on the close. Thus, the trade will remain open only if prices continue to move strongly beyond today's close. This is the toughest stop you can impose because the only trades that survive are the ones that are profitable immediately.

Observe that profits increase steadily as we loosen the initial stop (see Figure 3.3). There was a surprising profit of $158,103 with a $0 initial stop on just 20 (of 434) trades. This confirms a common piece of market wisdom that the best trades are profitable immediately. It also confirms that only 5 percent or so of the trades are the "big ones." So you should work hard not to miss them.

Figure 3.4 shows that a tight stop can produce a drawdown greater than using no stop at all. More and more trades recover their losses and

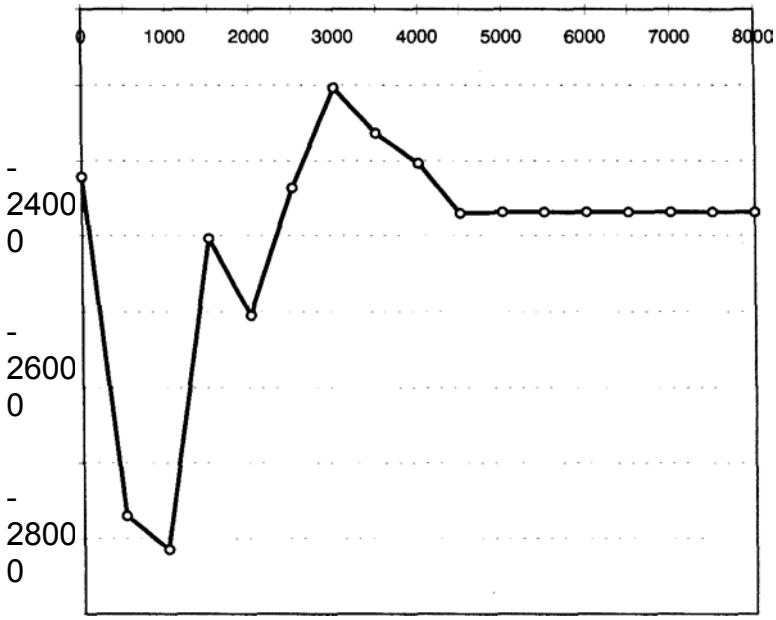
Changes In MIDD for 20-day CHBOC on Coffee

-2000

0

S -2200

0



-24000

-26000

-28000

-30000

-32000

-34000

-36000

Initial stop ($)

Figure 3.4 As we loosen the initial stop, MIDD first increases and then stops declining.

close at a profit as the stop widens. Eventually the stops are so large that they have little effect, and so MIDD stabilizes.

The initial stop cuts *off* fewer trades as we loosen it (see Figure 3.5), and hence the total number of trades produced by CHBOC decreases. Once the stop is "too loose" (more than $3,000 or so), it has little effect, and the number of trades stops declining.

Only 5 percent of the trades are profitable with a $0 stop. The percentage of winners increases quickly as we loosen the initial stop until the stop has little effect (see Figure 3.6). As we loosen the stop, more of the winning trades can survive the vagaries of market action.

As you may expect, the worst losing trade increases as we loosen the stop (see Figure 3.7, page 58). This occurs because the worst case with a $0 stop reflects slippage due to a weak opening. However, as we loosen the stop, the losing trade from a false signal can survive longer.

The highest average 10-day trading range in the coffee market over the last 20 years was approximately $5,025. The average value was $1,015 and the standard deviation was $641. The cumulative distribu-

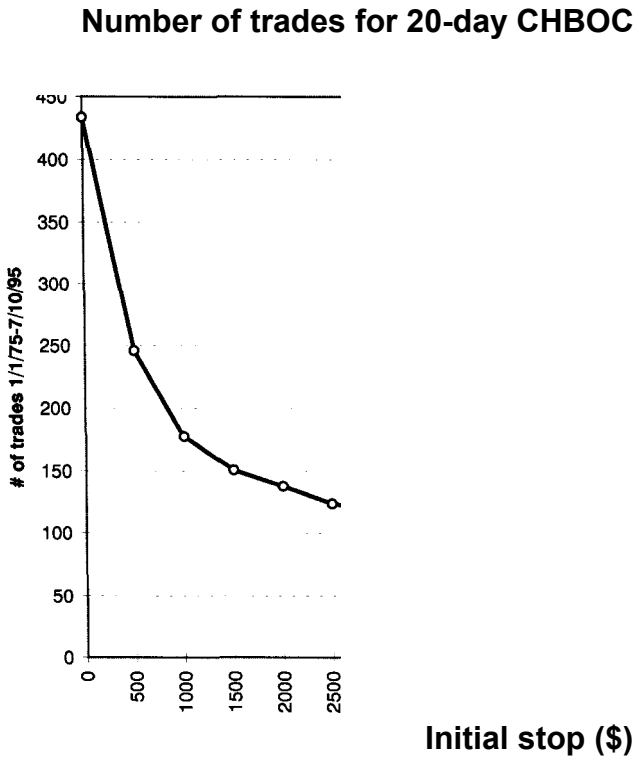
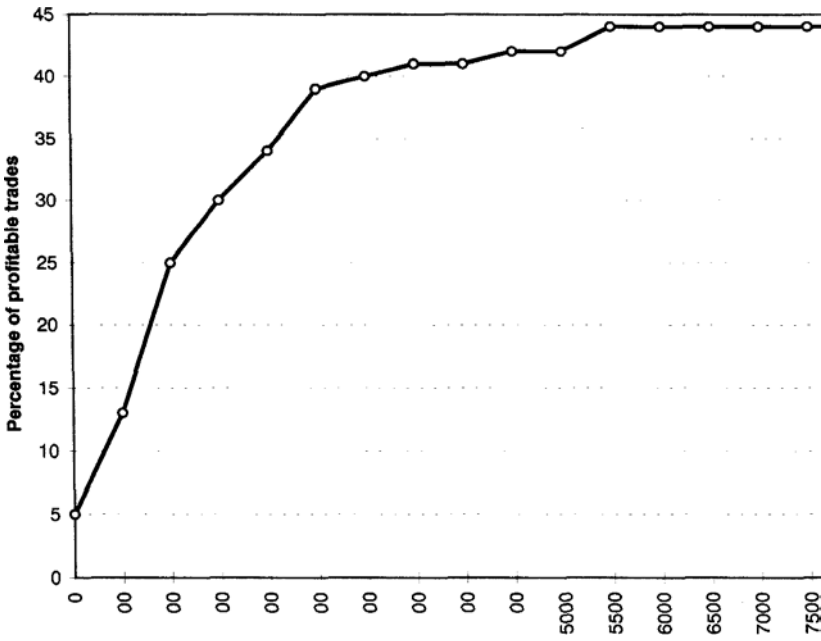


Figure 3.5 The number of trades drops and levels off as we loosen the initial stop.

Changes In percent profitable trades, 20-day CHBOC on Coffee



>o o 10 o irt o
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Ini tial stop ($)

Figure 3.6 The proportion of profitable trades increases and levels off as we loosen the initial stop.

tion (Figure 3.8, page 59) shows that a stop of $3,000 exceeds 98.3 percent of all the 10-day average trading range values seen in coffee over the last 20 years. Hence, $3,000 should be a loose stop. Figures 3.3 through 3.7 show that the changes in performance begin to level off beyond $3,000. Thus, you can view stops greater than $3,000 as "very loose" stops. A $500 stop that covers less than 20 percent of all observed values of the 10-day average daily range qualifies as a "tight" stop.

You can now use the cumulative frequency distribution to select a stop based on market volatility. An arbitrary stop may be too tight or too loose. This analysis assumes that you use the same dollar stop on every trade. If you vary the initial stop on every trade then this analysis will be of little use to you. We already know that stops are hit more frequently during trading range markets. Hence, you could use some measure of trendiness to vary your initial stop.

Many traders feel an aversion to taking a big loss, even though they have no problem taking many small ones. The maximum drawdown usually decreases as the stop increases (see Figure 3.4). Thus, you should

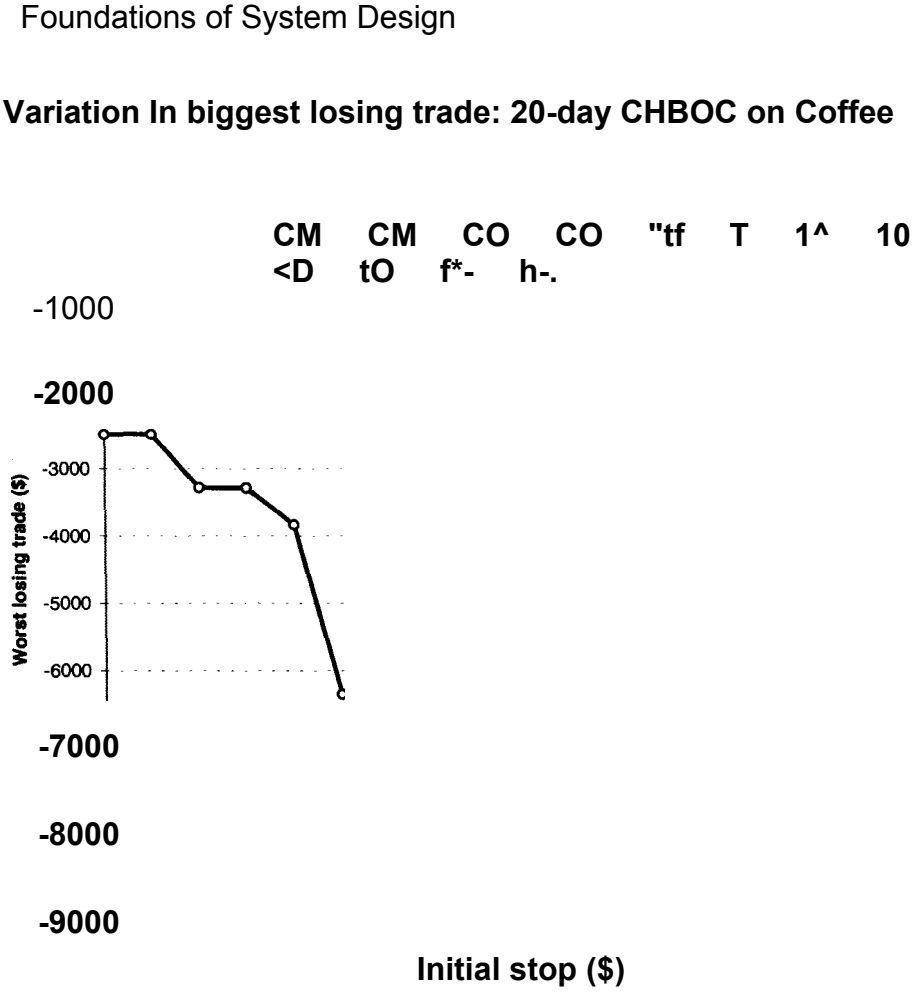

Figure 3.7 The worst losing trade increases as we loosen the stop.

try to take the long-term view when you set your stops. If you use a constant stop based on system design, then use loose stops. If you set the stop differently for each trade, then you have probably mastered the fine art of placing stops.

The risk of being stopped out is highest near trade inception, as shown by the calculations in Table 3.11, page 60. This table shows the effect on the length of the average losing trade of using no stop, a $1,500 stop, and a variable stop. A simple 20-day CHBOC model, with no exits other than an initial money management stop, is used, allowing $100 for slippage and commissions. The tests were over a 6-year period commencing May 26, 1989, using continuous contracts.

The data in Table 3.11 show that inserting an initial money management stop of $1,500 reduced the length of the average losing trade by approximately 40 percent to 17 days from 28 days. These calculations confirm that the risk of being stopped out is highest near trade inception. The average winning trade was typically 2 to 3 times longer than the average losing trade.

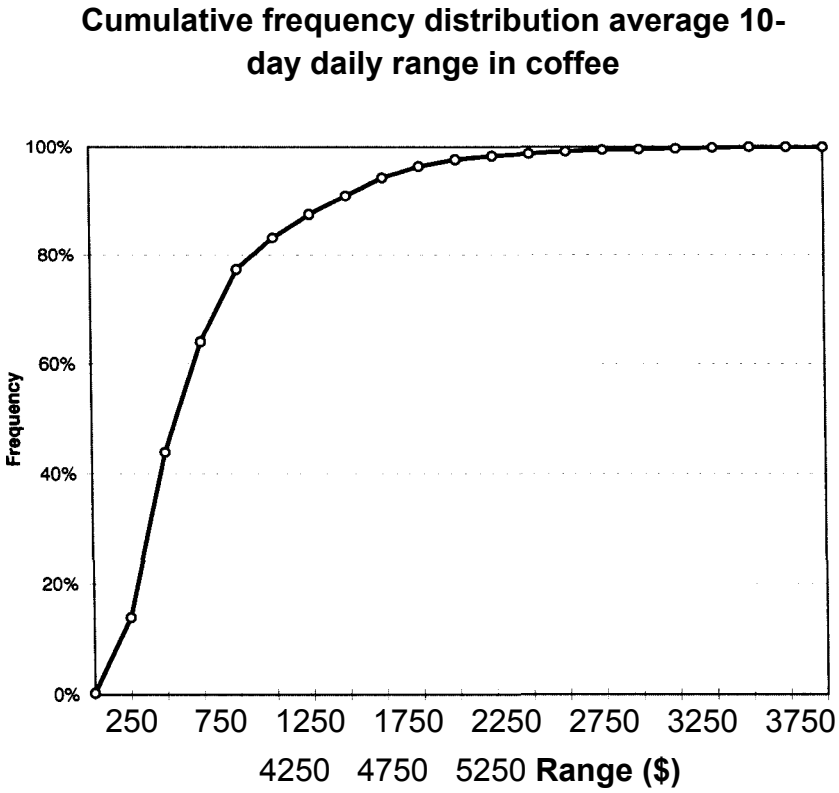

Figure 3.8 The cumulative frequency distribution of the 10-day average daily range shows that an initial stop of $3,000 or more covers 98.3 percent of all trading ranges.

If you look more closely at Table 3.11, you will see that for some markets, such as gold, sugar, and soybeans, the length of the average losing trade did not decrease much even after adding a stop. This means that the volatility in these markets is not as large as, say, the currency or bond market. An approximate initial stop that will produce an average losing trade length of 10 or 11 days is also shown in Table 3.11. The S&P-500 index futures contract and coffee were the two most volatile markets, followed by cotton, Swiss franc, and the U.S. bond markets. Conversely, gold, sugar, and crude oil were relatively less volatile. Hence, you may find it useful to consider overall market volatility when placing your initial stop.

In summary, you can get a better feel for system performance if you use loose stops with a self-correcting system. If a stop is "tight," then a small change in the stop can affect long-term performance. If a stop is "very loose," then changing the stop will have little effect. As you loosen your initial stop, the profits increase and then change more slowly. This

Table 3.11 Effect of initial money management stop on length of average losing trade

Market	Average Days in Losing Trades (-1,500 stop)	Average Days in Losing Trade (no stop)	Initial Stop Required to Give 10-11 days in Average Losing Trades
Coffee	92	6	1,600
Copper, high	21	28	500
Cotton	14	20	1,250
Crude oil	23	27	500
Deutsche	16	27	1.000
Gold, Comex	28	31	400
Heating oil	27	37	700
Japanese yen	13	26	1.000
Soybeans	24	27	500
S&P-500	7	26	2.000
Sugar	32	32	500
Swiss franc	13	27	1.250
10-year T-note	23	35	850
U.S. bond	12	27	1,250

means that once you pass some volatility threshold, increasing the initial stop adds little value.

Another reason to use loose stops is that you cannot properly test stops that are smaller than the daily price range. Ideally, you should base your initial stop on money management guidelines, the maximum adverse excursion of the system, and on market volatility. There are many ways to select an initial stop; once you pick a method, you should use it consistently.

Does Your Design Control Risks?

As you design your trading system, remind yourself that one of your key goals is to control the downside risk. *You* will quickly discover that risk is a many-splendored thing. This section briefly discusses some of the areas of risk you may wish to consider as you take a portfolio-level look at your trading system.

A trailing stop is a popular method to control portfolio volatility and protect profits. A trailing stop is simply a stop order that is placed some fixed distance away from the highest profit point in the trade. When the market reverses, or when market volatility increases, this stop will be touched off and will protect your profits. If you are using long-term systems that are slow to react to trend changes, then such a stop may smooth out your equity curve.

An important type of risk arises from correlation among markets. You know that correlated markets move roughly together. A good example is the currency markets such as the Swiss franc and deutsche mark (see Figure 2.10). These markets tend to experience broadly similar moves versus the U.S. dollar. As we saw in chapter 2, trading correlated markets in the same portfolio is equivalent to trading multiple contracts in a single market. This may increase your risk to market events such as unexpected and unexplained news events.

There is an execution risk to your portfolio due to market liquidity or lack of it. For example, lightly traded markets can produce significant slippage. *You.* experience slippage getting in and out, reducing profits, and increasing losses. In these markets your paper testing may not adequately account for slippage and commissions, thereby overestimating potential profitability.

Liquidity can be a particular problem near major holidays, such as Christmas and New Year's Day. During these thin market periods, it is common to see large one-day moves (see Figure 3.9) that can scramble the best-laid risk-control plans. These moves do not change the underlying trend, but can be difficult to model when you test your trading system.

Global trading produces a new set of risks to your portfolio. If news events occur when the U.S. markets are closed, then large price moves could occur in foreign markets. This is particularly true for currencies such as the Swiss franc, Japanese yen, or deutsche mark; energy markets such as crude oil; and metals markets such as gold and silver. Often, an emotional reaction in foreign markets will produce a large opening gap stopping you out at extraordinary slippage. You may find that your profits are lower than anticipated due to these large opening gaps. Then to make matters worse, the markets may stage a recovery to close well inside your stop loss point. Thus, round-the-clock trading adds new risks to your portfolio.

The DM contract in 1995 showed some large gaps during a volatile period (see Figure 3.10, page 63). Large overnight moves in foreign currency markets produced these large gaps, which are difficult to simulate correctly in historical testing. The first encircled gap was for $2,112.50,

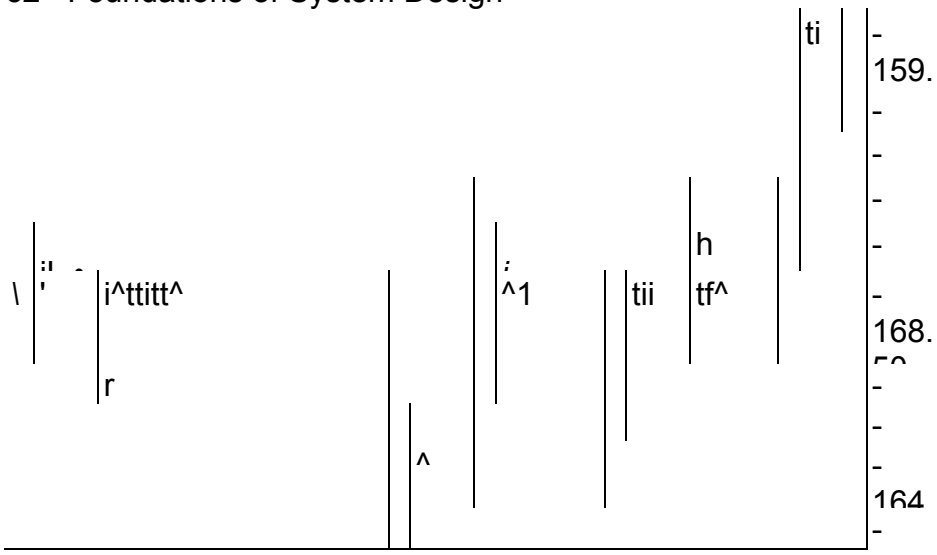

Figure 3.9 Increased volatility in the British pound market caused by thin markets at year end 1994 is clearly visible.

a big move against you if you were short. The island reversal in the middle ellipse in late March 1995 also left huge gaps, about $1,300 per contract. The gap circled in May was about $1,500. Here, your signal a day off on either side would show significantly different results.

The large intraday ranges in this contract also increases the difficulty with entering a market on the close. For example, you may lose a big move if you had the right signal on the right day, but entered the market on the close rather than on a stop. Say you had a sell order at 71.80 stop close only. ^bur fill would have been after a slippage of $2,400, quite unacceptable to most traders (see Figure 3.11).

The type of data you use often poses hidden risk. Consider a situation in which you are using weekly data to develop your trading system. Let us suppose you generate a signal at the Friday close, and purchase with a delay on Tuesday open. Since daily opening gaps are missing from weekly data, you can easily underestimate the slippage from actual trading. Another potential problem area is using systems that generate signals this week and ask you to trade next week. *You* could have a large move this week, and have missed a big portion of the profits by the time you enter the trade next week.

Your system could also experience a time-based risk. For example, the best moves seem to occur when the market moves rapidly immedi-

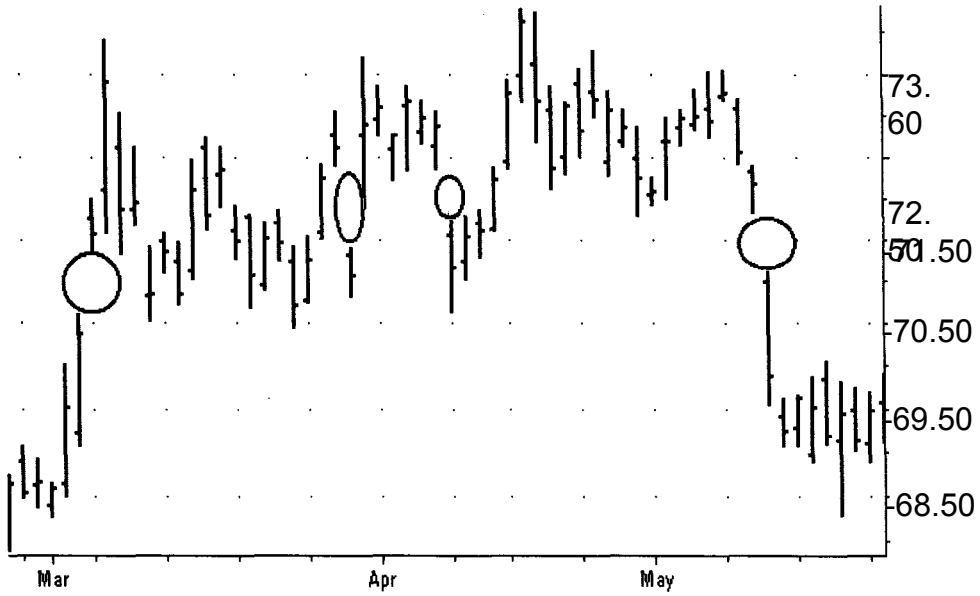

Figure 3.10 The large gaps are due to big moves overnight in overseas markets. Note the large close-to-open gaps in the bars highlighted by the ellipse in the middle of the chart.

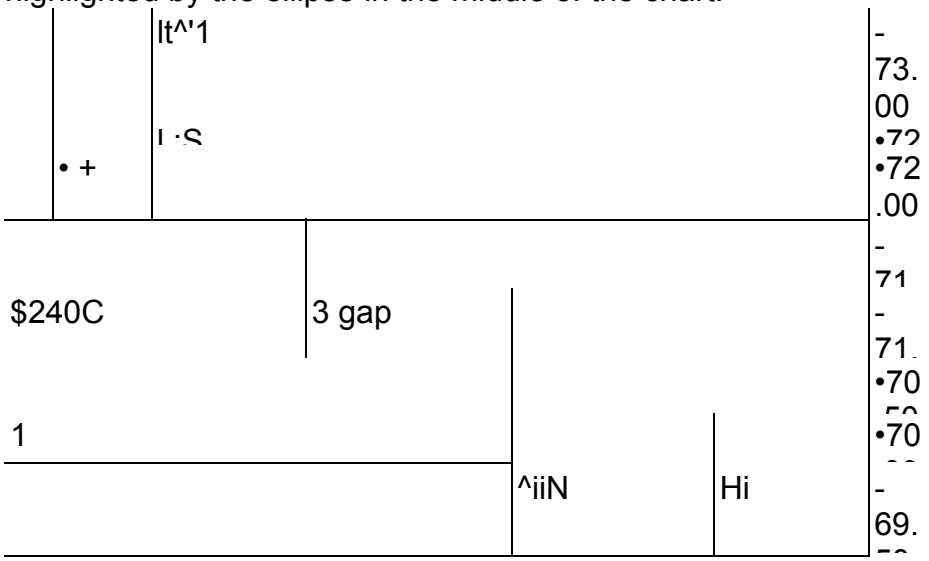

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Figure 3.11 A stop close only sell order would have a $2,400 slippage due to market volatility.

ately after a signal. Suppose the market consolidates immediately after giving you a new breakout signal. The risk of being stopped out is significantly higher in a sideways trend. Hence, you may want a filter that will exit within 5 days of entry if the trade shows a loss.

Another quirky situation arises when you get a new signal very close to a rollover date. It is possible to generate an entry signal on the contract about to expire, but not on the next active futures contract. In this case you must decide whether to take the signal as is, and then rollover immediately or in a few days, or just to wait until the next active contract generates its signal.

In testing with continuous contracts, you could easily underestimate the effects of rollovers on trading costs and profitability. You must also resolve the issue of where to place your initial stop on the new rollover position. Your real position may hit the stop, while your continuous contract merrily rolls along with its position intact.

This discussion does not include all types of risk, but highlights why you should consider risk control early in your trading system design process.

Data! Handle with Care!

You have many choices when you select data for your system testing. You should therefore exercise great care in choosing your test data because they have a big influence on test results.

Choose your data vendor with care, since data vendors differ in accuracy, depth of coverage, and reporting conventions. For example, there can be differences in the opening price of a contract between data vendors. Another policy difference is how errors are detected and corrected. You want a vendor with "clean" data all around.

If you are testing futures contracts, use a continuous contract or the actual contracts with rollovers. Unlike a cash market index, futures data are not continuous: contracts are dormant, become active, and expire. Hence, to produce a continuous, albeit "synthetic," data stream, different contracts must be combined in some consistent manner. You have two choices when you combine futures contracts. You can preserve the prices or price levels, at the cost of correctly preserving the amplitude of price movements, or, alternately, you can preserve the amplitude of price movements at the cost of adjusting prices. Continuous contracts that preserve amplitudes are preferred for testing. Each type of continuous contract will give slightly different numerical results.

A good choice is using actual data with rollovers if the software allows it. Results from continuous contracts come closest to data with rollovers, but they tend to underestimate the number of trades and hence the losses due to slippage and commissions. They also underestimate the difficulty with placing stops on rollover trades. For example, after rollovers, you can get stopped out on a real trade, while the system trading the continuous contract continues to hold its position.

Other than type of data, you must also choose the amount of data. In general, the more data you can use, the better, because you can then test a model over a wide variety of market conditions. There is also a statistical requirement, usually quoted as sufficient data to produce 30 or more trades over the test period. The idea here is simply that the more trades you have in a given sample, the better your estimate of the average properties for the entire universe. Hence, you can use the average properties (such as average trade) to estimate how the system will do in the future.

Although 30 trades may not seem like a large number, you may have difficulty obtaining 30 trades with weekly data using certain trend-following models. Thirty trades is probably too small a number to fully eliminate any effects of the data used for the tests. Hence, more than 100 tests is preferable, if possible, and you can obtain sufficient numbers by combining tests over multiple markets and multiple time frames. Later in the book you will learn how to generate synthetic data to generate a large sample of trades.

The point of this discussion is that different input data will give you different results. Besides, you cannot be certain that your trading will ever achieve those results because you do not actually trade the synthetic data. We now look at the results of testing a dual-moving average crossover system using 5-day and 50-day simple moving averages, an initial money management stop of $1,500, and $100 for slippage and commissions.

Table 3.12 was created by Continuous Contractor™ software from Tech Tools, Inc. to show different types of continuous contracts for the Swiss franc. Over the same period, model performance was calculated using actual contracts with automatic rollover on the twenty-first day of the month prior to expiration. The cautionary tale here is that test results vary widely with the type of data used.

Focus on the number of trades for the same entry and exit rules. There are 111 trades with the actual data, almost 37 percent more than the average number of trades created using continuous contracts. The extra trades result primarily from rolling over existing positions into the next active contract.

Table 3.12 Comparison of test results with different types of continuous contracts

Data Type	Profit ($)	MIDD ($)	Number of Trades	Wins (%)	Win/Loss Ratio
Actual with rollovers	17,963	-21,663	111	40	1.80
Continuous type 38/13	18,450	-24,813	79	31	2.74
Continuous type 49/25	20,413	-22,137	77	31	2.89
Continuous type 55/25	20,350	-21,115	86	34	2.42
Continuous type 56/25	10,625	-27,800	91	31	2.43
Continuous type 60/25	39,862	-18,363	70	35	3.12

Notice also that the ratio of average winning to losing trades is the smallest (1.80) with actual data. This occurs because rolling over positions decreases the amount of profit in winning trades. During a long trend the continuous contract goes on without any rollovers. Hence, the duration of the trade is longer and therefore its profit figure is also greater with continuous contracts. Thus, continuous contracts may underestimate the number of trades and overestimate the win/loss ratio and the duration of trades.

Choosing Orders for Entries and Exits

You have three basic choices for orders that you use to initiate or exit your trades: market, stop, or limit orders. There are three philosophies at work here. One says to get your price, implying you should use limit orders or stop limit orders to get into the trade. Another philosophy says to guarantee entry into trade, implying you should use market orders or stop orders. The third philosophy insists that you should exit positions with market orders, but can enter on a stop or a limit.

Timed-market orders on the open or the close are a good way to both exit and enter positions. Many traders recommend entering on the open, and avoiding the rush of orders at the close. Using stop orders can cause you extra slippage if the market opens beyond the stop price.

Remember that there can be divergences between what the testing software assumes and what actually happens in practice. You may get a fill from the software, but not from the floor due to the peculiarities of the market. For example, the software testing daily data has no idea if there were fast market conditions on a particular day. Hence, you may or

may not get a fill when the software says you did. It is important to understand how the software fills a particular order.

One other important feature is the difference between the signal day (or date) and execution day (or date). This means you can get your signal and open the trade the same day. For example, if you are trading a simple moving-average crossover system, you can calculate that a close beyond a particular point will give you a crossover today. Hence, your order may say buy (or sell) at *x,* stop close only. Alternatively, you can generate your signals after the close, and enter them the next day. The latter approach is preferable only because it is simpler, and when coupled with an order to enter on the open, it is a reliable way to measure system performance.

Entering tomorrow on a stop above the high or low of today is an effective filter when compared to buying tomorrow on the open. In effect, it filters out some whipsaw trades. Generating orders today and entering on the next day on a stop, on the open or on the close, is a consistent and realistic way to assess model performance.

Understanding Summary of Test Results

This discussion of the detailed summary of test results found in technical analysis programs uses in part the report from Omega Research's TradeStation™ software. The purpose of the summary is to show how a particular trading system would have done on historical data.

The summary shown in Table 3.13 is for the British pound continuous contract for the 65-day simple moving average, three consecutive closes (65sma-3cc) trend-following system. The 65sma-3cc trading system is discussed in detail in the next chapter. The summary here is for all trades, long and short. The software shows the same information for long trades only and for all short trades.

The summary is broken down into five blocks. The top-most block describes profitability. The second block gives physical trade count. The third block presents average trade data. The fourth block shows trade duration or length data. Finally, the fifth block gives important information on drawdowns, profit factor, and returns.

The total net profit is the difference between the gross profit and gross loss. The gross profit is the sum of the profits on all profitable trades. Similarly, the gross loss is the sum of losses on all losing trades. The open trade profit or loss is the value on a trade still open at the end of the test period. The net profit is an important figure that influences

Table 3.13 Typical performance summary for 65sma-3cc system

British Pound 38/13-dally 02/13/75 - 7/10/95 Performance Summary: All Trades			
Total net profit ($)	155,675.00	Open trade profit or loss ($)	-1,212.50
Gross profit ($)	266,918.75	Gross loss ($)	-111,243.75
Total number of trades	71	Percentage profitable	45
Number of winning trades	32	Number of losing trades	39
Largest winning trade ($)	40,768.75	Largest losing trade ($)	-7,993.75
Average winning trade ($)	8,341.21	Average losing trade ($)	-2,852.40
Average win/average loss	2.92	Average trade (win and loss)	2,192.61 ($)
<		Maximum consecutive losers	7
Maximum consecutive winners	6	Average number of bars in losers	29
Average number of bars in winners	123		
Maximum intraday drawdown ($)	-27,881.25	Maximum number of contracts held	1
Profit factor	2.40	Return on account (%)	504
Account size required ($)	30,881.25		

other calculations below. Note that the profit factor shown in block five is simply the absolute value of the ratio of gross profit divided by gross loss. In trading system design, a profit factor of more than 1 is highly desirable, since it says that gross profits exceeded gross losses over the test period.

The trade count block shows the total number of trades, and the breakdown into number of winning and losing trades. The percentage

of winning trades is a function of both the trading system rules and the test data, and helps influence the risk of ruin. Naturally, the larger this number, the better. It is common to have trend-following systems report in with a winning percentage of 30 to 50 percent. A number above 60 percent is difficult to find, and anything over 70 percent is remarkable.

The average trade performance block merely combines data from the two blocks above to report average numbers. The largest winning trade and largest losing trade are new numbers in this block. They are usually functions of the test data, trading system rules, and risk control specifications. If you do not use stops and the markets are volatile, there will be a large losing trade. Exceptional trends can give you a large winning trade. Beware if the largest winning trade is more than 50 percent

of your net profits. It probably means you should deduct this amount from net profits to evaluate true system potential.

The average winning trade is simply the ratio of gross profit divided by number of winning trades. The ratio of the average winning to average losing trade is useful for calculating risk of ruin. This is called the payoff ratio, and is a function of the test data, trading system rules, and the length of trades. The typical trend-following systems will return values greater than 2.

The average trade reported in the third block is one of the most important numbers in the summary. It is simply the ratio of net profit divided by the total number of trades. This number depends on the test data and trading system rules. This number would ideally be as large as possible. If this number is negative or less than $200, avoid trading this system unless you test it on other markets and other time frames. This number is the statistical edge for this system.

The trade duration block gives the length of the average winning and losing trades (average number of bars in winners equals length of average winning trade). This ratio should be greater than 1, and it could be greater than 5 for trend-following systems. Ask yourself if you would be comfortable holding a trade for the number of days shown in the length of average winning trade. Do you have the discipline to stay with a trade that lasted twice as long as the average winning trade? If you are not patient, this may be a difficult task, and you might miss out on a mega-trade.

Alternately, ask if the length of an average winning trade coincides with your trading horizon. If the length of the average trade it is too long or too short, test the system first over more data and then over other markets. If you are still not comfortable with this number, you should consider changing your trading system.

The maximum consecutive winners and losers data will vary with the test period. Maximum consecutive losers have a great influence on your drawdowns. You should carefully examine the period when the consecutive losers occur to understand under what conditions your trading system will produce large losses.

As a rough rule of thumb, ask yourself if you could tolerate twice the number of consecutive losers as the number reported for maximum consecutive losers. This will tell you how to set your money management guidelines to avoid serious drawdowns. Ask yourself also if you would hold a losing trade as long as the average losing trade number suggests.

The last block shows the maximum intraday drawdown. Ask yourself if you could tolerate a number twice as large. The account size and

return on margin numbers are not very useful. The profit factor, as discussed above, should be greater than 1.

What the Performance Summary Does Not Show

The test summary leaves out some important information, highlighted below. You may wish to examine these factors in greater detail.

One simple ratio is the recovery factor (RF). RF is absolute value of the ratio of net profit to maximum intraday drawdown, and it measures how far you recovered from the depth of the drawdown. In Table 3.13 the recovery factor is approximately equal to 5.6 (155,675/27,881). This number should be greater than 2, and the higher the better. It tells whether the potential benefits over the long haul are worth the aggravations caused by the drawdowns.

Another useful value is the adjusted gross profit, in which the largest winning trade is deducted from the gross profit. To penalize the system, do not correspondingly deduct the largest losing trade. The rationale here is not to expect to get the periods with large profits, but that a period of losses comparable to the worst losses in the test period is likely. The profit factor is then recalculated to see if it is still greater than 1. For the data in Table 3.13, the adjusted gross profit is $155,675 - 40,769 = $114,906. The adjusted profit factor is then 114,906/111,244 = 1.03. This is a sharp reduction from the reported profit factor of 2.40. Thus, a more realistic assessment of this system is that it will produce a small net profit over time.

The summary also does not give a histogram of your trades. You may wish to export your data to a spreadsheet to look for the maximum favorable excursion and maximum adverse excursion. These quantities will be explained in chapter 4 with the 65sma-3cc system.

The summary does not give you any feel for the variation in test results. It does not give a standard deviation of trade profits and losses for all trades. The variability is another important item you should calculate, using a spreadsheet if needed. The variation tells you what you can expect for volatility of returns.

You cannot get an idea of how a typical trade evolves in time from the test summary. For example, it does not tell you the average profit or maximum profit or loss on a day-in-trade basis. It does not show what happened on day 1 in the trade, or day 10 in the trade. A typical trade template, by Chande and Kroll, as discussed in *The New Technical Trader*

(see bibliography), would help you understand the time-price evolution of a typical trade.

In addition, the test summary does not give a realistic impact of slippage. The software provides fills in a manner that may not be representative of fills in the real world. It is safer to assume that you will experience greater slippage than the model. In some instances, the software will give you a fill that you could not have obtained in practice. If this happened to be a big winner, you may overestimate trade profitability. Hence, you are better off using the average trade numbers to assess system performance, since they have averaged out the effects over many trades.

The performance summary also does not give any idea of how many successive .v-month periods would have been profitable. For example, it is useful to know how many successive 6-month periods have been profitable over a 5-year period. You could use any time interval you like. This breakdown tells you how quickly you can expect to get out of drawdowns, and is a vital piece of information for your mental approach to trading the system.

The most important factor to recognize is that the test summary does not tell you how the system will perform in the future. Your test results are hostage to your data. You should look below the surface of the results to get a better understanding of your system tests.

Ideally, you should examine the results on a trade-by-trade basis on the charts to understand how your system rules worked. This will reinforce your trading beliefs, and give you a good feel for when the system does or does not work. A study of unprofitable trades often reveals flaws in your logic. Convince yourself that you want to follow this system because its rules make money under market conditions that are likely to repeat in the future. A trade-by-trade review may also strengthen your ability to use discretion in trade entries or exits.

A Reality Check

This section sounds a note of warning before you proceed: Test results are not what they seem. You should recognize that trading systems are designed with the benefit of hindsight. This is true because you know, a priori, what the market has done in the past. Any trading system you design or optimize reflects your view of past market action. You may state your understanding in a generalized way that avoids the dangers of

curve-fitting. However, it is worth recognizing that the influence of hindsight is difficult to eliminate.

It is also important to recognize that past price patterns may not repeat in precisely the same way. Hence, because the exact future sequence of trades is unpredictable, your system may not achieve profits or losses similar to the hypothetical system. It should be easy to conclude that past results are not indicative of future results because neither market action nor trader reaction is predictable.

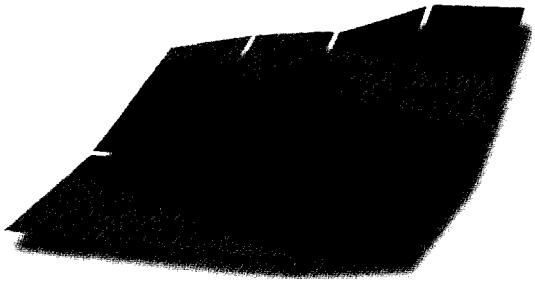
There is another key problem area with simulated trades. Hypothetical trades from a trading system design exercise have not been entered in the markets and do not represent actual trading. They do not accurately reflect the effects of market liquidity, slippage, bad fills, overnight trading, or fast markets. They also do not reflect a trader's psychology accurately since each and every signal is assumed to be executed with identical simplifying assumptions.

You, the trader, are perhaps the most capricious variable in the trading system. Because system testing is performed in an emotional vacuum, there is no assurance that you will execute all signals from a trading system without deviation. Thus, the biggest slippage could occur not in the markets, but at the source if you fail to enter orders as required.

As you will see in chapter 8 on data scrambling, it is possible to encounter market conditions that generate a long string of losing trades or one huge loss. Just because the probability that an event occurs is very small, this does not mean that it will not occur. The usual distribution of trades from a typical trading system has "fat" tails. This simply means that the probability that unusual market conditions will occur is much greater than you might expect from a normal distribution. Hence, system testing results will often underestimate market risks.

Thus, when you design trading systems, be aware that your hypothetical results do not accurately predict system performance in the future. In general, you should view any trading system results with all due caution.

Chapter



Developing New Trading Systems

Don't count your chickens until they are incubated.

Introduction

A trading system is only as good as your market intuition. *You* can formulate and test virtually any trading system you can imagine with today's software. The previous chapters studied the basic principles of system design. This chapter develops and tests several original trading systems to illustrate the application of those principles:

1. A simple trend following system—the 65sma-3cc system.
2. A pattern-based system for long trades only—the CB-PB system.
3. A trend-seeking, strength-of-trend system—the ADX burst system.
4. An automatic mode-switching system—the Trend-Antitrend system.

5. Intel-market systems for correlated markets—the gold bond systems.
6. A system for picking bottoms—a bottom-fishing pattern.
7. A system for increasing bet size—the extraordinary opportunity model.

In this chapter, each case illustrates a different design philosophy. The 65sma-3cc system is examined in the greatest detail; the same principles can be applied to all other systems. Long-term test results with continuous contracts are shown for every system.

This is not a recommendation that you trade these systems. These systems have all the limitations of hypothetical test results. They are discussed here only as examples of the art of developing systems that suit your trading style.

The Assumptions behind Trend-Following Systems

The basic assumptions behind a simple trend-following system are as follows:

1. Markets trend smoothly up and down, and trends last a long time.
2. A close beyond a moving average signals a trend change.
3. Markets do not have large countertrend price swings.
4. Prices do not move too far away from an intermediate moving average.
5. Whipsaws are relatively few and do not cause large losses.
6. Significant price moves last many weeks or months.
7. Markets are predominantly in a trending mode.

The reality of a trend-following system is that:

1. Markets are often in ranging mode with choppy swing moves, so losses in trading ranges are significant.
2. There are large swings in trade equity, since the model "gives back" a large proportion of profits before signaling an opposite trend.

3. These systems need a relatively "loose" stop in order to avoid missing about 5 percent of trades that account for major profitable moves.
4. These systems often enter the market on strength or weakness, so that they can be stopped out during short but vicious countertrend moves.

The advantages of simple trend-following systems are:

1. They provide guaranteed entry in the directions of the major trend.
2. They are profitable over multiple markets and multiple time frames, as long as time frames are 6 months to 5 years in hori zon.
3. These systems are usually robust.
4. These systems have well-defined risk-control parameters.

The 65sma-3cc Trend-Following System

This section discusses how to formulate and test a simple, nonoptimized, trend-following system that makes as few assumptions as possible about price action. It arbitrarily uses a 65-day simple moving average of the daily close to measure the trend. Sixty-five days is simply the daily equivalent of a 13-week SMA (13x5= 65), representing one-quarter of the year. This is an intermediate length moving average that will consistently follow a market's major trend.

As shown in Figure 4.1, when the market is trending up, prices are above the 65-day SMA, and vice versa. In sideways markets, this SMA flattens out and prices fluctuate on either side. Clearly, the trading system picks up and sticks with the prevailing trend (see Figure 4.2).

There are many ways to make the decision that the trend has turned up. The usual way is to use a shorter moving average of, say, 10 days, and decide that the trend has changed when the shorter average crosses over or under the longer moving average. If you decide to use a short moving average, its "length" will be crucial to your results. Another weakness is that often prices will move faster than the shorter moving average, so that the entries can seem rather slow.

Figure 4.1 September 1995 Japanese yen contract showing the 65-day SMA and the signals generated by the system.

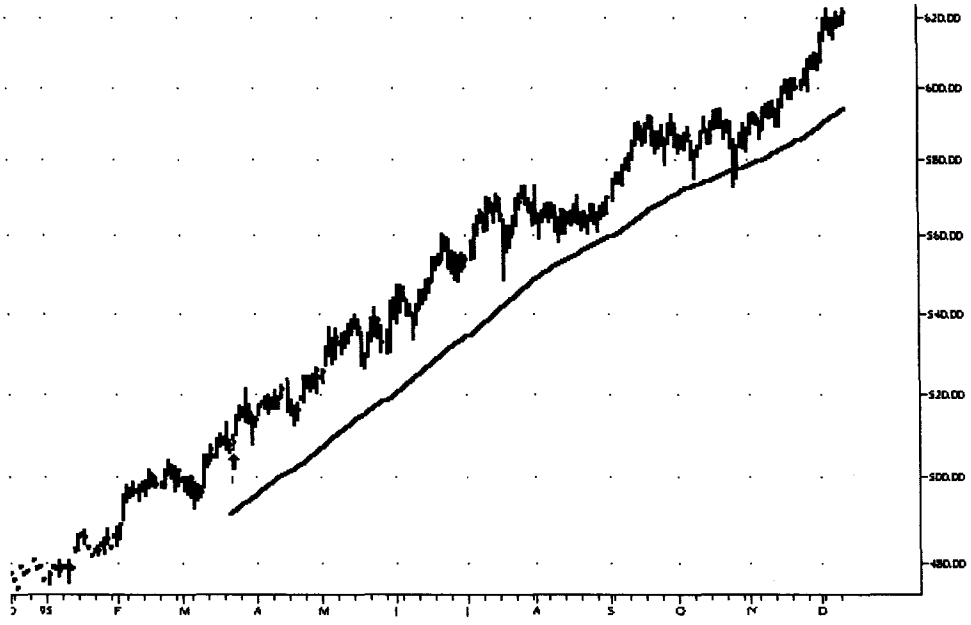


Figure 4.2 The 65sma-3cc system stayed long throughout this major uptrend in the S&P-500 index in 1995.

Hence, the 65sma-3cc system will require three consecutive closes (3cc) above or below the 65-day SMA (65sma) to determine that the trend has changed. For example, the trend will be said to have turned up after three consecutive closes above the 65-day SMA. Similarly, the trend will have turned down after three consecutive closes below the 65sma. Once again, the requirement of three consecutive closes is arbitrary. It could be ten consecutive closes or any other number. Clearly, the results will vary with the number of confirming closes.

If you are afraid of false signals (see Figure 4.3), then the number of closes you use will act like a filter in reducing the number of trades. In a fast-moving market, requiring a large number of consecutive closes will give delayed entries (see Figure 4.4). Conversely, if a market is moving sluggishly, a small number of consecutive closes will give false signals. Thus, there is a trade-off here that determines how quickly you recognize a change in trend.

Once you recognize a change in trend, you still have to decide how to enter the trade. You should enter the trade on the next day's open, to guarantee that you can execute the signal and get a fill. For example, if the three consecutive closes criterion is satisfied as of this evening's close, you should buy at the market on the open of the next trading day. You will get a fill somewhere in the opening range the next day. It is likely that you will be filled near the top of the opening range for buy orders, and near the bottom of the opening range for sell orders. This

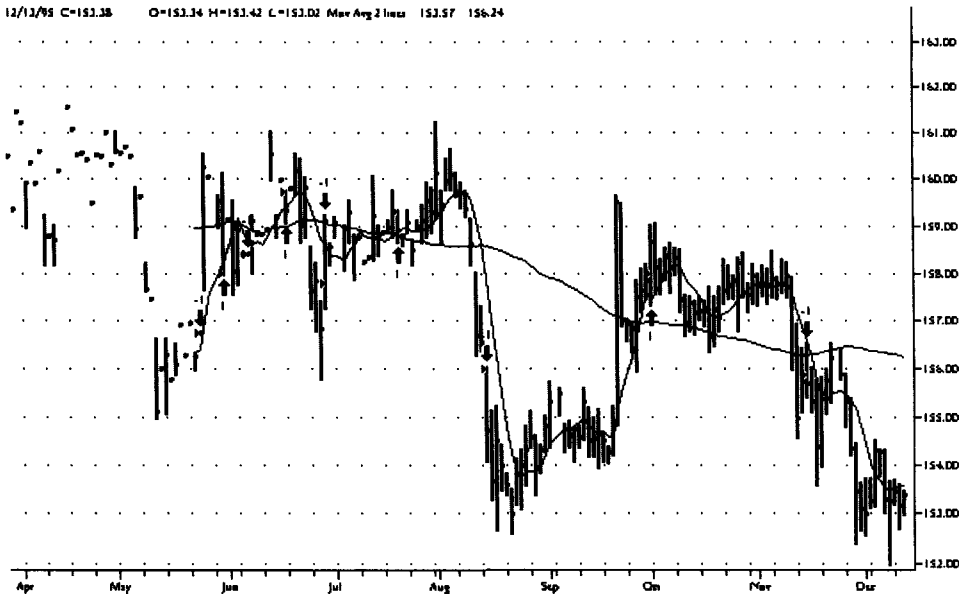


Figure 4.3 The choppy sideways action in December 1995 British Pound generated a string of whipsaw losses for the 65sma-3cc system.

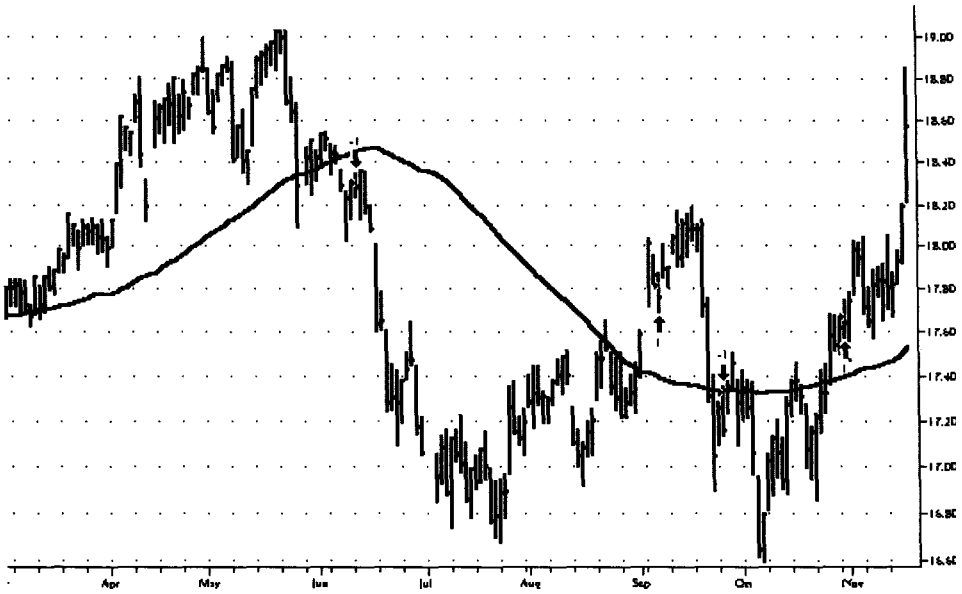


Figure 4.4 These swing moves in December 1995 crude oil produced many trades but small profits because the 65sma-3cc system does not have a specific exit strategy.

slippage should be ignored, and just lumped into your $100 allowance for slippage and commissions. The main effect of this entry mechanism is that you are not filtering out any entry signals, and ensuring that you will put on this position the first time the entry conditions are satisfied.

There are a number of choices on how to actually enter the trade. For example, you could enter the trade on the close of the third consecutive close above or below the 65-sma. A second choice would be to enter the next day on a stop order beyond the previous, or a nearby, high or low. In effect, you would also filter out some entry signals, because you would not get a fill on every signal. This may be useful in situations where prices briefly spike beyond the 65-sma during prolonged trends.

A third entry choice would be to delay entry for *x* days after the signal, and then enter beyond a nearby *n-day* high or low. This is another way to filter down the entry signals in order to find more profitable ones. Note that if you use a limit order for your entries, occasionally you may not be filled at all, missing the entry by just a few ticks. Hence, you should enter on the next day's open to assure an entry into the new trend.

Before we proceed, let us put this entry signal through a critical test to check if the 65sma-3cc entries are better than random. Following the approach of Le Beau and Lucas (see bibliography for details), let us

test the entry signal with exit on the close of the ra-th day, without any stops, and no deductions for slippage and commissions. For simplicity, only the effect of long entries are shown. The proportion of trades that are winners should consistently be more than 55 percent. The test includes the long entry over 21 markets, stretching from January 1, 1975, through July 10, 1995, using a continuous contract. Because not all markets were trading back in 1975, all available data are used.

Table 4.1 shows that, on average, 55 percent of the long entries were profitable, suggesting that the 65sma-3cc model probably does better than random. The result for short trades is similar, and you can be reasonably confident that this model provides robust entry signals. Your task is now to combine this model with risk control and exit methods that match your trading mentality.

Table 4.1 Testing 65sma-3cc long entry for randomness over 21 markets
using all available data between 1 /1 /75 and 7/10/95. Exit on the close of the n-th day.

Market	5 days	10 days	15	20	30	50 days
British pound	55	59	60	58	60	60
Coffee	54	57	56	54	50	51
Copper	51	49	50	52	50	46
Corn	53	55	56	57	59	55
Cotton	60	61	62	63	64	60
Crude oil	54	53	53	56	58	45
Deutsche	59	59	60	58	59	63
Eurodollar	59	59	61	62	63	62
Gold	54	55	54	49	53	47
Heating oil	53	55	58	56	51	51
Japanese	55	53	60	61	59	69
Live hogs	57	57	59	57	55	59
Orange juice	53	52	52	55	55	45
Silver	48	50	45	46	44	46
Soybeans	52	47	51	52	53	51
S&P-500	54	59	58	62	58	69
Sugar	56	56	55	58	57	52
Swiss franc	56	56	59	58	63	61
10-year T-	57	59	59	58	58	56
U.S. bond	55	52	56	50	50	46
Wheat	52	52	51	51	51	51
Average	54.62	55	55.95	55.86	55.71	54.52

To summarize this nonopdmized system, the actual trade entry is at the market on the open of the next trading day after the close of the day the signal is received. You will notice that there are no specific exit signals at this point, which means that the short entry signal is also the long exit signal, and vice versa. In practice this means that if you are long one contract, you will sell two contracts to go net short one contract, and vice versa.

Note that for the tests below we will add a condition to prevent back-to-back entries of the same type. This will allow an apples-to-apples comparison when studying the effect of adding stops or exits. *YOVL* do not need this condition for actual trading.

To summarize what is not defined at this point: There are no specific risk-control rules in terms of an initial money management stop, nor any money-management rules to determine the number of contracts to trade. We will just trade one contract for simplicity without any risk-control stop. This is not a recommendation to trade without a risk control stop; the calculations are done without any stops here to illustrate a point. Later, we will examine how to add risk control and study the effect of money management.

The 65sma-3cc system should make all its profits during strong trends. It should lose money in sideways or nontrending markets. And it should have between 20 and 50 percent profitable trades. We tested this model over 23 markets using 20 years of continuous contract data. If a contract was not traded for 20 years, then we used all available data from the starting date. The usual allowance of $100 per trade for slippage and commissions was made. Thus, this is a rigorous test for a nonoptimized system over a long test period, and across a large number of markets. The results are summarized in Table 4.2.

The results for this simple, nonoptimized trend-following system are encouraging. You could have made a paper profit of $1,386,747 by trading just one contract for each market, and been profitable on 19 of 23 widely diverging markets. The test sample generated 2,400 trades, so this is a highly significant test. Approximately 34 percent of all trades were profitable, a number typical of trend-following systems.

The ratio of average winning to average losing trades was excellent, at 3.3 averaged over the 2,400 trades. This number is useful for calculating the risk of ruin; a number above 2.0 is desirable, and anything over 3 is welcome news. The average trade made a profit of $558, an attractive amount, considering transaction and slippage costs. It is customary to seek a number over $250 for the average trade. The average profit per market was $60,293, approximately 2.74 times the average maximum in-

Table 4.2 Test results for 65sma-3cc trend-following system

Market	Years	Paper Profit ($)	Total Trades	Winning Trades (%)	Average Win/Loss	Average Trade (S)	Maximum Intraday Draw-
British	7/75-7/95	125,34	105	34	3.72	1,193	-25,431
Canadian dollar	6/77-7/95	-12.750	125	25	2.32	-102	-21.030
Cocoa	5/80-7/95	-15.370	101	28	1.80	-153	-2.219
Coffee	5/75-7/95	239.09	120	30	5.83	1.993	-36.956
Copper, high-grade	12/88-	-7.890	49	34	1.48	-161	-17.355
Corn	5/75-7/95	26.081	106	38	2.98	246	-4.331
Cotton	5/75-7/95	112.49	110	38	4.26	1.023	-8.730
Crude oil	8/83-7/95	17.570	74	35	2.58	238	-11.690
Deutsche mark	7/75-7/95	68.575	102	38	2.90	673	-1
Eurodollar	6/82-7/95	34.175	60	25	3.16	569	-7.150
Gold.	5/75-7/95	53.770	121	33	3.44	444	-28.440
Heating oil	7/79-7/95	56.198	103	32	3.89	545	-18.021
Japanese yen	12/76-	143.42	87	47	3.80	1.649	-12.963
Live hogs	5/75-7/95	31.971	120	42	2.49	266	-5.863
Orange	5/75-7/95	13.018	120	27	3.05	109	-27.950
Silver	5/75-7/95	197.30	144	37	6.87	1.370	-51.040
Soybeans	5/75-7/95	62.406	114	38	2.86	547	-21.768
S&P-500	9/82-7/95	-7.260	101	24	3.13	-72	-97.470
Sugar	5/75-7/95	49.493	113	37	3.75	438	-10.806
Swiss	7/75-7/95	108.47	100	40	3.28	1.086	-11.638
10-year T-note	9/82-7/95	34.219	85	29	3.66	402	-1
U.S. bond	1/78-7/95	50,143	102	35	2.62	491	-38,819
Wheat	5/75-7/95	6,263	138	28	2.78	45	-19,663
Total		1,386,7	2,400				
Average		60.293.	104	34	3.3	558	-22.014
Standard Deviation		66.698	22	6	1.17	583	20.342

traday drawdown, of-$22,014. This is a healthy recovery factor, or coverage of the worst losing streak of the system.

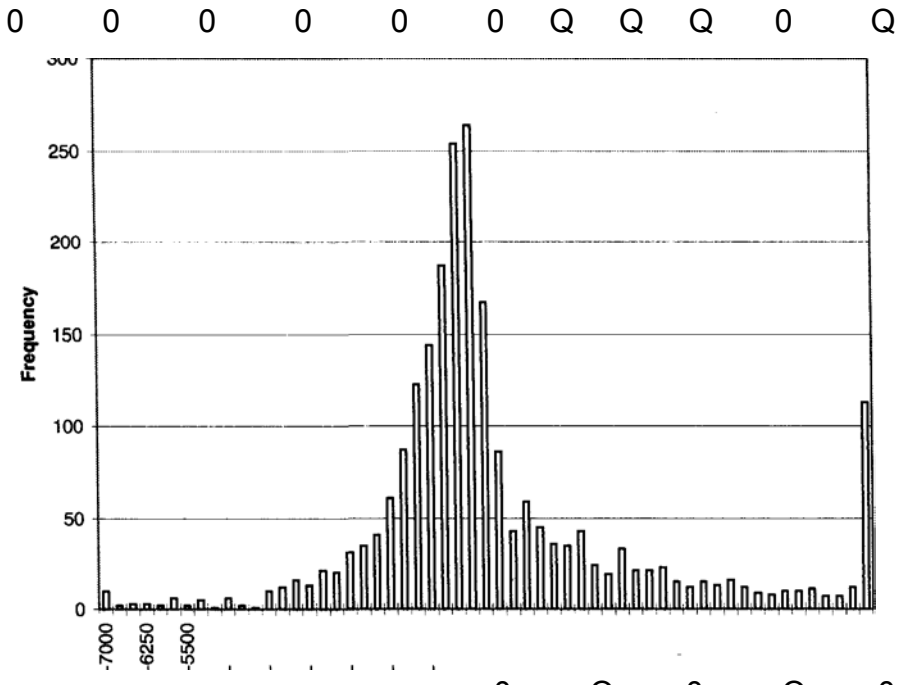
In summary, a simple trend-following approach worked on many markets over a long time period with few assumptions and no optimization.

The results also point out some weaknesses of this system. The average profit per market is 90 percent of the standard deviation of the average profit. This means that profitability varied widely from market to market. The maximum intraday drawdown was 108 percent of its standard deviation, implying that the drawdowns also varied considerably among markets. The standard deviation of the average trade also implies that results can vary substantially over time or across markets. A further weakness is the relatively small number of profitable trades. Thus, we can summarize the principal weakness as a large variability in the results over time and across markets.

Combining the strengths and weaknesses, you would say that this is a sound trend-following system with good chance of being profitable over many markets over a long time period. But because of the large variability in results, you would have to trade this system relatively conservatively. You should allow a large equity cushion to absorb drawdowns.

A look under the hood of this trading system, so to speak, and a closer examination of the results of the analysis reveal further details of

Frequency distribution of 65sma-3cc trades



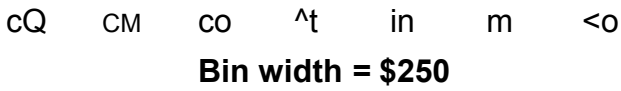


Figure 4.5 Histogram of all 2,400 trades for the 65sma-3cc trading system.

65sma-3cc trades. A histogram of all 2,400 trades shows the distribution of trade profits and losses (see Figures 4.5 and 4.6). There are more large winners than large losers, and many small losers. Remember that these results were calculated without using an initial money management stop. Most of the trades are bunched between -$3,000 and $2,000, with the highest frequency near zero. There are few losing trades worse than -$5,000, balanced by even more trades with profits greater than $5,000. An initial money management stop will clean up the negative part of this histogram.

Thus, it should be obvious that most of the profits come from a relatively small number of trades. In Figure 4.6, 12.5 percent of the trades are seen to have closed-out profit greater than $3,000. Be aware that if you get out too soon, you are likely to miss one of 100 or so (4 percent) of the mega-trades that make trend-following worth the aggravation.

Many measurements follow what is called a standard normal distribution. For example, if you measured the diameter of ball bearings, the

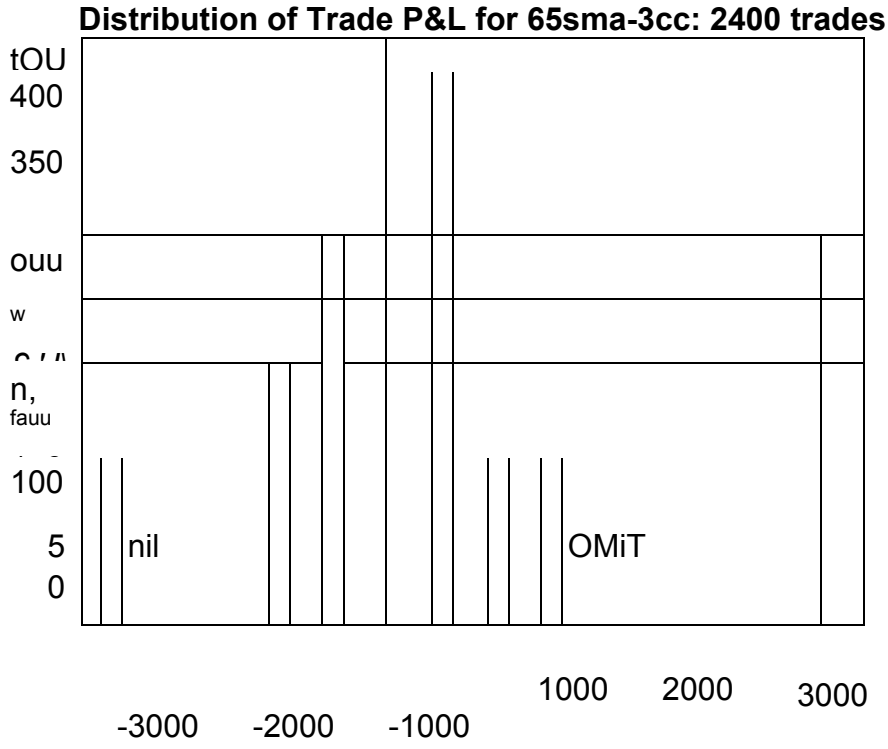


Figure 4.6 A histogram of the 65sma-3cc system over a narrower range of profits and losses. Notice that only a small number of trades show large profits.

measurements will follow a normal distribution. The normal distribution is a bell-shaped probability distribution of the relative frequency of events. The standard normal is a special case of the normal distribution with a mean of zero and standard deviation equal to one. To compare the distribution of the 65sma-3cc trades to the standard normal distribution, we first have to "normalize" the bin sizes. The comparison is shown in Figure 4.7.

The 65sma-3cc curve is more sharply peaked than the standard normal curve. To generate a normal distribution that would fit our data, I used a Microsoft Excel 5.0 spreadsheet and employed an iterative process of manually tweaking the values. The fitted normal curve, with a mean of-0.16 and standard deviation of 0.18 is shown in Figure 4.8. The fitted normal distribution shows that the actual 65sma-3cc distribution has "fat" tails. This simply means that there is a larger probability for the "big" trades than would be expected from the normal distribution. This chart shows that unusually large profits or losses are more likely than might normally be expected.

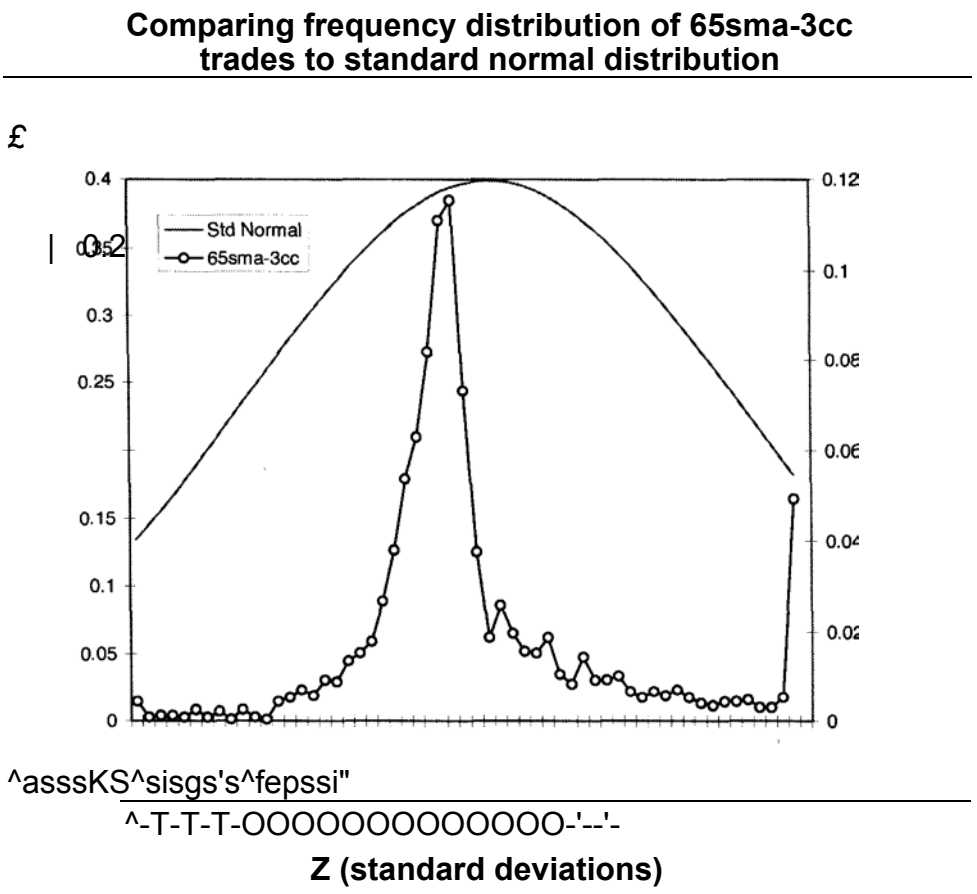


Figure 4.7 The distribution of 65sma-3cc is peaked more sharply than the standard normal distribution.

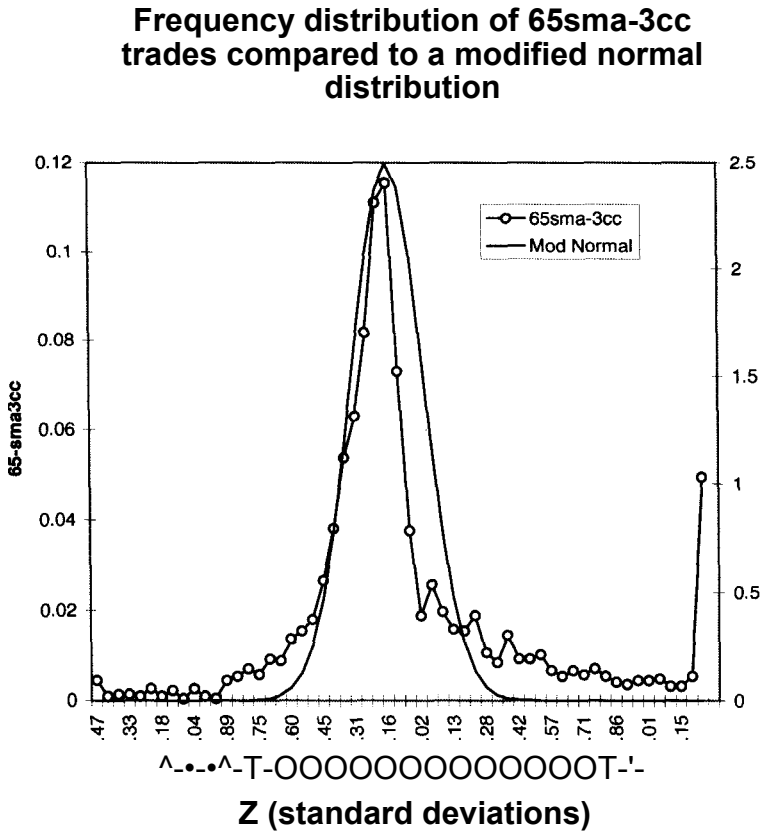


Figure 4.8 A fitted normal distribution shows that the 65sma-3cc trade distribution has "fat" tails, and falls off more quickly for small positive trades.

The modified normal distribution fits the observed curve nicely on the losing side, but the small positive trades fall off sharply. This implies that you will not get very many small positive trades with a trend-following model. Small trades will occur during broad consolidations, and these are not very common. Small losing trades are more likely during consolidations, as shown by the good fit on the left side of the peak.

The huge spike at the right-hand edge of the Figure 4.6 represents the 4 percent or so of mega-trades that make trend following worthwhile. The distribution shows you it is easy to miss these trades, and if you do, your portfolio performance will drop off quickly. You should try to develop such a frequency distribution curve for your own systems to get a better feel for model performance.

A closer look at losing trades reveals another weakness of the 65sma-3cc system. Figure 4.9 is a distribution of the maximum profit of each of the 1,565 trades that were closed out at a loss, called the maximum favorable excursion (MFE). The glaring weakness is that because there is no specific exit strategy, many trades with profits greater than

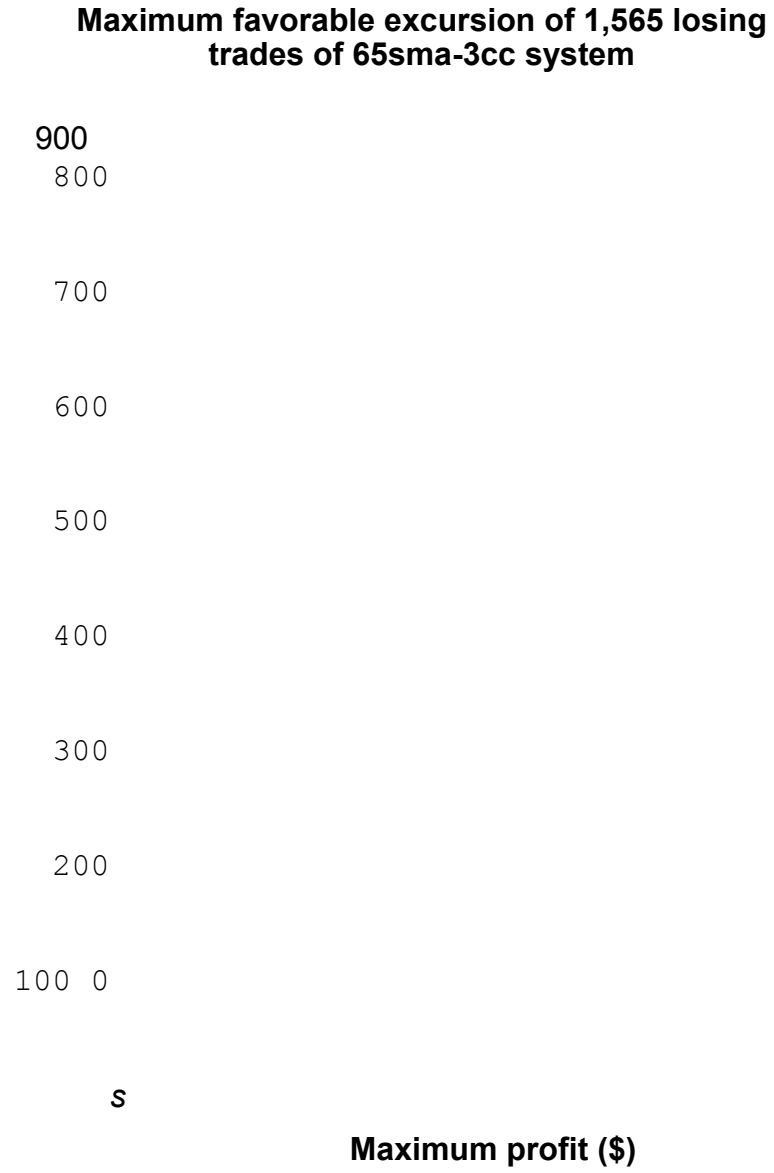


Figure 4.9 A histogram of maximum profit in 1,565 losing trades over 20 years and 23 markets from the 65sma-3cc system. This is a maximum favorable excursion plot.

$3,000 were eventually closed out at a loss. However, we have to be careful with our exit strategy, since only 4 percent of the trades were mega-winners. If we are not careful, we may lock in some profits from losing trades, but lose out on the truly big winners. Another way to use the information from the maximum favorable excursion plot is to select the profit point at which to move your trailing stop to break-even. For example, you can move your stop to break-even after a $2,000 profit and capture a significant proportion of losing trades.

^bu can also use the maximum adverse excursion plot to set profit targets for scaling out of large positions. For example, if you were trading ten contracts, you could sell some at each of the profit targets

of $500, $1,000, $2,000 and $3,000. We continue our analysis by examining the maximum drawdown in 777 winning trades following John Sweeney (see bibliography for details). This drawdown is on an intraday basis. These trades show some loss, but were eventually closed out at a profit. The histogram (Figure 4.10) reveals several interesting insights.

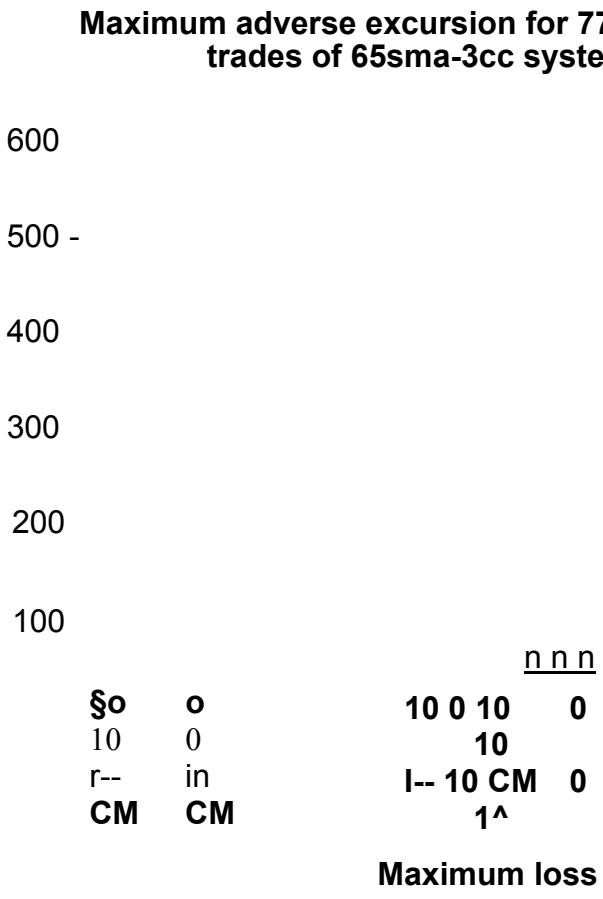


Figure 4.10 Analysis of 777 winning trades: maximum loss in trades that were closed out at a profit. This is also known as the maximum adverse excursion plot.

About 500 (64 percent) of the trades were immediately profitable, with a loss during the trade of less than -$250. Another 100 trades showed drawdowns of less than -$500.

Thus, almost 77 percent of the trades showed a loss of -$500 or less during their evolution. There were very few trades that showed losses greater than -$1,750 and then closed out at a profit. This suggests that we could set an initial stop at $1,000 and capture almost 88 percent of the winning trades. This is a realistic way to pick the point at which a mechanical initial money management stop could be placed.

The same information can be viewed as a cumulative frequency chart to see how many trades achieved a certain profit target (see Figure 4.11). This type of chart shows what proportion of trades had a maximum favorable excursion of, say, $500. It shows, for example, that 50 percent of trades had reached a $1,000 profit target, and so on.

In summary, the 65sma-3cc system test over 20 years of data and 23 markets showed it is a robust and profitable system that makes money in trending periods. Since we tested the system without any

initial

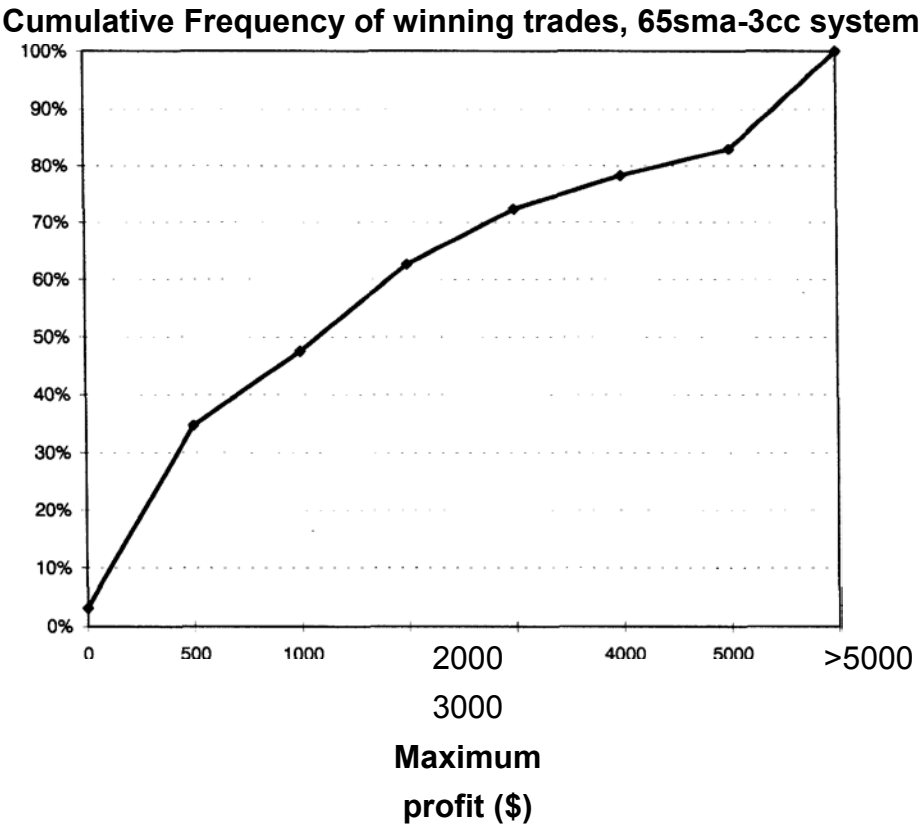


Figure 4.11 Cumulative frequency of maximum favorable excursion of 65sma-3cc system. Note that horizontal scale is not linear.

money management stop, there were several trades with losses greater than -$3,000. We can try to clean this up by placing a stop at $1,000, as shown by the MAE plot. The detailed analysis showed several profitable trades that were closed out at a loss. We would like to minimize such trades. There were about 4 percent truly huge trades with profits in excess of $5,000. We must find an exit strategy that does not miss out on such mega-profits.

Effect of Initial Money Management Stop

Since the initial test of the 65sma-3cc model was encouraging, we can now do more testing. The first item of business is to insert an initial money management stop into this model. Our detailed analysis of the *MAE* showed that we could safely set bur stop at $1,000, or even as high as $1,750, and capture substantially all profitable trades.

However, we should insert another condition into the formulation of the model before testing for the effect of initial stops. If our stop is too "tight" during testing, we will be stopped out right after the first signal. Then, there may be a succession of trades, all in the same direction (all long or short signals), that will also result in losing trades, before one of them kicks into the major trend. Thus, the analysis would be distorted. What we want is to pick off exactly the same trades as we did without any initial stop. To achieve this goal, we must insert rules that do not allow successive trades of the same type, to ensure that we will not have two back-to-back long or short trades if we get stopped out after the first signal. In effect, with this rule, if we get stopped out, we must wait for the opposing signal before getting in. Of course, you do not need this condition for actual trading.

Inserting an initial condition should have two effects. (1) It should reduce the maximum intraday drawdown, since some potentially large losing trades will be cut off. (2) It should also reduce the number of profitable trades and the total paper profit, since the same stop will also cut off some potentially profitable trades. Some calculations will show if we can verify these expectations.

The results of these calculations are shown in Table 4.3, which can be compared to the results in Table 4.2. The markets and test periods are identical in both tables. Adding a $1,000 stop reduces total paper profits by 21.5 percent, from $1,386,747 to $1,088,804. Similarly, the number of winning trades fell to 689 from 810, or by 17.6 percent. As expected, the average maximum drawdown and its standard deviation also decreased, showing the desired smoothing effect due to the initial stop. The reduction was about 18.5 percent in the drawdown, and 40 percent in the standard deviation. Thus, adding a hard dollar initial money management stop had the desired effect of reducing drawdown and smoothing out the variation in system performance. There was also a resultant reduction in total returns.

We chose the $1,000 initial money management stop from the MFE plot. Calculations for a $500 stop result in an even greater reduction in profits, drawdown, and volatility.

We can continue this line of thought by looking at the U.S. bond and deutsche mark markets. Our analysis of 777 profitable trades showed that once the drawdown exceeded -$1,750, few trades ended with a profit. Hence, the initial stop is varied from $250 to $1,750 in the following tests to look at the effect on the total number of profitable trades. As the initial money management stop increases, the number of profitable trades increases and then levels off (see Figure 4.12, page 90). This shows that the initial stop acts as a filter, and as the stop widens, it

Table 4.3 Effect of adding a $1,000 initial money management stop to the 65sma-3cc system

Market	Paper Profit ($)	Winning Trades	Average Trade (S)	Maximum Intraday Drawdown (S)
British pound	121,325	28	1155	-18,100
Canadian dollar	-8.490	32	-68	-17.080
Cocoa	-9.670	29	-96	-17.110
Coffee	203.719	23	1698	-24.953
Copper, high-	478	17	10	-9.175
Corn	26.525	41	250	-4.175
Cotton	99.695	39	906	-7.810
Crude oil	8.290	24	113	-10.410
Deutsche mark	69.100	34	677	-6.675
Eurodollar	1 7.875	21	298	-5.225
Gold, Comex	36.850	37	305	-36.960
Heating oil	16.760	24	163	-22.328
Japanese yen	106.388	33	1222	-12.963
Live hogs	29.970	50	250	-5.609
Orange juice	20.435	32	170	-22.188
Silver	143.165	29	994	-47.710
Soybeans	47.281	38	415	-23.806
S&P-500	29.975	14	297	-47.295
Sugar	32.044	34	283	-8.582
Swiss franc	55.638	27	556	-14.975
10-year T-note	30.407	22	358	-8.606
U.S. bond	2.706	22	26	-22.700
Wheat	8,338	39	60	-18,331
Total	1,088,804	689		
Average	47.339	30	436	-17.946
Standard	53,800	9	465	12,301

allows more trades to pass through. Eventually, the filter is too big, and does not cut off any trades. This allows the number of profitable trades to level off.

We have so far placed our stop using a dollar figure without accounting for market volatility. However, whereas in the coffee market, a $1,000 stop may seem too tight, in the corn market it may seen too wide. Thus, in some markets, a given stop will work like a stop near the left edge of Figure 4.12, and, conversely, in other markets, the same dollar stop will work like a stop on the right side of the figure.

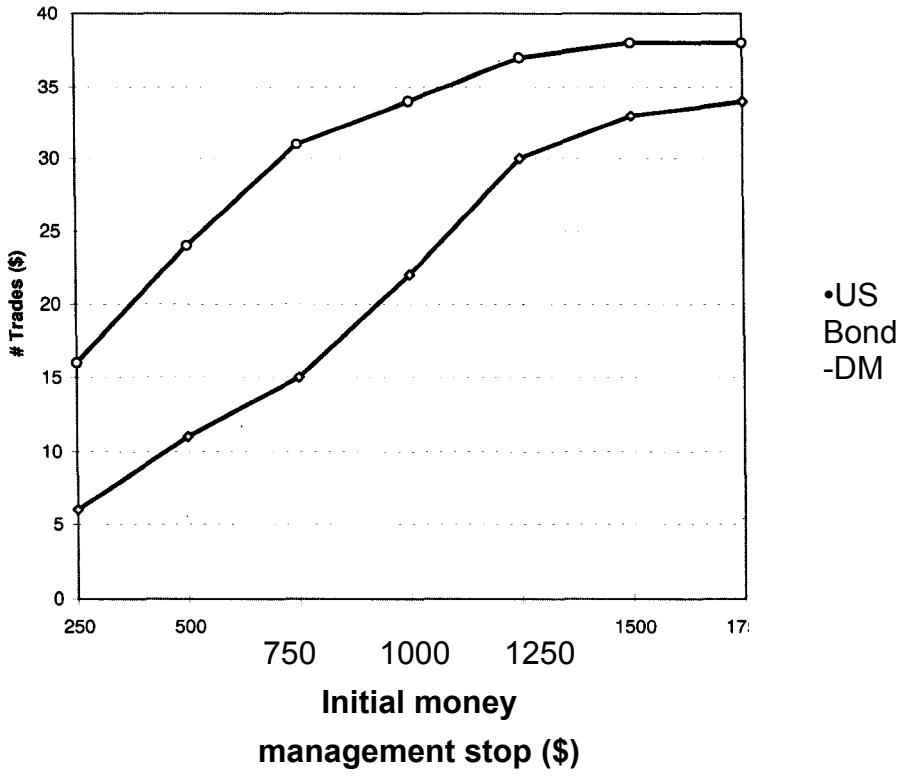


Figure 4.12 Effect of initial money mangement stop on number of profitable trades. As the stop tightens, fewer and fewer profitable trades survive. The upper line is for the deutsche mark and the lower line is for the U.S. bond market.

We can get around this problem by using a volatility-based initial money management stop. For our calculations, we can set an initial money management stop as a multiple of the 15-day SMA of the daily true range for measuring volatility. We use the same continuous contracts as in Table 4.2 to test the U.S. bond market with volatility-based stops ranging from 0.25 to 3.0 times the 15-day SMA of the daily true range.

Figure 4.13 shows that a stop set at less than 1.25 times the average volatility is too tight. Once the stop increases past 2.00, the paper profit increases and the drawdown increases. The drawdown is minimized at a 1.50 stop. This means there is a balance between being too tight or too loose. The same behavior can be seen very nicely in the live hogs market (see Figure 4.14, page 93).

As might be expected, when we increase the money-management stop, the largest losing trade will probably increase. This happens because our stop is farther and farther away from the entry price. The sugar market shows this nicely (see Figure 4.15) when tested over the

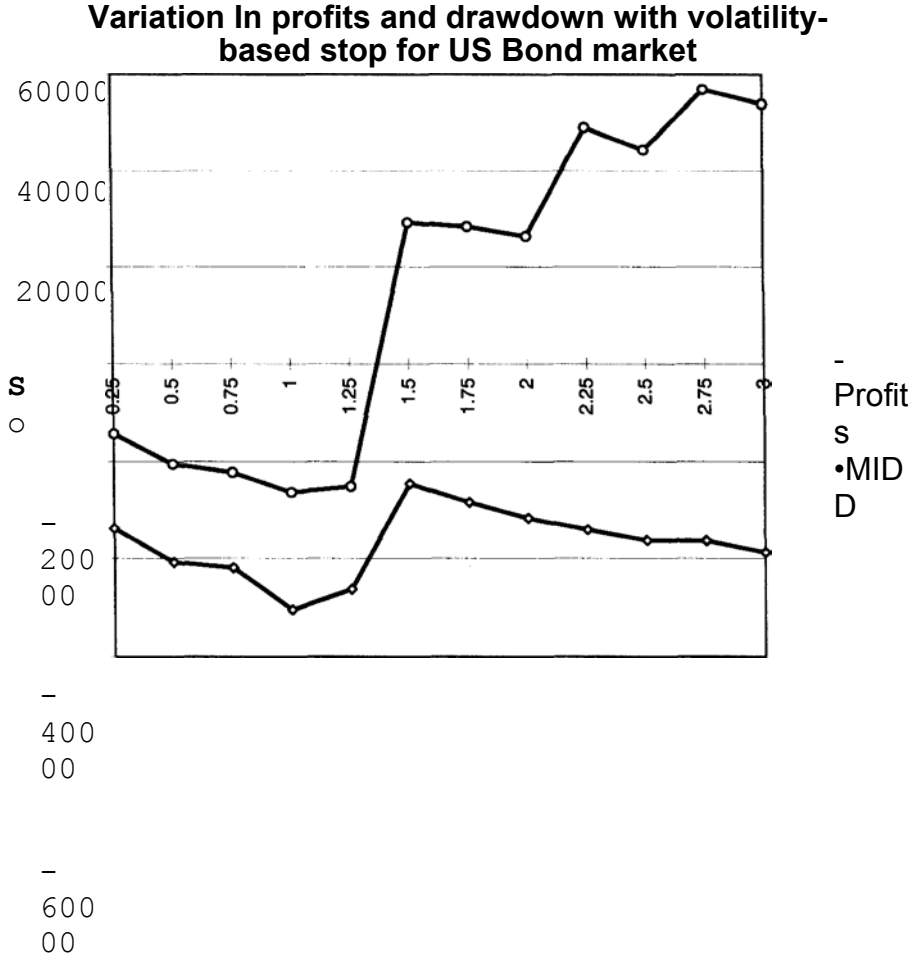


Figure 4.13 The profits (upper line) increase as the initial money management stop is loosened. Eventually, the stop is too wide and profits begin to level off. The lower line is the maximum intraday drawdown. Data are for the U.S. bond market.

same period as Table 4.1. Other calculations (not shown) show that the largest winning trade is affected only a little by the initial stop, since these trades usually are profitable from the very beginning. *You* may set a volatility-based stop or a hard-dollar stop with equivalent results. You may have to set a different dollar stop for each market, although you could use the same volatility stop across all markets. Note that with a volatility stop, the actual dollar amount changes over time, aad hence you must ensure that this stop is within your overall hard-dollar limits for risk control.

You should note some limits on how the initial money-management stop can be tested. In most cases, the amount of the stop must be larger than the daily trading range. The software cannot determine if your stop could have been hit intraday if the stop is smaller than the

daily trading range. Unless you have intraday data, you cannot test the effect of, say, a $250 stop using daily data.

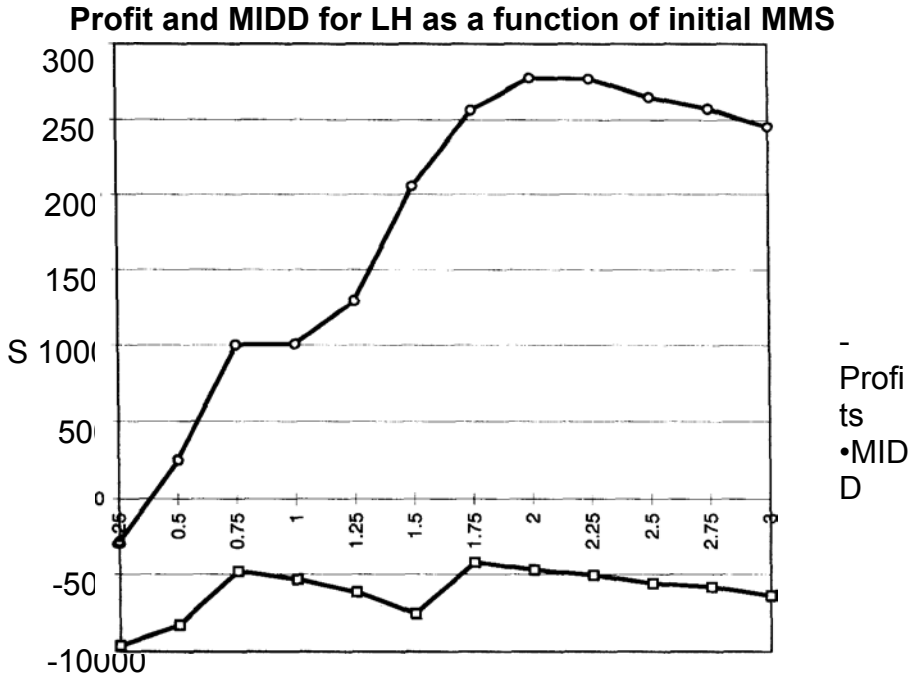


Figure 4.14 The profits (upper line) increase as the initial money management stop is loosened. The lower line is the maximum intraday drawdown. Data are for the live hogs market.

In summary, adding an initial money-management stop is useful from a risk-control point of view because it reduces the largest losing trade and the maximum drawdown. But, it also cuts off some winning trades, and hence total profits are lower over the long term. *You* may add a dollar stop or a volatility-based stop, but both must follow sound guidelines.

Adding Filter to the 65sma-3cc System

So far, we have let the trading system generate pure signals without trying to filter the signals in any way. As we have seen, this system will generate many short-lived or "false" signals when a market is in a consolidation region. A filter is simply a set of rules that will try to refine the entry signals. By design, this system is always in the market. Remember that we do not have a specific exit strategy, and the long entry signal is

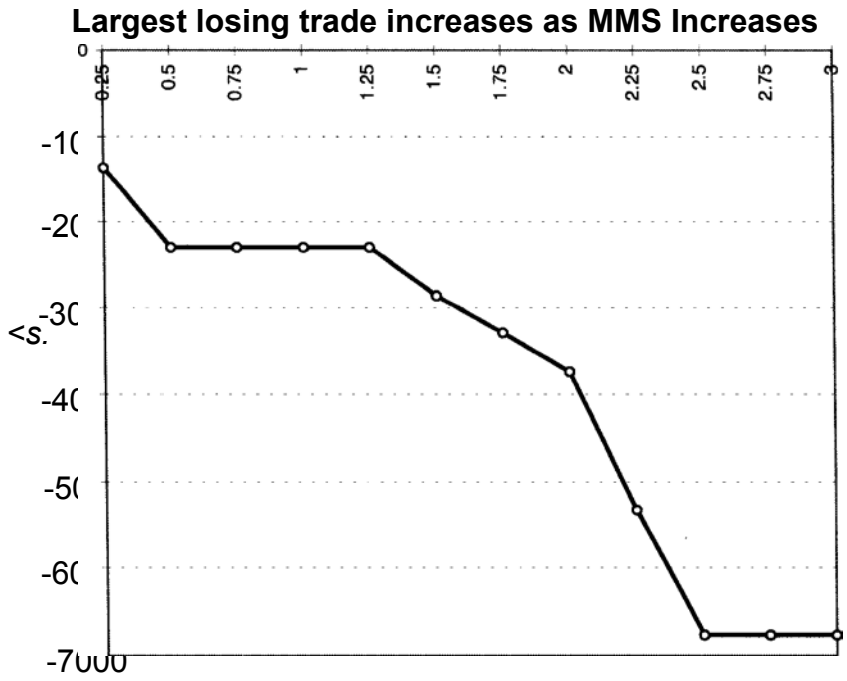


Figure 4.15 Largest losing trade for sugar using the 65sma-3cc trading system increases as the volatility-based initial money management stop increases.

also the short exit, and vice versa. At this stage, the goal of the filter is only to reduce some of the signals in a congestion area.

You can design many types of filters. Here we use a momentum-based filter using the range action verification index discussed earlier. The RAVI is the absolute percentage difference between the 7-day and 65-day simple moving averages of the daily close. This n-eans that when the market is in a congestion or consolidation phase, th • short (7-day) and long (65-day) moving averages tend to be close together. Conversely, when the markets are trending, these averages are far apart.

You can also use Wilder's ADX (average directional index) as a filter for trending or nontrending markets. Specifically, if the ADX is declining, and/or below 20, then you can assume that the market is consolidating or entering a congestion phase. You could also use the .r-day high-low range, or other momentum oscillators, to diagnose market conditions. Remember that any indicator you use, including the RAv^I, will not work perfectly every time.

First, let us briefly review the performance of 65sma-3cc trading system in consolidating markets. As prices begin to trade in a narrow

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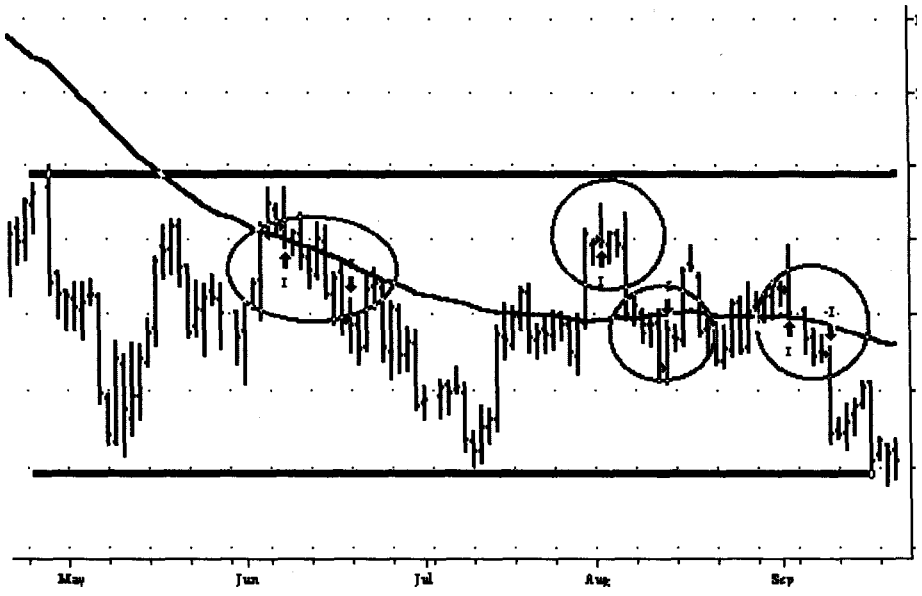

Figure 4.16 The 65sma-3cc trading system generated several entry signals as the U.S. bond market consolidated after its now-famous bear market tumble. The circled areas show the six signals—three long entries and three short entries—in this broad consolidation region.

range, without a definite direction, the longer moving average (65sma) flattens out. Prices oscillate on either side of this average. Hence, you can get a succession of long and short signals as the market posts three consecutive closes above or below the 65sma.

In some sense, this becomes a self-correcting process, because the entry signals are not very far apart in price. Hence, even though you will have several losing trades in succession, the amount of the losses will be relatively small. *You* can imagine that in some cases the market will trade within a broad trading range, with sharp, but quick moves in '30th directions. The U.S. bond market has a tendency to

form such consolidations. This is a worst-case scenario for the 65sma-3cc system because you will get short-lived entry signals but incur relatively large losses, since the market is making choppy moves that quickly span the trading range. Some examples of such market action follow.

Figure 4.16 shows the September 1994 U.S. bond contract consolidating after its now-famous bear market. Observe the six "false" signals from the system. Since the market was in a broad trading range, and prices were moving about on either side of the average, the false signals are inevitable given our definition of the trading system. This is a good illustration of a general principle: Whatever conditions you define, markets can always find ways to trigger false signals.

Figure 4.17 shows the results of the same trading system with a filter. Now there are only two trades in the congestion region. The RAVI is plotted under the prices, so you can see that the signals occurred in regions where the RAVI was greater than 1. Since the model was already short coming into the picture, the first trade is a buy. The filtered model could generate a buy signal only if RAVI was greater than one and there were three consecutive closes above the 65sma.

A tight consolidation region developed immediately after the buy signal, dropping the RAVI below 1. Hence, this filtered out the next two signals, a sell and then a buy. Similarly, it also filtered out a buy signal and a sell signal in June. The last sell signal occurred when the RAVI climbed above 1 and there were three consecutive closes below the 65sma. Thus, we used the level of the RAVI to filter out some whipsaw signals.

What should be the barrier value for the RAVI to filter out signals? There is no perfect answer to this question; you will have to pick a value using one method or another. Raising the RAVI barrier to 1.5 from 1 will filter out even more trades. As Figure 4.18 shows, this model would have been short from the previous October 1993, all the way down and through two major consolidation areas, for a per contract profit of $13,696. Notice how the RAVI rose strongly above 1 when the trend

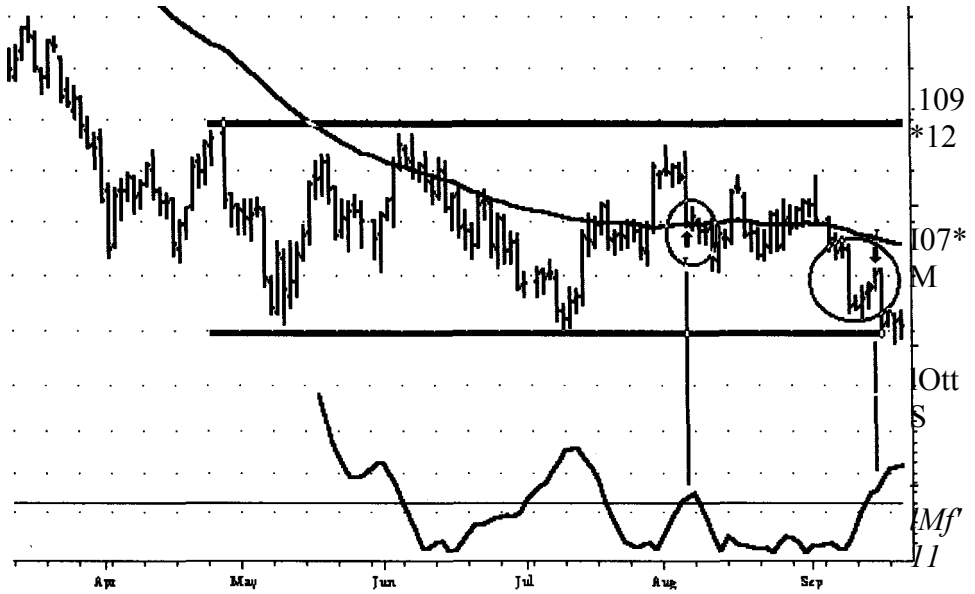

Figure 4.17 Adding a RAVI filter with barrier equal to 1.0 eliminates four of the six false trades in this broad congestion region. Notice that the 65sma-3cc model is fired only if RAVI is greater than 1 in both remaining instances.

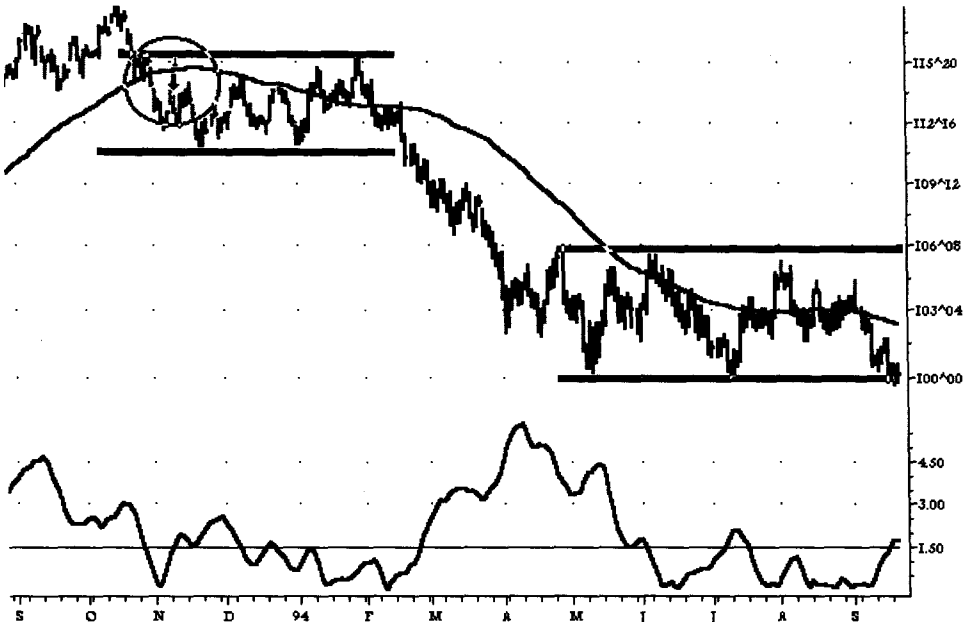

Figure 4.18 Increasing the RAVI filter barrier to 1.5 eliminates even more trades.

gathered strength, peaking just before the start of the lower consolidation phase.

These figures illustrate that you can use a filter to reduce the number of trades from a trend-following model. You can use different filters, and for a given filter you can use different barrier levels. Note that this system still is in the market at all times: either long or short.

By now, the effects of adding a filter should be clear: (1) We filter out some false signals; (2) we can reduce the maximum intraday drawdowns; (3) we can improve the profit factor of a system, i.e., the ratio of gross profit to gross loss over the test period; (4) the average trade usually increases; and (5) the length of the average winning trade increases. Our results will depend on how we choose the filter and its barrier level.

These comments can be supported with more data. Table 4.4 shows the results of calculations for adding a 0.5 percent RAVI filter to the 65sma-3cc model with a $1,000 initial stop and $100 deducted for slippage and commissions for 14 arbitrarily selected markets. These markets are a broad basket of softs, grains, metals, energies, currencies, and index and interest rate contracts. *You* can compare them to Table 4.2 for an estimate of their performance without stops or filters.

Table 4.5 shows the effect of the 0.5 percent RAVI filter on the dollar value of the average trade. The filtered system has a higher average trade, reflecting the improved quality of the entries.

Table 4.4 Effect of adding a filter of RAVI = 0.5 to the 65sma-3cc system;
filtering reduces the number of trades

Market	Test	Paper Profit ($)	Numbe of (Filtere	Numbe of Winner (Filtere	Number of (No Filter)	Number of Winner (No Filter)
British	2/75-7/95	111,10	80	10	102	13
Corn	2/75-7/95	26.613	81	35	105	41
Crude oil	3/83-7/95	2.150	63	18	73	22
Deutsche	2/75-7/95	49.613	81	28	103	34
Eurodollar	2/82-7/95	11.775	14	3	60	20
Gold	2/75-7/95	36.690	95	30	120	38
Silver	2/75-7/95	152.58	107	23	143	28
S&P-500	4/82-7/95	59.310	80	10	102	13
Sugar	2/75-7/95	29.055	102	31	112	33
U.S. bond	8/77-7/95	31.588	71	19	102	22
10-vear T-	5/82-7/95	16.750	50	12	85	21
Wheat	2/75-7/95	-2,040	111	36	137	38

Tables 4.4 and 4.5 show that as you filter a trading system, the number of trades decreases, the average trade increases, and the profit factor improves. These results are sensitive to the filtering rules. You can choose to filter a system many different ways. For example, you can use

Table 4.5 Adding a filter increases the average trade

Market	Average Trade (No Filter) (S)	Average Trade (Filtered) (S)
British pound	1,269	1,543
Corn	231	329
Coffee	2.783	3.488
Crude oil	-66	34
Deutsche mark	699	613
Eurodollar	221	841
Gold. Comex	323	389
Silver	1.014	1.426
S&P-500	406	741
Sugar	253	284
U.S. bond	56	449

the ADX instead of the RAVI. Again, you have to make trade-offs in every choice you make.

In summary, we took the 65sma-3cc trend following system and tested its performance over 20 years of data and 23 markets. Then, we analyzed the winning and losing trades to select an initial money management stop. We filtered the system to reduce the number of signals. We used a "one-way" model, which does not allow back-to-back long or short trades. The main advantage of using a one-way model for testing is that it allows an apples-to-apples comparison of changes in trading strategy. *You* do not need this restriction for actual trading.

We have not tried to manage the equity curve in each of our analyses; the system was allowed to run to maximize profits. However, this system was always in the market. If we add a neutral zone, the system will not be always in the market. We can also consider adding one or more exit rules to get a smoother equity curve. With a bit of luck, the exit strategy will also create a neutral zone.

Adding Exit Rules to the 65sma-3cc System

Selecting general and powerful exit rules is a difficult challenge in system design because the markets exhibit many different price patterns. One form of exit that is particularly easy to implement is the initial money-management stop. If the stop is hit, you exit the trade, no questions asked. However, taking profits is another matter, since you must design reentry rules should the trade continue on after meeting your exit criteria.

In the 65sma-3cc system, the approach of using entry rules as exit rules does catch long trends, but at the cost of wide swings in account equity. Hence, including exit rules tends to smooth out the equity curve. If possible, you should trade multiple contracts in each market, assigning one or more contracts to each exit rule. This allows you the luxury of not having only one "best" exit strategy.

As an alternative to the entry-triggers-exits approach, you can consider many exit strategies. One simple rule is to use a fixed-dollar trailing stop. In this case, you will set a stop, say, $1,500 away from the point of highest equity in the trade. Instead of a fixed-dollar stop, you can use a volatility-based stop, which sets a stop some multiple of the true-range away from the point of highest trade equity. Yet another exit strategy is to use a time-based stop, such as the price extremes of the last w-days. Another effective exit strategy is to exit on the close of the w-th day in

the trade. For example, you could exit on the close of the fifth day in the trade. This approach works nicely if you can trade multiple contracts, and arrange to close trade from say the fifth through the twenty-fifth day in the trade.

If you use exit strategies without an effective reentry strategy, you will miss significant moves. Hence, it makes little sense to use a trend-following strategy and then to cut off trades with a sensitive exit strategy. Exit strategies offer many opportunities for discretionary approaches. Hence, if you wish to use discretion, exit strategies are a good place to focus your attention.

An example of the effect of adding a 14-day exit to our 65sma-3cc model run with a 0.5 percent RAVI filter and a $1,000 initial money-management stop is shown in Table 4.6. The trailing exit closes out a trade if prices exceed the previous 14-day range. For example, if long, we would exit a trade tomorrow on the open if today's close is lower than the lowest low of the last 14 days. This is a trend-following exit that should get you out near the end of a major trend, with the criterion being a 14-day reversal in prices.

Adding an exit condition decreased the days in market by 45 percent on average. At the same time, you can confirm that the profitability and maximum drawdown decreased also. Any investments you make in money market instruments during the time that the system is out of the

Table 4.6 Effect of adding an exit on number of days in the market

Market	Profit ($)	Maximum Intraday Drawdown ($)	Days in Market, All Trades (With Exit)	Days in Market, All Trades (No Exit)
British pound	38,788	-12,350	1,070	2,609
Coffee	227.610	-29.500	880	1.692
Corn	8.125	-$4.544	2.086	4.790
Crude oil	8.250	-$7.680	1.446	2.718
Deutsche mark	25.887	-$7.275	1.851	3.863
Eurodollar	-2.450	-$7.874	335	2.000
Gold. Comex	24.130	-$7.080	2.034	4.170
Silver	44.970	-32.410	1.506	3.459
S&P-500	2.490	-29.640	460	1.290
Sugar	10.386	-$7.854	1.991	4.591
U.S. bond	17.925	-20.887	1.218	1.689
Averages	36,919	-15,190	1,352	2,988

market will add to your total return. Thus, as you make the model more restrictive, the overall profitability is restricted also. Your choice in this case is governed by your preference for a smooth equity curve versus growth in equity.

Channel Breakout-Pull Back Pattern

This section discusses a trading system based on a pattern observed in mature markets, that is, markets with a large volume of institutional activity. In these markets, the big players have a tendency to fade market moves. Thus, they will resist advances and support declines. For example, when a market makes a new 20-day high, many big players will short it heavily, and push the market back into the previous consolidation. If the fundamental forces underlying the market are strong, the up trend will resume after a brief consolidation. A trading system that trades the long side only, by going long during the pull back after new 20-day highs, is called the channel breakout-pull back (CB-PB) system.

We begin with a few examples of how the CB-PB system works, and show the actual code used for the tests. Next, we test the basic CB-PB entry strategy across 22 markets to illustrate the general validity of the idea. Then, we discuss three different exit strategies to show how you can convert the same entry strategy into vastly different trading systems. These systems vary from a short-term system, which is in the market for 7 to 9 days, to a long-term trend-following system. We will also explore the effect of using a $1,500 "close" initial stop versus a $5,000 "wide" stop. The analysis focuses on the following mature markets: coffee, Eurodollar, Japanese yen, Swiss franc, S&P-500, 10-year T-Note, and the U.S. bond.

The channel breakout-pull back pattern is for long trades only. The assumptions underlying this system are:

1. The market will begin an uptrend after the consolidation ends, because it has recently made a new 20-day high.
2. The entry during the consolidation is a low-risk entry point.
3. Exits could be placed at the nearby 20-day high, by using trailing stops, or by exiting after .r-days in the trade.

The reality is that markets may have an extended consolidation after making a new 20-day high, or could even make new 20-day lows.

Hence, a bias to the long side may be correct only 50 to 70 percent of the rime. It is also difficult to find consistent exits, since the markets do not follow the same script every rime. Hence, another difficulty with the CB-PB system is finding a consistent exit strategy. A third area of difficulty is where to place the initial stop. If the market rolls over and starts a new downtrend, then an initial stop is critical for risk management and loss control, whether it is a simple-dollar stop or a volatility-based stop.

The first example of the CB-PB pattern uses the March 1995 deut-sche mark contract. Figure 4.19 shows the daily bars and, superimposed on the bars, the 20-bar trading range. The 20-day range lines have a 13-rick barrier added to both the lines to filter out some false breakouts. The chart shows that the deutsche mark broke above its 20-day range in December 1995 and then consolidated for 7 days before moving higher. Upon moving higher, it made a higher high, and consolidated again.

Ideally, we would like to buy some rime during the pullback, but we do not know how long the pullback will last. Hence, the problem is how to specify that a pullback has occurred. During the pullback, markets often also make new 5-day lows. Hence, we can define this breakout and pullback long entry rule as follows: the market must make a new 20-day high, and then define a 5-day low in the next 7 days. Once it forms a

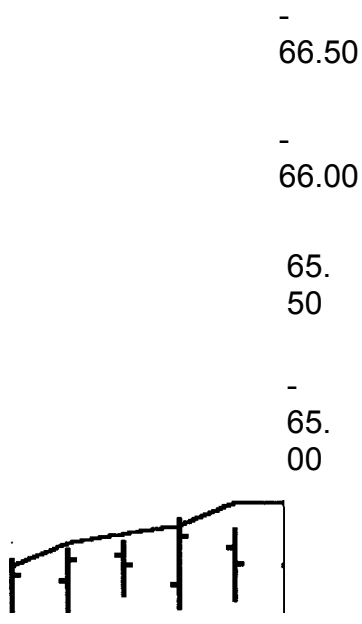

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Figure 4.19 The deutsche mark pulls back after making a new 20-day high. The goal is to buy after the pullback. The 20-day price channel is shown for visual reference.

5-day low, buy on the open the next trading day. These choices are arbitrary, and you can experiment with these numbers. For example, we can buy on the close instead of on the open after the market forms a 5-day low following a 20-day high.

We now need an exit condition to evaluate this entry rule. To keep it simple, we will exit on the close of the w-th day in the trade, with *n=5* for short-term systems and *n=50 for* intermediate systems. Again, these numerical values are arbitrary. *You* may try other values, such as a 3-day low instead of a 5-day low.

Using the Omega Research TradeStation Power Editor™, the rule appears, in part, as:

```
Input: Xdays (14);
If Highest Bar(High,20)[1] < 7 and Low < Lowest
   (Low,5)[l] then buy tomorrow on the
open:
If BarsSinceEntry - Xdays then exitlong at the close:
```

The first line defines "Xdays" as an input-variable with a default value of 14 days. You can change this value during testing. The Highest Bar function returns the number of bars (trading days) since the 20-day highest high. The second line first checks if 7 or fewer days have elapsed since the new 20-day high. Then, it checks if today's low is lower than the previous 5-day low (i.e., a new 5-day low). If both conditions are true, then you can buy tomorrow on the open. By default, this system will buy one contract. The third line is the exit condition, which says that if today is the r-th day since entry, then exit the long trade at the market on the close. This system will fill the long trade at the opening price of the entry day, and at the closing price of the exit day.

There is a quirk in how the Highest Bar function works. The function counts 20 days back from the day it is testing. Hence, the function will occasionally give a signal that does not work off the highest high as intended. Hence, to accurately pick off the highest high of the last 20 days, the rule should say Highest Bar(High,27)[l]. However, the difference in the results over the long run is insignificant.

Figure 4.20 shows that the March 1995 deutsche mark chart with a 14-day exit worked well. The first breakout occurred on December 28, 1994, and the pullback entry occurred on January 9, 1995, at the open of 64.11, which was the exact low of the ensuing 14 days. The exit was on the close of January 30, 1995, at 66.52, for a profit of $2,913, after allowing $100 for slippage and commissions. The next entry occurred on

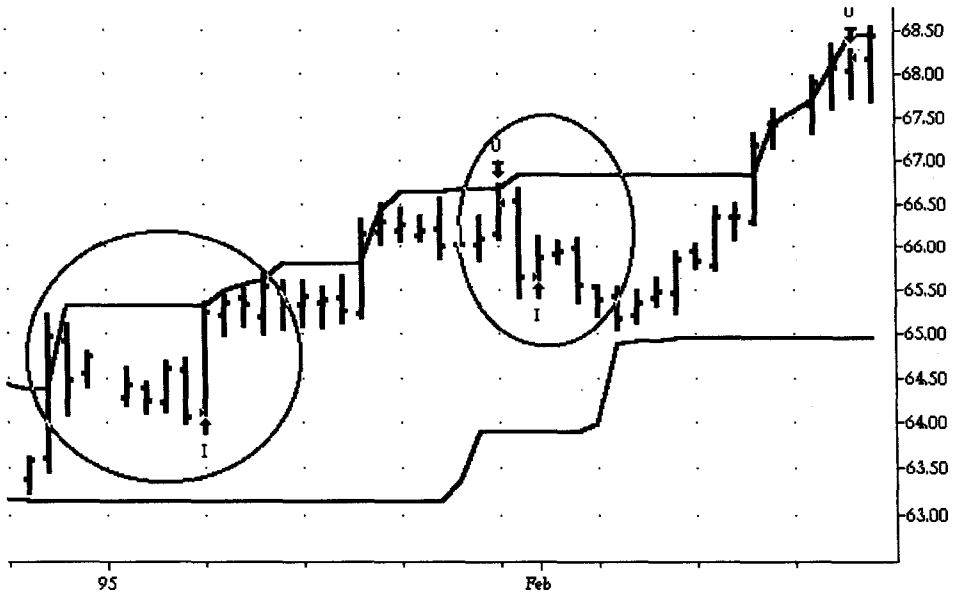


Figure 4.20 The CP-PB strategy gave good trades with low-risk entry points.

February 1, 1995, on the open at 65.65. The low of the trade occurred four days later at 65.07, for a 58-dck risk of $725. The exit was on the close of February 23, 1995, at 68.19. The nominal profit was $3,075.

Thus, the CB-PB system generated low-risk entries into an emerging up trend in the March 1995 deutsche mark contract. The exit on the 14th day was a lucky choice for this chart. You could use a number based on your individual preference just as well.

Note here that we specified a generic entry pattern with no specific assumptions about DM price patterns. The exit was again arbitrary. Of course, if you had exited on the 5th-day close instead of the 14th-day close, the profits would have been smaller. Note that the CB-PB pattern offers a relatively low-risk entry method. You can use it as a short-term system or a long-term system by simply varying the exit strategy.

So far, the exit strategy has been trend-following in nature, with some variation based on the actual day of the exit. For example, we could vary the exit from 5 days to 50 days and get completely different results. However, we will never make the "perfect" choice of *x* days. We can anticipate market action in a different way that does not use time as the exit signal. Instead, we will use a price we already know. Since we are buying a pullback, it is plausible to assume that the market will retest the recent 20-day high. Hence, we can write an exit signal that buys the

pullback and exits the retest of the recent high. Here is how we would write the new system variation in TradeStation™:

```
If Highest Bar(High.20)[l] < 7 and Low < Lowest
(Low.5)1:1] then buy tomorrow on the
open;
Exitlong at highest(h,20)[1] limit;
```

The first line of the CB-PB rule is exactly the same as before. The second line specifies a long exit for tomorrow with a limit order at the most recent 20-day high. This turned out to be the "perfect" model for the December 1995 S&P-500 contract. There were 12 winning trades in a row, with a total profit of $50,000 (see Figure 4.21).

The noteworthy feature here is that we started with the DM contract, using very general price patterns, and arrived at an intriguing short-term system, which performs particularly well in choppy uptrends. We made no contract-specific assumptions, and captured a general market behavior that we can expect to see in every market in the future. The CB-PB entry with an exit at a recent high works well in consolidations.

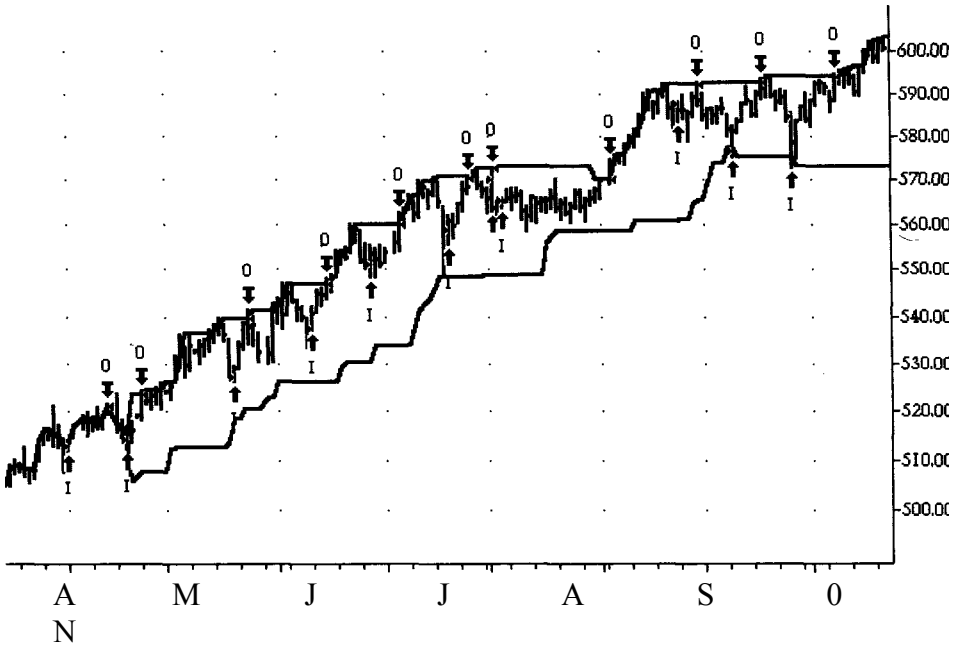


Figure 4.21 The CP-PB model with exit at the recent 20-day high using limit orders produced 12 winning trades in a row for a nominal profit of $50,000.

Another exit strategy involves a trailing stop, but one that will not cut off long trends prematurely. Hence, we will exit at the lowest low of the last 40 days. This will convert CB-PB into a long-term trend-following system.

```
If Highest Bar(H1gh,20)[l] < 7 and Low < Lowest
(Low,5)[l] then buy tomorrow on the open;
exitlong at lowestClow. 40)[1] - 1 point stop;
```

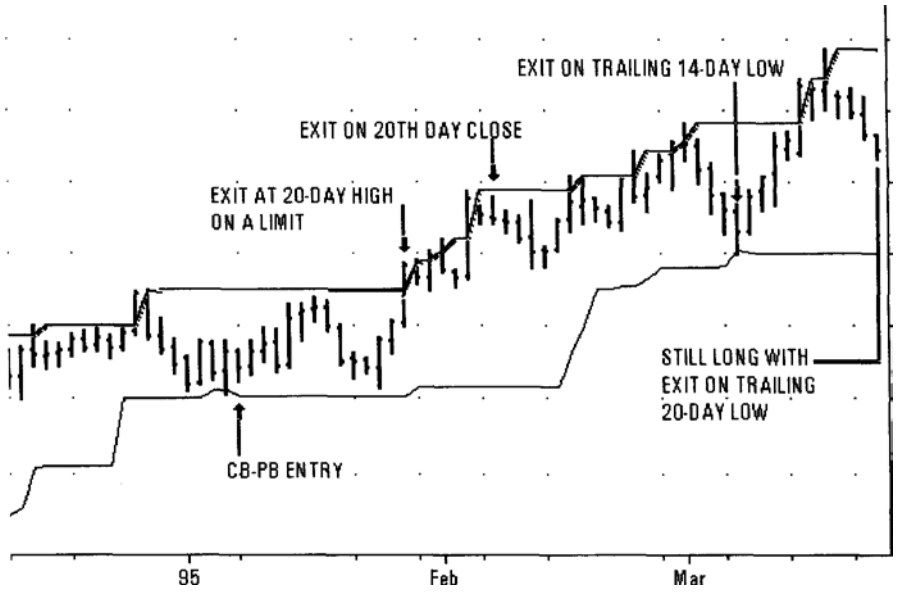
The CB-PB entry rule remains intact. The second line exits on a stop set one tick below the trailing 40-bar (trading days) low. *You* can see that this will become a trend-following exit. Our initial stop will close out our trade should the market head lower. The trailing stop at the 40-bar low will keep us in the trade through minor consolidations.

Notice how we took an intuitive understanding of a market pattern and adapted it to three different exit philosophies to meet specific trading preferences. Remember you could use it as a short term system by exiting at the recent high. *You* could exit on the close of the *n-th* day in the trade, for short- or intermediate-term trading. Or you could use a trailing stop. Each exit produces a trading system with different characteristics off the same entry signal. These are the types of modifications you should consider as you look at trading systems. Figure 4.22 from the March 1995 U.S. bond market will help you visualize the three exit strategies.

Now let us take a closer look at the entry signal, to see if it is any better than a random entry system. Following the suggestion of Le Beau and Lucas (see bibliography), we will try to isolate the effect of this CB-PB entry signal.

We test the CB-PB entry signal with exit on the close of the *n-th* day *(n=5,* 10, 15, and 20), without stops and assuming no slippage or commission costs. Le Beau and Lucas suggest that if the entry signal is performing better than a random system, it should result in at least 55 percent profitable trades over a range of markets. They tested only 6 years of data and 6 markets to measure a signal's ability to perform better than random. Here we use 22 markets and continuous contracts using all available data from January 1, 1975, through July 10, 1995. This should be a severe test of this entry signal, and our goal is to check if it is consistently profitable more than 55 percent of the time.

Table 4.7, page 108, shows that about 55 percent of all CB-PB entries were profitable. Hence, you can be reasonably confident that the CB-PB entry signal provides better than random entries. *You* can now



-106*08

-104*22

-103*04

-101*18

-100*00

-98*14

-96*28

Figure 4.22 The CB-PB gave a low risk entry into the new trend for the March 1995 U.S. bond contract.

marry this entry signal to a variety of risk control and exit strategies to fashion a trading system that fits your trading mentality.

The first exit strategy is simply to exit on the close of the w-th day in the trade. You are making the working assumption that the market is going to trend after the entry signal. Hence, consider now the CB-PB entry using continuous contracts, $1,500 initial stop, and allowing $100 for commissions and slippage. As discussed at the beginning of this section, we are focusing on "mature" markets. Let us consider the case when we exit the long trade on the close of the fifth

day. The test uses all available data from January 1, 1975, through July 10, 1995.

The results of exiting on the fifth day of the trade are not impressive (see Table 4.8, page 109). Since we are buying the markets during a consolidation, most of them have not done much in the 5 days after entry. Hence, we should consider holding on to the long trade for a little while longer.

Consider what happens if we hold the long position for 50 days, exiting on the close. The conditions for the test are identical to those for Table 4.8. Table 4.9, page 109, shows there is a dramatic improvement in performance with $n = 50$ days. The average profit per market has increased three-fold, and the profit factor is up 46 percent. Thus, our basic assumption that the market will trend after the consolidation seems to work well about 39 percent of the time on these markets. Thus, we have

Table 4.7 Percent winning trades for CB-PB entry signal calculated over all available data from January 1, 1975, through July 10, 1995

Market	5-Day Exit	10-Day Exit	15-Day	20-Day Exit
British pound	55	52	55	54
Canadian	54	48	52	45
Coffee	52	56	45	46
Copper	51	48	52	56
Corn	57	52	50	46
Cotton	57	62	55	58
Crude oil	57	55	62	58
Deutsche mark	55	55	54	55
Eurodollar	60	58	60	60
Gold	55	52	53	53
Heating oil	52	53	55	54
Japanese yen	56	49	50	55
Live hogs	56	51	53	51
Orange juice	54	54	50	50
Silver	54	53	56	48
Soybeans	56	58	53	46
S&P-500	64	54	56	61
Sugar	57	53	57	48
Swiss franc	48	50	52	53
10-year T-note	63	57	60	57
U.S. bond	56	53	52	52
Wheat	63	52	51	47
Average	56	54	54	53

converted our anemic short-term system into an interesting intermediate term system by exiting on the close of the fiftieth day.

We have previously stated that the initial stop should depend on market volatility. For example, the $1,500 stop may be "too close" given the volatility of the S&P-500 market. For the CB-PB system with exit on the 50th day using a $5,000 initial stop instead of the $1,500 initial stop, the profits dropped for all markets in Table 4.9 except S&P-500. Profits for S&P-500 increased to $141,840 on just 55 trades with 56 percent winners, a $2,579 average trade. The maximum drawdown was -$24,795, with the profit factor increasing to 2.29 from 1.62. Hence, the initial stop will influence overall system performance.

We can continue to explore the long-term nature of this entry by using a trailing stop. We know from Table 4.9 that we should use a trailing stop that will allow trends to develop. Hence, let us arbitrarily spec-

Table 4.8 CB-PB long trades with exit on the 5th day using $1,500 initial stop, tested on all available data from January 1, 1975, through July 10, 1995

Market	Profit ($)	Number of Trades	Percentage of Wins	Average Trade ($)	Maximum Intraday Drawdown ($)	Profit Factor
Eurodollar	6,050	99	54	61	-4,350	1.27
Japanese	27.450	96	51	286	-9.863	1.63
Coffee	-11.273	122	54	-94	-23.500	0.86
S&P-SOO	69.330	185	42	375	-19.640	1.42
Swiss	-4.988	120	45	-42	-1 7.913	0.94
10-year T-note	18,831	122	58	154	-8,756	1.39
U.S. bond	27,306	126	52	217	-13,219	1.45
Average	18,958	124	51	280	-13,892	1.28

ify an exit on the lowest low of the last 40 days; this should convert the intermediate system into a long-term trading system. As before, we will use $1,500 initial stop and allow $100 slippage and commissions.

Table 4.10 shows the long-term performance of this entry with a profit factor of nearly 3 and an average trade of $1,082. The ratio of net profits to drawdown is more than 4.5. These numbers suggest that you

Table 4.9 CB-PB long trades with exit on the fiftieth day, using $1,500 initial stop, tested on all available data from January 1, 1975, through July 10, 1995

Market	Profit ($)	Number of Trades	Percentage of	Average Trade	Maximum Intraday Drawdown ($)	Profit Factor
Eurodollar	21,875	45	56	485	-8525	1.74
Japanese	76,613	52	46	1,473	-11,525	2.69
Coffee	27,434	71	27	387	-18,719	1.33
S&P-500	86,085	102	22	781	-26,475	1.62
Swiss franc	52,889	63	37	839	-13,900	1.81
10-year T-	49,799	58	47	831	-9,575	1.98
U.S. bond	63,094	66	37	923	-14,169	1.95
Average	53,970	65	39	817	-14,698	1.87

Table 4.10 CB-PB long trades with exit on a trailing stop at the 40-day low, using $1,500 initial stop, tested on all available data from January 1, 1975, through)uly 10, 1995

Market	Profit ($)	Number of Trades	Percentage of	Average Trade	Maximum Intraday Drawdown ($)	Profit Factor
Eurodollar	32,200	37	35	870	-3,375	3.65
Japanese	70.419	34	38	2.063	-7.112	4.39
coffee	53.928	59	14	914	-24.020	2.00
SScP-500	85.200	70	14	510	-25.480	1.41
Swiss franc	55.200	59	20	936	-11.550	2.42
10-vear T-note	57.250	51	28	1.123	-8.038	3.39
U.S. bond	62.513	54	24	1.158	-11.475	2.13
Average	59,530	52	25	1,082	-13,007	2.77

can take the same entry and make it into a strong long-term trend-following system.

Let us now take the CB-PB entry and attach it to an exit at the recent 20-day high. It is reasonable to assume that the market will retest the recent 20-day highs as part of the backing and filling during the consolidation. Table 4.11 summarizes the test results using a $1,500 initial stop and a $100 allowance for slippage and commissions.

Table 4.11 CB-PB long trades with exit at the recent 20-day highs^on a limit, using $1,500 initial stop, tested on all available data from January 1, 1975, through July 10, 1995

Market	Profit (S)	Number of Trades	Percentage of	Average Trade	Maximu Intraday Drawdown ($)	Number of Days	Profit Factor
Eurodolla	7,250	98	72	74	-8,750	9	1.24
Japanes yen	17.200	93	54	185	-11.225	13	1.30
Coffee	-7.751	117	43	-66	-24.463	11	0.93
S&P-500	48.860	185	36	264	-25.070	6	1.25
Swiss	-5.963	116	50	-51	-16.625	7	0.97
10-vear note	26.781	120	65	223	-8.388	9	1.42
U.S.	37,306	126	60	296	-10,856	8	1.47
Average	17,669	122	54	132	-17,377	9	1.22

The CB-PB system with an exit at the recent 20-day high was interesting only on the Eurodollar, S&P-500, 10-year T-note, and U.S. bond markets. The large proportion of winning trades makes this exit particularly attractive. Notice that the length of the average winning trade was only 9 days.

You can develop other variations of this strategy. For example, one of the design features of the CB-PB system is that we want a low risk entry point into long trades. Hence, you can use a multicontract trading strategy to improve performance. Another approach would be to add a filter to reduce the number of trades.

Thus, the CB-PB system has a flexible entry to suit many trading styles. The CB-PB strategy is more profitable with an intermediate to long-term trading strategy. A short-term approach worked on a few active markets. Note also how we can develop different systems from the same entry signal by changing the exit strategy.

An ADX Burst Trend-Seeking System

We have assumed that the market was about to trend in both the 65sma-3cc and the CB-PB systems, although we did not actually verify that the market was trending because it is difficult to measure trendiness consistently. As was shown in the discussion in chapter 3 on the range action verification index, market momentum is often a good measure of trendiness. Unfortunately, a certain amount of smoothing is essential to minimize noise in the indicator, and this smoothing usually causes undesirable lags in indicator response.

Figure 4.23 shows the March 1993 U.S. T-bond contract trending upward nicely from December 1992 through March 1993. The indicator under the daily bars is the 18-day average directional index. ADX measures the amount of activity outside the previous bar over a given period; a strong trend usually leads to a rising ADX line. An ADX reading above 20 is considered to indicate a trend, but the ADX is a lagging indicator, and there is little significance to any particular indicator value.

ADX is closely related to double-smoothed absolute momentum, and hence will often have quirky lags. The ADX will often seem to be late in signaling a trend, and choppy markets will not follow through in the original direction that caused the ADX to rise. In fact, the market can reverse strongly, and the ADX will keep on rising.

During a strong trend, as markets make big daily moves in the direction of the trend, the daily ADX momentum can "pop" over 1.0

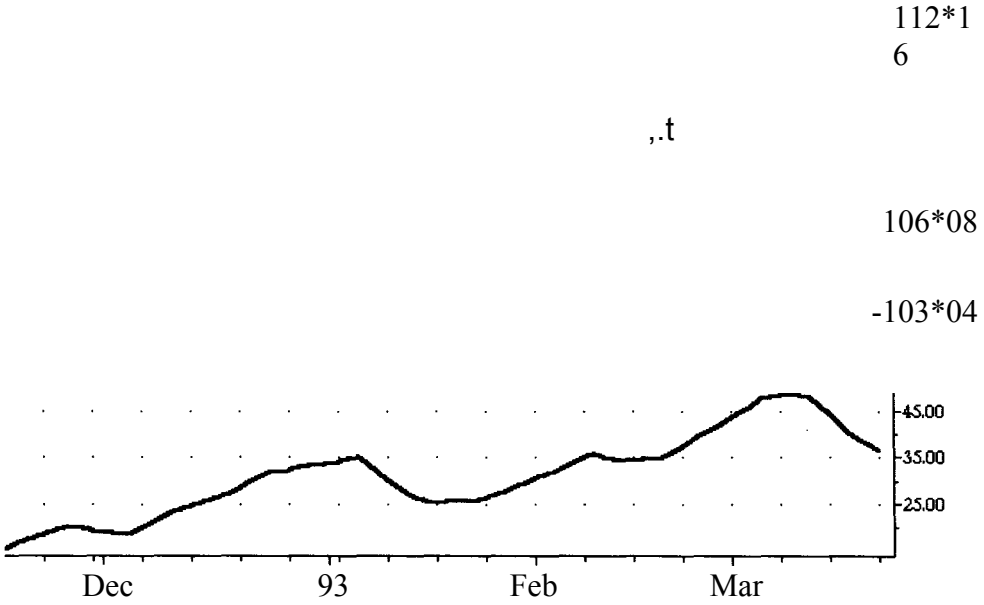


Figure 4.23 A rising 18-day ADX can be a good indicator of a trending market.

point, an ADX "burst." Figure 4.24 shows the March 1993 U.S. bond contract with the histogram of the ADX burst superimposed on the 18-day ADX line. As the trend accelerates, the daily ADX changes are more than 1, and you can see relatively large bars associated with this ADX

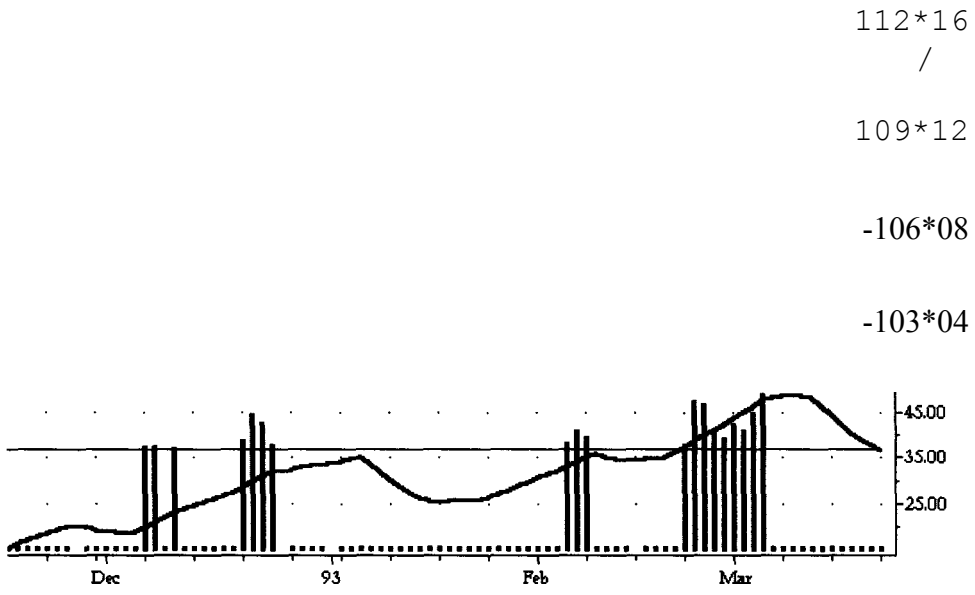


Figure 4.24 The histogram of ADX burst momentum shows daily changes greater than 1.

burst activity. Now you can build a trading system using this idea as shown in Figure 4.25, where the entries are circled.

Obviously, the ADX burst indicates accelerating momentum. So, here the design philosophy has changed to begin with a check that increases the odds of success of a trend-following strategy. Notice that the ADX burst is itself triggering the trade, and that the ADX is not acting as a filter. For reference, you can look up a similar system in Lucas and Le Beau (see bibliography for reference). Our goal is to take the trade in the direction of the short-term trend. If the 3-day SMA is greater than the 12-day SMA, then the trend is up, and vice versa. Table 4.12 shows the results using a simple 20-day exit strategy and allowing $100 for slippage and commissions, over all available data from Janury 1, 1975, through July 10, 1995.

The rather large profit factor suggests that the entries are effective in identifying profitable trades, so that an ADX burst is a good entry into strong trends. The profit factor is overestimated here to some degree because we are using continuous contract data. The results can be improved with multiple contracts, and you can try a variety of other exit strategies.

If you compare the number of trades here to that for the 65sma-3cc system, you will find that you have fewer entries, suggesting that the ADX burst is working as both a trade filter and a trigger. For example,

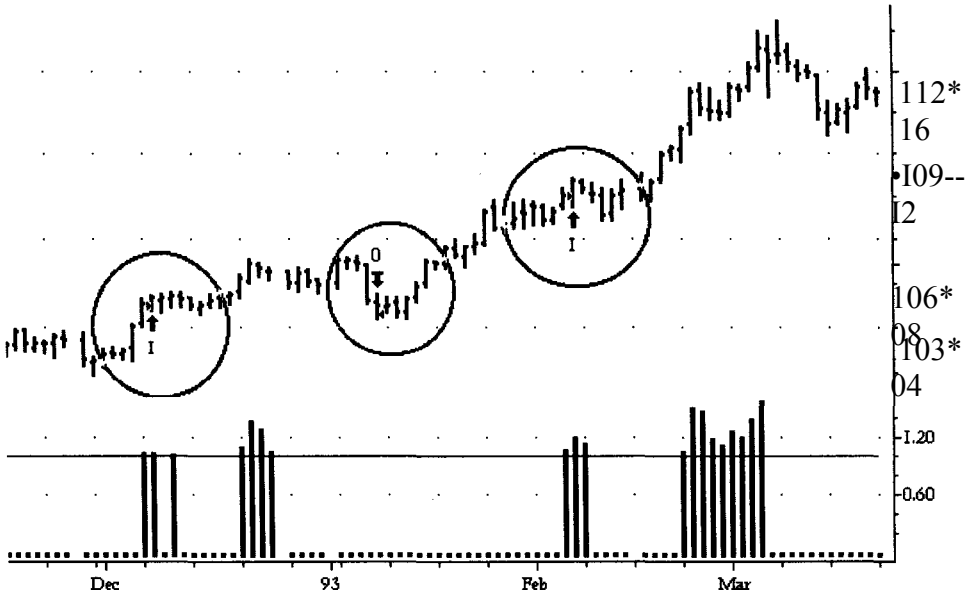


Figure 4.25 A trading system triggered by ADX burst with daily momentum changes more than 1.

Table 4.12 ADX burst system performance with $5,000 initial stop

Market	Profit ($)	Winning Trades; Total Trades; Winning	Profit Factor (Gross Profit; Cross	Average Trade (S)	Maximum Intraday Drawdown ($)
British	40,531	34;75;45	1.39	540	-25,113
Canadian	6.830	20:56:36	1.28	122	-7.060
Coffee	137.014	29:75:39	3.86	1826	-21.225
Copper. grade	4.770	15:25:60	1.29	191	-5.970
Corn	22.269	37:70:53	2.58	319	-3.356
Cotton	72.770	32:64:50	3.49	1.138	-4.860
Crude oil	10.590	21:54:38	1.44	196	-13.400
Deutsche	63.300	40:73:55	3.49	867	-8.675
Gold	4.770	31:84:37	1.04	30	-27.450
Heating oil	52.469	30:56:54	2.61	937	-7.850
Japanese	63.450	37:69:54	2.35	920	-18.050
Live hogs	20.080	36:75:48	1.65	268	-6.140
Orange	25.013	29:80:36	1.63	313	-12.692
Soybeans	38.606	31:73:42	1.81	529	-10.713
S&P-500	-28.650	20:55:36	0.79	-520	-65.815
Swiss franc	76.238	35:68:51	2.75	1.121	-8.075
U.S. bond	54.531	27:60:45	2.56	909	-11.306
Average	39,093		2.12		

this system was in the market about 35 to 45 percent of the time, indicating it has a rather large "neutral zone." A trading system with a neutral zone is out of the market unless it rises above stiff entry barriers. The 65sma-3cc system is always in the market, and is a reversal-type system, whereas the ADX burst system steps aside 55 to 65 percent of the time.

We used a wide initial stop of $5,000 in these calculations to isolate the performance of the system. Table 4.13 includes performance data on selected markets with an initial stop of $1,500. The performance with the two different initial stops was generally similar.

One of the quirks of the ADX burst system is that it will often get in late, near the tops or bottoms of short but swift moves (see Figure 4.26). Such moves fire its entry signals, but the capricious market fails to follow through with a trend in the advertised direction. Hence, you

 Table 4.13 ADX burst system performance with a $1,500 initial stop

Market	Profit ($)	Number of Trades	Percentage of	Average Trade	Maximum Intraday Drawdown ($)	Profit Factor
British pound	64,438	82 85	39 33	744	-18,719 -	1.82
Coffee	148.584			1.749	13.851	3.07
Cotton	66.800	66	48	1.012	-6.015	2.95
Crude oil	6.070	55	38	110	-13.440	1.24
Deutsche	62.088	73	55	851	-8.457	3.34
S&P-500	19.160	68	25	282	-33.675	1.24
Swiss franc	61.575	72	44	855	-9.125	2.88
U.S. bond	40,556	66	36	615	-12,944	1.74

should always trade a system such as this one with a preplaced stop loss order.

In summary, the ADX burst system provides entries into strong trends. It tests well across many markets and over long time periods. The system has a large neutral zone, so it is in the market only 3 5 to 45 percent of the time. It differs from the 65sma-3cc system, which is

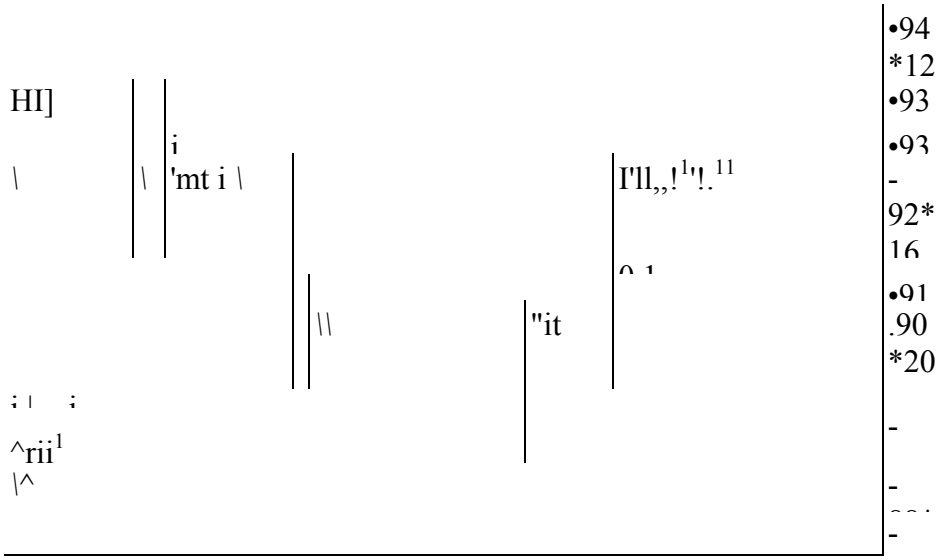


Figure 4.26 The June 1990 U.S. bond contract sells off beyond a trading range to make a new low with good momentum. The system kicks in with a short. The bond market soon reverses, to get back into the prior consolidation region.

always in the market, and does not have a trend filter. You can use it to enter trades or increase the position in those markets. You can derive other variations using different values of the ADX burst, the look-back period for the burst calculations, and other exit strategies.

A Trend-Antitrend Trading System

In this section we explore the trend-antitrend (T-AT) system, designed to switch automatically between an antitrend mode and a trend-following mode. You will like this system if you aggressively like to fade the market, but do not mind reversing into a with-the-trend position if needed. This system shows you that trend following is not the only way to trade the markets. Many institutions and money managers, with their deep pockets, big positions, excellent execution, and low costs, usually assume the market is ranging. These sophisticated souls will be selling new highs and buying new lows. Of course, the difference is in the trading time frames: They are in and out a dozen times, before most of us are warming up to the trade.

The challenge in this type of system is to find a consistent basis to define when to trade with the trend and when to fade it. Markets will often make new 25-day highs or lows, but without strong momentum. This can be interpreted to mean that the market is likely to reverse, so we should try to sell the highs and buy the lows. However, if the market then goes on to make news highs or lows with increasing momentum, we must immediately reverse into a trend-following position.

For this system, we will use the 18-day ADX to measure market trendiness, and an 18-day SMA of the ADX as the reference. If the ADX is above its own 18-day SMA, then the market is trending, and we will buy new highs, and sell new lows. Conversely, if the ADX is below its 18-day SMA, we will sell new highs, and buy new lows. Since we will be going against the short-term trend, we must use an initial risk control stop, or the losses will be unbearable.

We must also decide how to enter the trade. For simplicity, we will enter on the open of the next trading day. We can use the usual 20-day exit to check on the trend-following aspects. Again, for simplicity, we will test this system without specific exits, so that the entries also serve as the exit for the opposite position.

You can see how this trading system works in Figure 4.27 from the September 1993 U.S. bond contract. The market formed a base during a congestion phase, and then rallied strongly, experiencing one brief

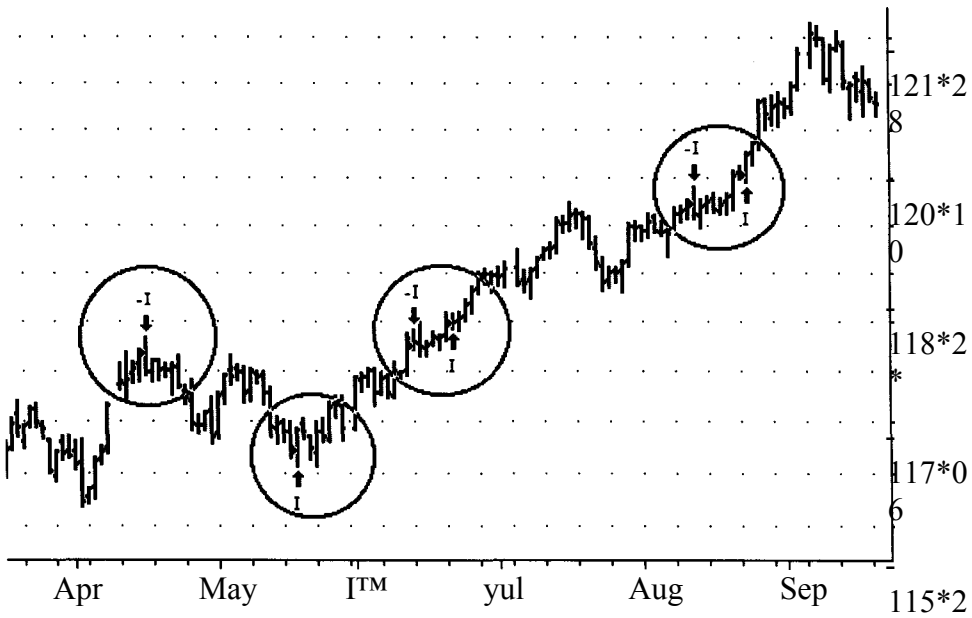


Figure 4.27 The trend-antitrend system in action on the September 1993 U.S. bond contract. Notice how it picked off turning points nicely during the consolidation. It detected two turning points during the uptrend, but quickly reversed to follow the up move.

sideways period. Observe how the model readily fades new highs, and then quickly reverses in the direction of die trend. This system picked off the top and bottom cleanly during the consolidation in April and May. It was long coming into the rally off the May bottom. It hiccuped twice, in June and August, but quickly returned to the underlying long trend.

As Figure 4.27 shows, the T-AT system caught some turning points very well. This system will also see turning points that turn out to be insignificant, and, of course, there will be some turning points that it will not notice at all. The drawback of the T-AT system is the potential for significant loss as it switches fruitlessly between its anti-trend and trend-following modes.

The usual T-AT system worked beautifully on the December 1985 deutsche mark contract (see Figure 4.28). The DM was defining a broad consolidation region after a down trend. Note how the T-AT system quickly reversed to long in September after a premature short signal. The subsequent market turns were timed flawlessly. This is quite remarkable for a mechanical system using a single trend-checking rule.

You must use good risk control with this system, since the market could move against the position in a vicious countermove. The June

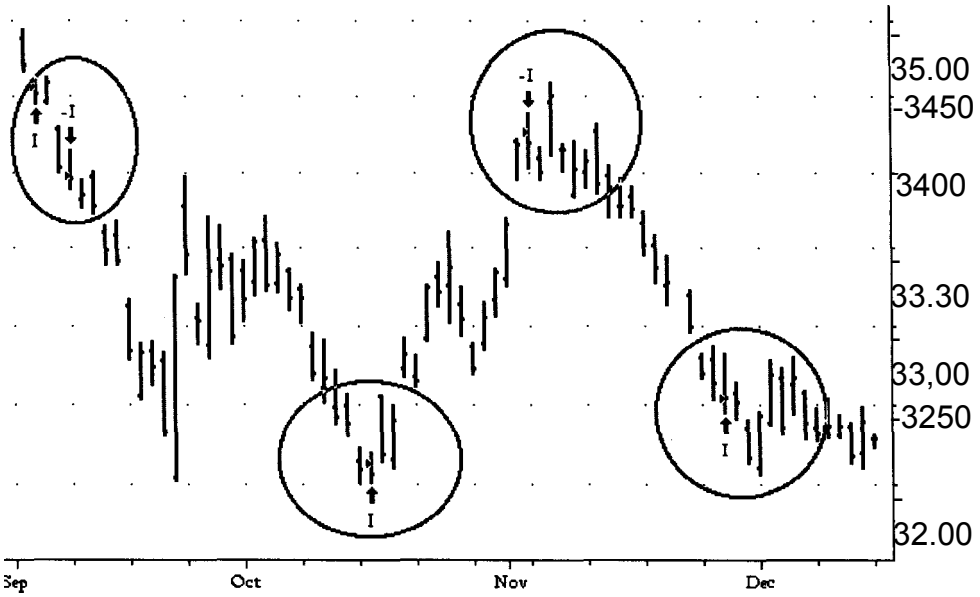


Figure 4.28 The T-AT system picked off turning points flawlessly in this December 1985 deutsche mark contract. Notice how it quickly returned to a trend-following mode in September, as the market drifted lower.

1995 deutsche mark contract provides a good illustration of this (see Figure 4.29). The T-AT system signaled a perfect short trade within a day of the actual contract high. Then, it correctly picked off the bottom of the quick sell off. However, it rolled over to short during the brief congestion and then was short through the volatile countermove in late May. Trend-antitrend trading requires great faith in the system and rigid risk control, with the added benefit that the risk/reward ratio can be excellent.

The June 1995 deutsche mark contract also illustrates the difficulty of using a heavily smoothed ADX indicator in volatile markets. The same smoothing that desensitizes ADX works against it if the market is choppy and thin.

Another quirk of the T-AT system is that it will often be slow in signaling a countermove if the market is drifting slowly, as the December 1993 cotton contract was doing near the summer top. T-AT logic correctly picked the first low (see Figure 4.30), but had to sit through the ensuing double bottom in November before the trend turned up. Once again, we have the hiccup at the start of the trend, with the system quickly reversing into the intermediate trend.

Let us briefly explore how this system was actually written, using the Power Editor from Omega Research's TradeStation™ software.

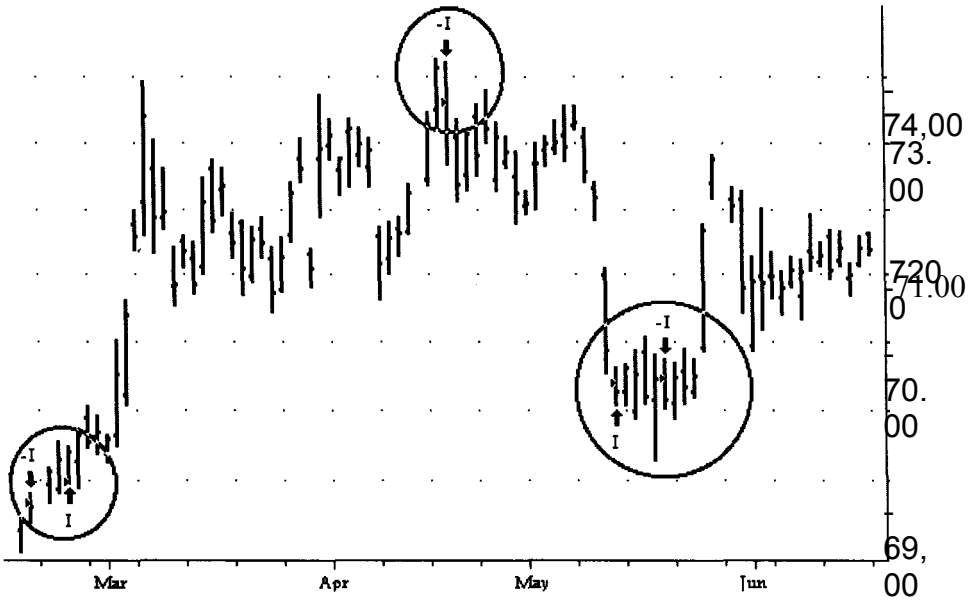


Figure 4.29 The June 1995 deutsche mark contract illustrates how the T-AT system can get trapped by a volatile countermove.

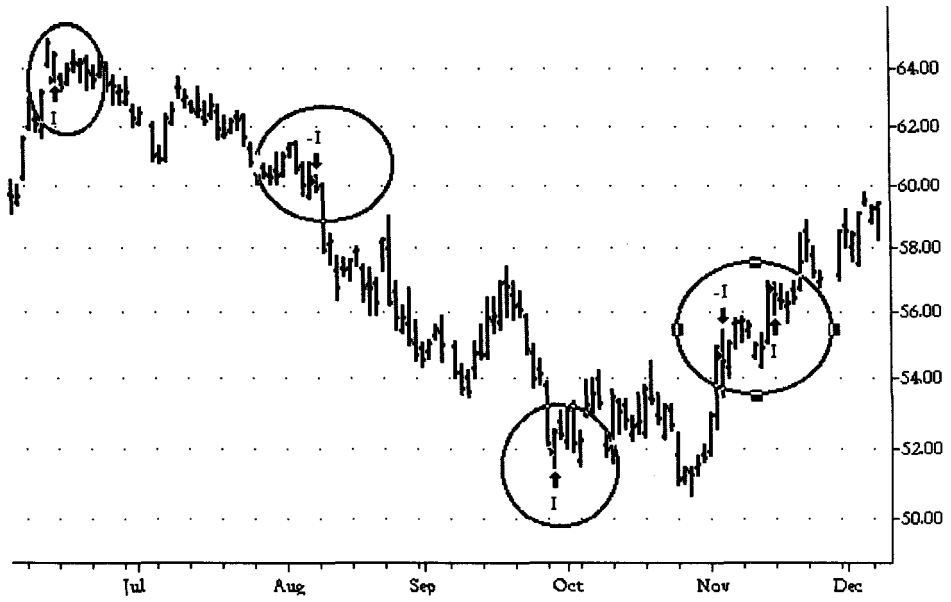


Figure 4.30 The T-AT system was slow to respond to the market drift in the summer for the December 1993 cotton contract. It correctly picked the first dip of the eventual double bottom.

There is only one input variable, the length of the breakout period, currently set to 25 bars (days). The antitrend entry at a new 25-day high is written as follows: if today's high was the highest high of the previous 25 days, but the 18-day ADX was below its 18-day SMA, then sell tomorrow at the market on the open. The countertrend buy signal is also similar.

```
If high > highest (H.25)[1] and ADX(18) < average
(adx(18).18) then sell tomorrow on
the open.

If low < lowest (L,25)[1] and ADX(18) < average
(adx(18).18) then buy
tomorrow on the open.
```

This approach gives a symmetric long and short sell order on an antitrend basis. Let us assume you have a long position near a potential bottom. However, the market bounces up for a few days, and then reverses to begin a strong downtrend. In this situation, you want the system to switch to a short trend-following position only if it is long to begin with. Similarly, a new 25-day high with rising momentum is your signal to switch to a long position if you were short to begin with. Thus, the trend-following entries are similar to the antitrend entries, but you should first test if the system is short or long.

```
If MARKETPOSITION(O) - 1 and low < 1owest(L,25)[1] and
ADX(18) > average(ADX(18),18) then sell tomorrow on the open.

If MARKETPOSITION(O) - -1 and high > h1ghest(H.25)[l]
and ADX(18) > average(ADX(18),18) then buy tomorrow on the open.
```

Here MARKETPOSITION is a special built-in function that returns 1 if the system is long, and -1 if the system is short. Once again, we have the symmetric conditions for long reentry. If we sell a new 25-day high, but the market makes new 25-day highs with increasing momentum, then the T-AT system switches to long. A similar condition holds for the short reentry.

By design, the T-AT system first tries the antitrend entry, and with-the-trend positions occur on reentry. Therefore, you should remember that this system will lose money as it hunts for a reentry market condi-

tion. Of course, if the resulting trend is a long one, then the loss at reentry will seem minor.

If you like this approach, you can try a number of variations. You could enter not on the open, but on the close or beyond the previous day's high or low. You could also use a more sensitive reentry, as just a new 25-day high or low, not requiring the additional ADX conditions.

Table 4.14 shows the results of long-term testing on all available data from January 1, 1975 through July 10, 1995 with a $5,000 stop and allowing $100 for slippage and commissions. Only markets with positive results are included, since this strategy requires active markets.

Table 4.14 points out the strengths and weaknesses of the T-AT system. First, it does not work on all markets, and second, it generates a lot of trades. Hence, this is an expensive system to run, as shown by the drawdown numbers. The initial stop had to be rather wide, at $5,000, to allow a cushion for the antitrend component to work. However, the profit factor is healthy, as is the average trade. Hence, on mature and active markets, the T-AT system seems to work quite well. The strategy requires excellent risk control and good discipline to implement. You can now develop other variations of this system, adapting it to your trading preferences.

Figure 4.31 presents a frequency distribution of 1,311 trades generated by the T-AT system. This distribution is broader than the distri-

Table 4.14 Long-term performance of T-AT system over all available data from January 1, 1975 through July 10, 1995 with $5,000 stop and $100 for slippage and commissions.

Market	Profit ($)	Total Trades	Profit Factor	Maximum Intraday Drawdown ($)	Average Trade ($)
British pound	46,956	207	1.17	-42,163	226
Coffee	29.005	203	1.08	-101.753	145
Copper, high-grade	1 7,563	57	1.55	-7,333	308
Cotton	91 585	194	1 77	-12 300	467
Crude	26.260	103	1.45	-17.310	255
Deutsche	69.775	175	1.53	-11.975	399
Gold	22.060	168	1.16	-19.050	131
S&P-500	92.435	141	1.34	-56.030	656
Swiss franc	103.850	188	1.58	-16.475	552
U.S. bond	106,269	172	1.68	-20,281	617

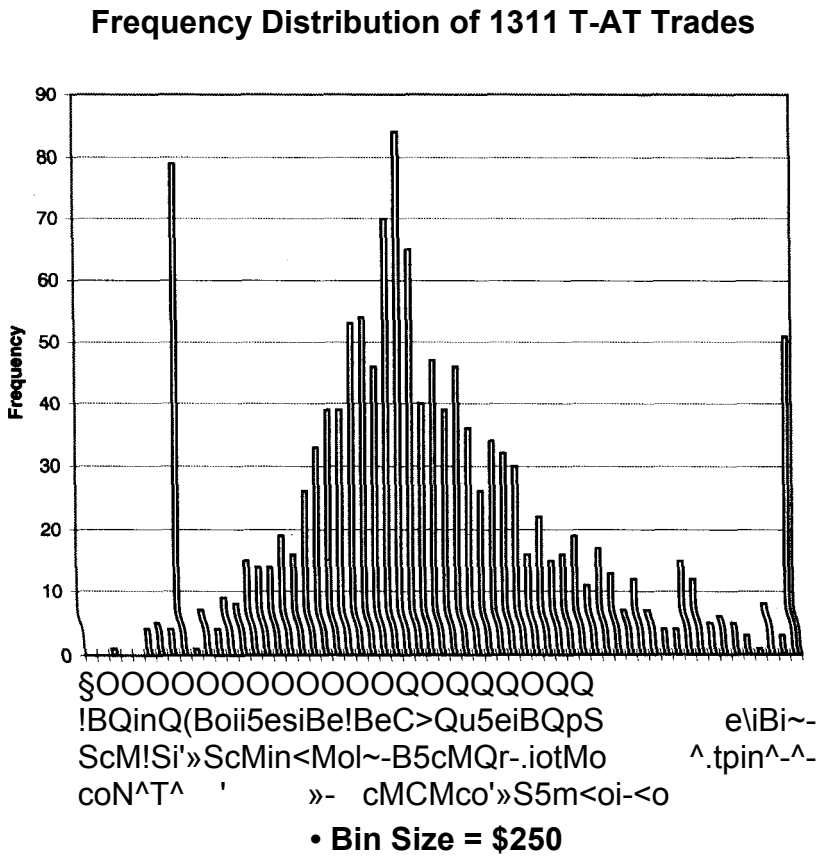


Figure 431 Frequency distribution of T-AT trades showing a spike at the $5,000 initial stop and at trades with profit greater than $8,000.

button for the 65sma-3cc system (see Figure 4.5). It also shows a spike near the $5,000 initial stop. Like the 65sma-3cc distribution, it also shows a spike for trades with big profits. Figure 4.32 shows this distribution normalized and compared to a fitted normal distribution. It is immediately clear that the T-AT trade distribution has "fat" tails compared to the normal distribution. Thus, the probability of a trade far from the center is much greater than the corresponding normal distribution. The tail on the profits side is fatter than on the losing side, suggesting that the entries are working well. Observe how the initial stop cuts off losing trades. However, there is no such cutoff on the profit side, as seen by the spike at the right edge of the distribution. This is the TOPS COLA principle introduced in chapter 1 applied to a trading system in practice.

In summary, the T-AT system illustrates how to develop a system that automatically adjusts to market conditions. It differs from the 65sma-3cc system in that its initial stance is to take an antitrend position; the 65sma-3cc system always takes a position with the trend. A reversal condition switches the T-AT system from antitrend to a trend-

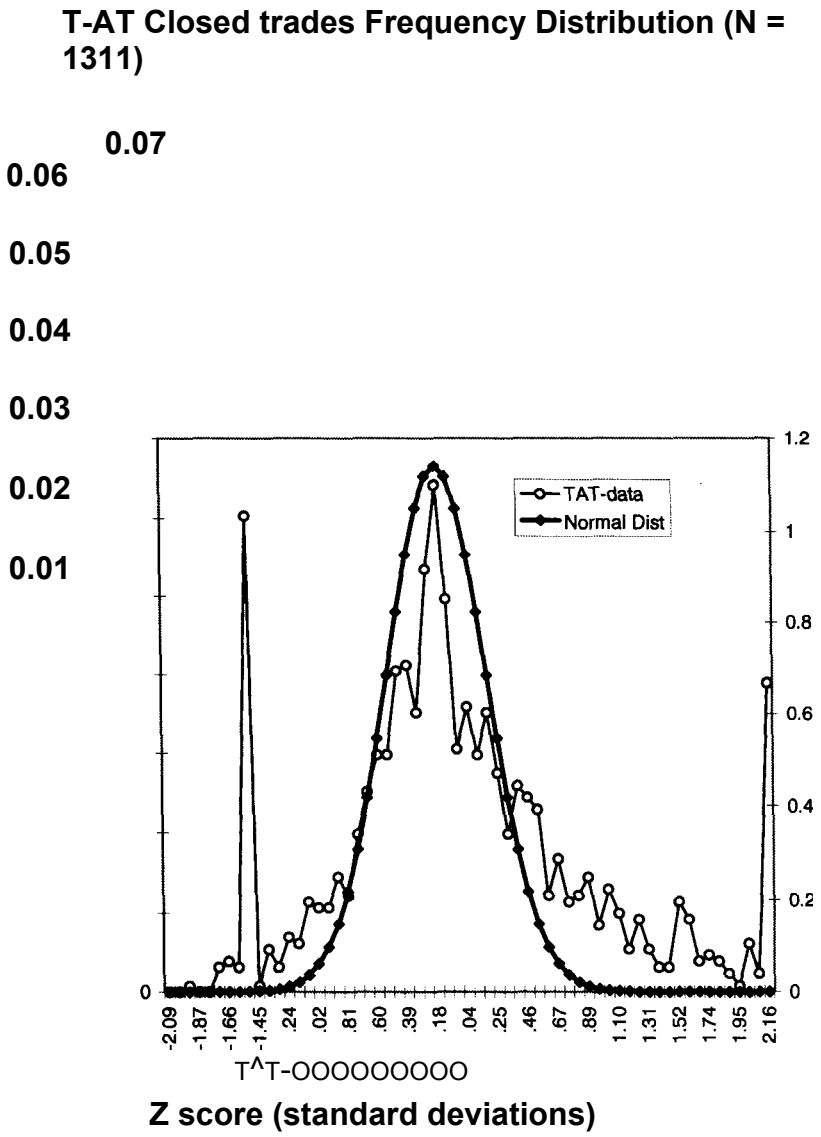


Figure 4.32 T-AT frequency distribution normalized and compared to a fitted normal distribution.

following mode. The objective reversal condition assures entry in the direction of a major trend, thus allowing you to take advantage of all market conditions.

Gold-Bond Intermarket System

This section develops intermarket trading systems for trading negatively or positively correlated markets. We begin with a quick review of the difficulties of formulating intermarket models. The gold-bond system is illustrated for negatively correlated markets and tested on other market combinations also. An example of using three markets for intermarket analysis is then given. Lastly, the gold-bond system is

modified for positively correlated markets. This section will convince you that it is possible to develop interesting intermarket systems. You may have greater confidence in such systems because they contain a weak form of cause-

and-effect relationships. Hence, they are often a good addition to your analytical tool set.

Many analysts have recognized intermarket relationships, which imply some form of weak cause-and-effect relationship. For example, bond prices decline when inflation is rising, and rising gold prices suggest potentially higher inflation. Therefore, we expect gold prices and bond prices to move in opposite directions (see Figure 4.33). You can also measure inflation with the prices of industrial metals such copper or aluminum. The idea is that increasing economic activity will raise the price of copper, and herald a rise in inflation. Therefore, we expect copper prices and bond prices to move in opposite directions (see Figure 4.34).

Other intermarket relationships occur with positive correlation. This means that the prices of some commodities rise and fall together. For example, rising crude oil prices suggest potential inflation, and we should expect gold prices to rise. You can use the currency markets as another good example of correlated markets. Exchange rates reflect long-term fundamental forces in the economy such as inflation and interest rates. Thus, we expect the U.S. dollar to decline at approximately the same time against other foreign currencies such as the Japanese yen and the deutsche mark. Thus, we should expect that Japanese yen and

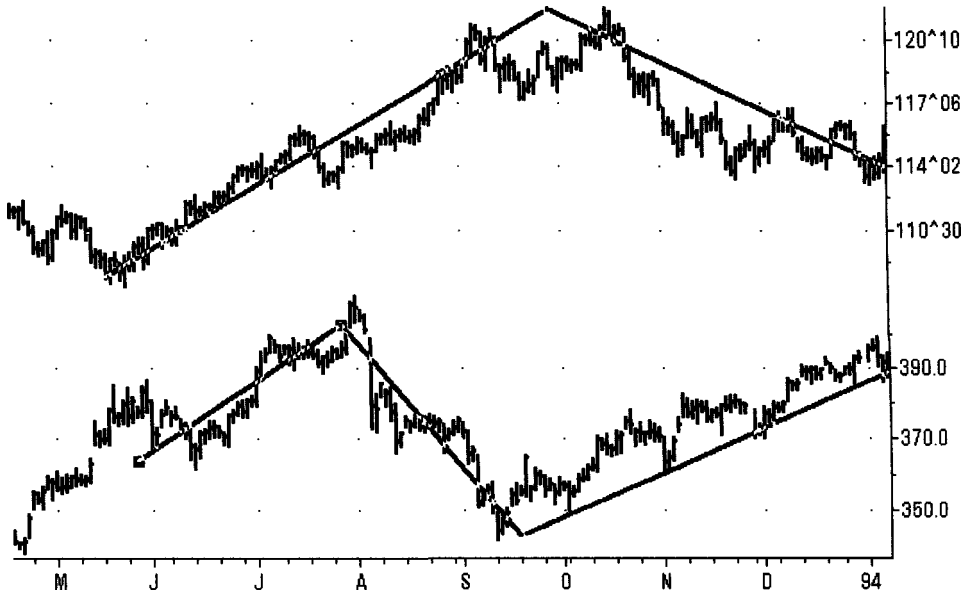


Figure 4.33 Bond (top) and gold (bottom) prices generally, but not always, move opposite one another. Thus, intermarket relationships are often imperfect.

Figure 4.34 The general inverse relationship between weekly bond (top) and copper (bottom) prices.

deutsche mark prices are correlated, and we should be able to generate buy or sell signals for one market from the other.

There are several difficulties involved with exploiting intermarket relationships. First, weak intermarket cause-and-effect relationships have time lags. Thus, the price of copper may rise for several months before bond prices begin to fall. This difference in the timing of peaks and troughs among related markets is called a time lag. The problem is that the time lags are neither constant nor consistent.

A second difficulty is that each market has its supply and demand forces, which will often distort the usual intermarket relationships. For example, we would expect copper and gold prices to move up or down at about the same time. However, there have been periods when gold and copper prices have moved in opposite directions (Figure 4.35). Thus, any systems built on intermarket forces will not be correct all the time.

A third problem is the internal technical condition of each market. Each market can become "overbought" or "oversold" at different times. The usual intermarket trends are broad trends, which could unfold over many months. Hence very short term trends in the markets can move opposite the cause-and-effect relationship. Such movements can complicate your entry signals because they can trigger a risk control exit without changing the underlying trend.

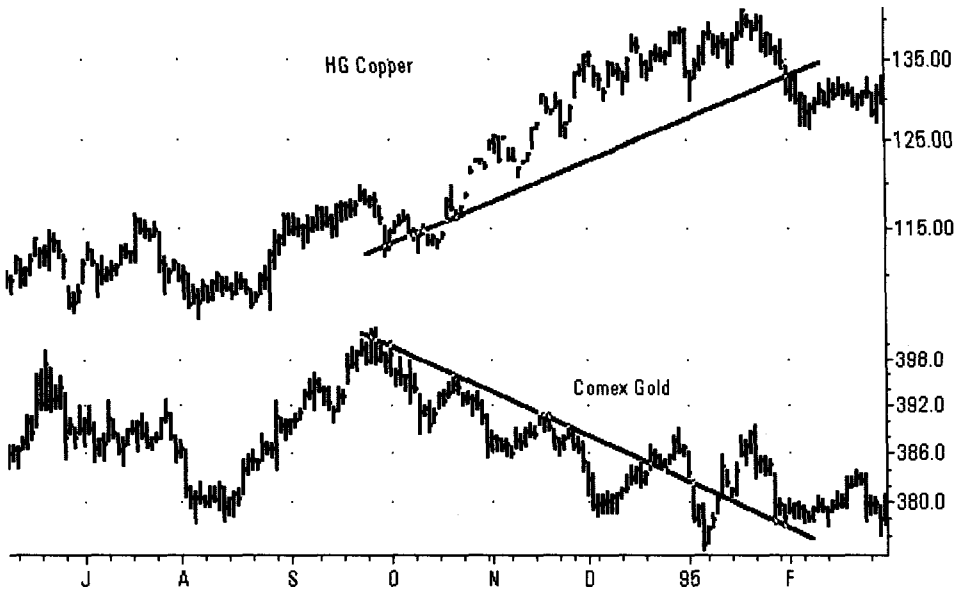


Figure 4.35 An example of copper and gold prices moving in opposite directions in late 1994-early 1995.

All these issues influence the precise form of relationship you select for your system. You must also decide if you want to relate two markets or more than two markets.

The gold-bond system, which assumes that bond prices move in the opposite direction of gold prices, is a simple but effective example of how to construct an intermarket trading system. The system assumes that rising gold prices signal potential inflation and thus influence the bond market. We will use a dual moving-average crossover system, using arbitrary 10-day and 50-day simple moving averages to build the system. Here are the rules:

1. If the 10-day SMA of gold crosses above the 50-day SMA, then sell the T-bond futures tomorrow on the open.
2. Conversely, if the 10-day SMA gold crosses under the 50-day SMA, then buy the T-bond futures tomorrow on the open.

These rules say that an upside crossover of the moving averages signals rising gold prices and therefore predicts falling bond prices. Here we have not used any filters for the emerging trend in the gold market, but you could certainly use the ADX indicator. To use the ADX filter,

simply require that the 14-day ADX be rising, and determine the direction of the short-term trend by comparing the 3-day SMA to the 20-day SMA. The specific rules for the ADX-filtered system are as follows:

1. If the 14-day ADX is greater than its value 14 days ago, and if the 3-day SMA is below the 20-day SMA of the daily gold closes, then buy the bond futures on tomorrow's open.
2. Similarly, if the 14-day ADX is above its value 14 days ago, and the 3-day SMA is above the 20-day SMA of daily gold closes, then sell the bond futures on tomorrow's open.

We tested both of these models on U.S. bond and Comex Gold continuous contracts from August 23, 1977, through July 1, 1995, with an initial $5,000 money management stop and $100 allowed for slippage and commissions. As discussed above, the short-term trends in the markets can be a problem for trade entry. The results are summarized in Table 4.15.

These results suggest that there is indeed a broad inverse relationship between gold and bond prices. However, from a trading perspective, only about half the signals are profitable. The filtered gold-bond system was significantly more profitable than the dual moving average crossover system, with about half the maximum drawdown. The gold-bond system could function as a filter to check whether the "trading environment" favors rising bond prices.

We know that there are lags between the price movements among markets. Since a hint of inflation can move many other markets, we should check out the basic gold-bond system on other market combina-

Table 4.15 Results of testing the gold-bond systems, August 21, 1977 through July 10, 1995

	Dual MA Gold-Bond System	ADX Gold-Bond System
Net profit ($)	38,675	92,488
Profit factor (gross loss)	1.24	1.62
Total number of trades	122	152
Percentage of winning	48	52
Ratio: average win/loss	1.37	1.50
Average trade ($)	317	608
Maximum intraday	-34,724	-16,506

tions, such as the soybeans-bond, copper-bond and deutsche mark-bond combinations. The grain markets often signal inflation, and the soybeans market is used as a proxy for those markets. The copper market follows strength in the industrial sector and is a leading indicator of inflation. Lastly, interest rates signal broad forces in the economy that also influence the currency markets, such as the deutsche mark. We used the gold-bond system for negatively correlated markets with the same $5,000 initial stop, one contract per trade, and $100 for slippage and commissions, and tried to generate buy and sell signals for the bond market from the markets indicating inflation.

The data in Table 4.16 confirm that changing trends in markets heralding inflation can be used to trade the bond market. Of all the combinations tested, the copper market seems to provide the best indication. In every case, only about half of the signals were profitable. Thus, these systems follow the well-known principle of economic forecasting: if you must forecast, forecast often.

So far, we have used only one market to develop trading signals for bonds. However, you could use more than one market to derive trading signals. We tested the use of two markets, gold and soybeans, to develop trading signals for bonds. We chose these two markets because they seemed to have unrelated supply-demand forces. We also tested the gold, copper, and bond combination for completeness.

Table 4.16 Results of testing the gold-bond system on other market combinations

	Soybeans-Bond	Copper-Bond	Deutsche Mark-Bond
Test period			
Net profit ($)			
Profit factor (gross profit/gross loss)			
Total number of trades			
Percentage of winning trades			
Ratio: average win/loss			
Average trade ($)			
Maximum intraday drawdown ($)			

Test period	8/21/77-	7/28/88-7/10/95	8/21/77-7/10/95
Net profit ($)	7/10/95 34,556	41,269 2.27	42,950 1.39
42 57 1.70	**122 52**		88 53
983 -12,694	1.15		1.21
	282		488
	-		-
	16,100		28,006

We extended the basic gold-bond system to three markets by specifying that both gold and soybeans must be trending up or trending down at the same time to generate the opposite signal for bonds. For example, if the 10-day SMA of the daily close was below the 50-day SMA for both gold and soybeans, then that would trigger a buy signal for bonds. The results of the historical tests for the combined gold-soybeans-bond system were better than either the gold-bond or soybeans-bond systems. As usual, we used a $5,000 initial stop and allowed $100 for slippage and commissions .

The test results in Table 4.17 show that using three markets reduced the total number of trades, as you would expect. For example, the gold-bond tests and soybeans-bond tests produced 122 trades, whereas the gold-soybeans-bond trio produced only 77 trades. The profit factor also improves with three markets, as you would expect from improved filtering. For example, the gold-copper-bond trio had an impressive profit factor of 2.53, and produced essentially the same profits as the copper-bond combination with 35 percent fewer trades. These tests show that you could try to improve the effectiveness of intermarket systems by using three or more markets to filter out the signals. Note that as you add more markets, the effectiveness often decreases because of random noise among markets.

The basic gold-bond system tries to capture the weak negative correlation between the gold and bond markets. Such correlations also exist among other markets. Most trend-following systems have tested out

Table 4.17 The gold-bond system extended to three markets

	Gold-Bond System Extended to Three Markets: Cold, Soybeans, and Bond	Gold-Bond System Extended to Three Markets: Gold, Copper, and Bond

Test period 01 /02/75 - 07/10/95		07/28/88-07/10/95
Net profit	69,706	42,206
Profit factor (gross profit/ gross loss)	1.56	2.53
Total number of trades	77	
Percentage of winners	47	27 56
Ratio: average win/loss	1.78	2.02
Average trade ($)	905	1,563 -
Maximum intraday drawdown ($)	-30,600	12,388

poorly on the crude oil market, losing more than -$40,000. A negative correlation exists between crude oil and corn (Figure 4.36), and between crude oil and short-term interest rates. The Eurodollar market can be used as a proxy for short-term interest rates. Results of tests of the gold-bond system as developed on the corn-crude oil and Eurodollar-crude oil combinations are shown in Table 4.18. These tests use trend change signals from the corn and Eurodollar markets to trade crude oil.

The results show that the gold-bond system could be used to make a small profit on the crude oil markets, if we derive our signals from the corn market or the Eurodollar market. This is a big improvement over the results for typical trend-following systems.

Thus, these results show that you can use the gold-bond system to trade weak negative correlations among markets. The negative correlation between crude oil and corn is not obvious; it may have to do with the rising costs of international shipments—as crude oil prices increase, transportation costs increase, and U.S. corn producers must pay for flie higher costs by lowering corn prices. The inverse relationship between rising crude oil prices and short interest rates is through the fear of future inflation.

So far, all the intermarket systems we have discussed exploited the negative or inverse price relationships between markets. You could certainly extend these ideas to trade positively correlated markets, in which

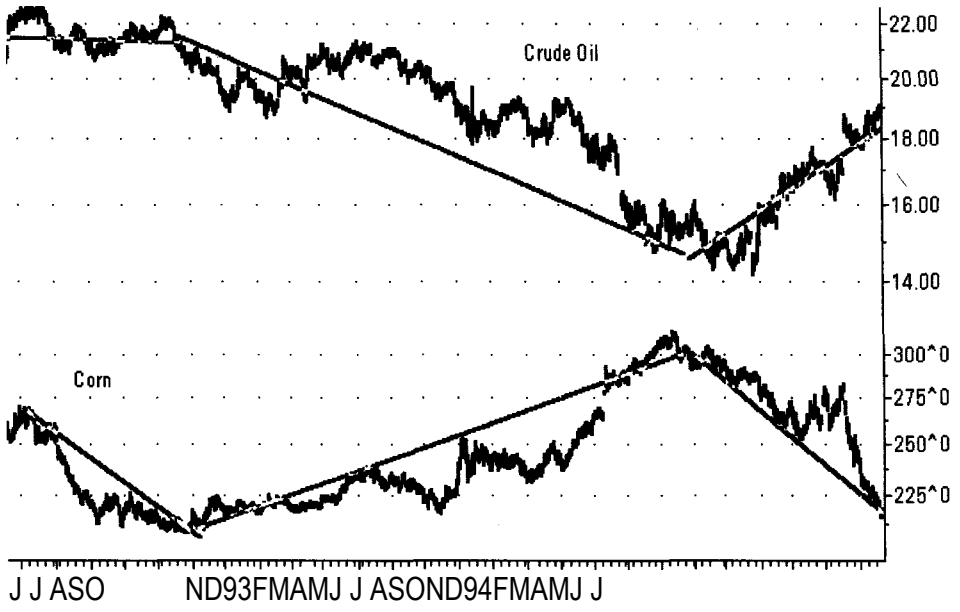


Figure 4.36 The approximate inverse price relationship between crude oil and corn.

Table 4.18 The gold-bond system tested to trade crude oil using corn and Eurodollar markets for signals

	Gold-Bond System Tested on the Corn-Crude Oil Markets	**Gold-Bond System Tested on the Eurodollar-Crude Oil Markets**
Test period	03/30/83-07/10/95	02/01/82-07/10/95
Net profit	11,550	16,320
Profit factor (gross profit/gross loss)	1.25	1.36
Total number of	57	57
Percentage of	53	53
Ratio: average	1.13	1.22
Average trade ($)	203	286
Maximum intraday drawdown ($)	-11.390	-20.020

a rising trend in one market would be a buy signal in the other market. The Japanese yen-deutsche mark combination uses trend change signals in the Japanese yen market to produce signals for the deutsche mark. The corn-live hogs combination uses trend changes in corn to generate signals for live hogs. Since corn is fed to hogs, rising corn prices could increase the production costs for hogs (see Figure 4.37). To test the gold-bond system in these correlated markets, we use a $5,000 initial

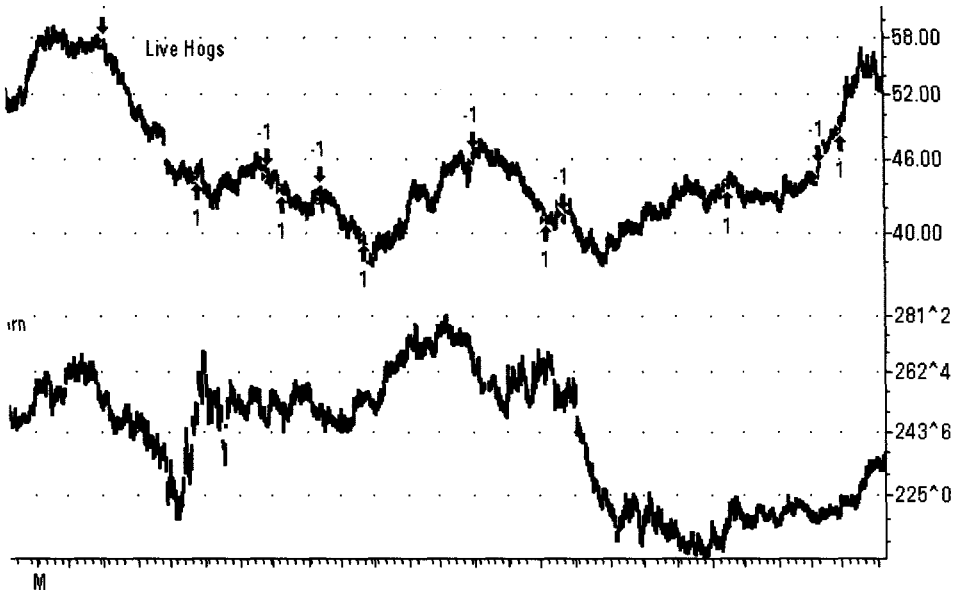


Figure 4.37

The relationship between corn prices and live hog prices.

Table 4.19 Gold Bond system extended to correlated markets, such as JY-DM and C-LH.

	Cold-Bond System for Correlated Markets: Japanese Yen-Deutsche Mark	Gold-Bond System for Correlated Markets: Corn-Live Hogs
Test period	02/13/75-07/10/95	01/02/75-07/10/95
Net profit ($)	51.188	34.052
Profit factor (gross profit/gross loss)	1.53	1.64
	99 46	105 44
	1.77	2.11
	517 -	324 -
	12,80	12,184
	0	
Total number of	99	105
Percentage of winners Ratio: average win/loss Average trade ($) Maximum intraday drawdown ($)		

stop for the currency markets, but only a $1,000 initial stop for the live hog market due to its relatively low volatility. As usual, we deduct $100 for slippage and commissions (see Table 4.19).

In summary, these results show that you can successfully use correlated markets to generate trading signals. You may feel more comfortable with the signals from intermarket systems because there are weak cause-and-effect relationships that have stood the test of time. At a minimum, you could use intermarket analysis to develop "background" information that could be used as input into your money-managetnent algorithm. For example, an intermarket system signal could be used to increase the size of existing positions or put on new ones. You could also use an intermarket signal as an exit strategy for conventional single-market systems.

A Pattern for Bottom-Fishing

Market-specific systems work best on a particular market because they capture some unusual feature of that market. It is difficult to speculate why certain markets show signature patterns. We should take extra care when developing such systems because the market mechanics driving such patterns could change abruptly.

The S&P-500 futures contract can be used to illustrate a pattern-based approach. For instance, we consider a continuous contract from April 21, 1982, through July 10, 1995, and test the standard simple moving average crossover system with 10-day and 11-day simple moving averages. We use a relatively loose $2,000 initial stop, which will absorb random price fluctuations, and allow $100 for slippage and commissions.

The 10- and 11-day dual crossover system lost $181,005 on paper, with 530 trades. Only 34 percent or 178 trades, were profitable, with a maximum intraday drawdown of $189,370. One interesting feature was that virtually all the loss ($185,545) was on short trades. This makes sense if we recognize that the market has been generally moving up since 1982. However, it is striking that this simple trend-following system fared poorly in spite of the prolonged uptrend. So the S&P-500 futures market is not a trend-follower's delight.

Because all of the losses were on the short side in the previous test, it makes sense to try the simple moving crossover system in the an-titrend mode. The antitrend rules are as follows:

1. Buy if the 10-day SMA crosses below the 11-day SMA on the close.
2. Sell if the 10-day SMA crosses above the 11-day SMA on the close.

Using the same test period, initial stop, and allowance for slippage and commissions as the previous test, the turnaround in profits with the antitrend rules was remarkable. This antitrend 10- and 11-dayJystem netted $55,920 for a swing of $240,925 on 531 trades. Fully 48 percent, or 254 trades, were profitable, with a maximum intraday drawdown of $32,735.

The results of the antitrend approach are not spectacular. However, they do highlight the unusual nature of the S&P-500 market. They suggest that you could find market-specific systems that would test poorly on other markets. For example, the 10/11 antitrend strategy lost $56,775 when tested on the Swiss franc continuous contract over the same period, but the 10/11 trend-following strategy lost just $13,088 over the same period.

The following is a glaring example of how "hindsight" influences system design. There were many "V" bottoms on the daily bar-charts of the S&P-500 market, so a bottom-fishing strategy that tries to pick bottoms was attempted. Theoretically, it should test well since this is an

andtrend approach. The rules for the S&P-500 "bottom fishing" pattern are as follows:

1. A 20-day low has formed within the last 5 days.
2. Today's high-low range > X; $X = 4$ for conservative trades; $X = 1$ for aggressive trades (each point is not one tick, but one full S&P index point = $500)
3. Today's closing-opening range > Y; $Y = 3$ for conservative trades; $Y = 0$ for aggressive trades.
4. If rules 1,2, and 3 are true, then buy tomorrow on the close.
5. Exit on the close of the twentieth day in the trade.
6. Initial money management stop = $2,000 per contract.

Note that we can fully automate the bottom-fishing pattern. We have no difficulty getting entries, because if we get a signal today, we can buy on tomorrow's close. So it is easy to implement using a mechanical system. For example, the analysis can be done after market hours, and the order entered before trading begins.

This system has a conservative entry combination and an aggressive entry combination. The conservative approach generates fewer trades. *You* can modify this pattern in many ways. The most obvious change is the exit strategy. For example, you could set an exit target at the most recent 20-day high.

The system was tested using System Writer Plus™ and actual S&P-500 contracts. The rollover date was the twentieth day of the month before expiration. The results are in two blocks in Table 4.20 because System Writer can process only 30 contracts at a time. You can treat either the conservative or the aggressive set of X and Y values as an unop-timized set. Both combinations were profitable on both blocks of data.

The equity curves for both options are shown in Figures 4.38 and 4.39. The equity curve for the conservative option is smoother than the aggressive option. Also, the aggressive option can produce larger drawdowns than the conservative values.

Data using the March, 1995 S&P-500 contract yield Figure 4.40, page 136, for $X = 4$ and $Y = 3$, and Figure 4.41 is for $X = 1$ and $Y = 0$. This system picked off the bottoms very accurately. Entry and reduced slippage are assured by entering and exiting on the close. Thus, a pattern-based, antitrend, bottom-fishing approach works nicely on the S&P-500 market.

Table 4.20 Performance of bottom-fishing system with $2,000 initial stop and exit on the close of the twentieth day in the trade using actual S&P-500 data with rollover

Pattern	Test Period	Net Profit ($)	Number of Percentage of Wi...	Ratio: Average Wi.../...	Average Tr...	Maximu Intraday Drawdo... ($)	Profi t Fa...
X= y=3	9/82-2/88	40,900	18; 44	3.80	2,272	-6,300	3.04
X= /=3	2/88-7/95	60.650	46: 39	3.25	1.319	-13.675	2.09
X= v=o	9/82-2/88	58.625	57: 45	2.45	1.029	-11.425	2.06
X= y=o	2/88-7/95	70,600	93; 35	2.81	759	-27,125	1.54

Equity Curve for SP#1: VarA = 4, VarB = 3, MMS = $2,000, Exit = 20th close

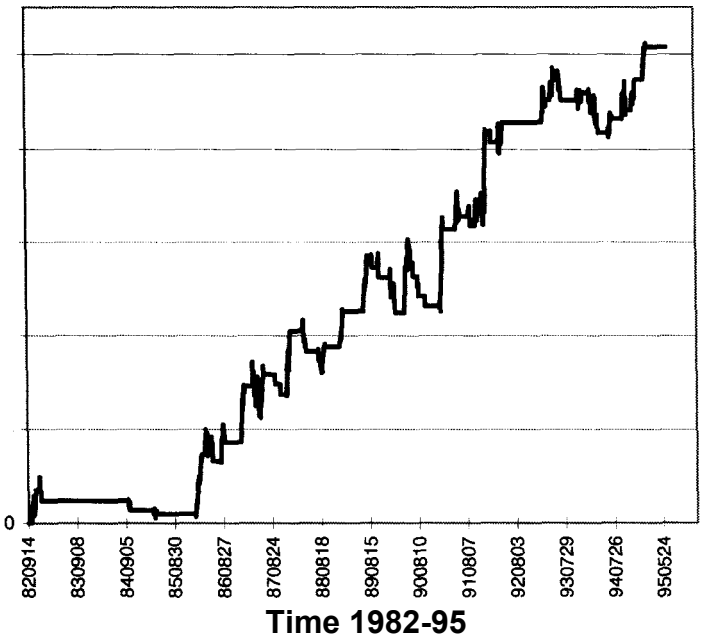


Figure **4.38** Equity curve for bottom-fishing pattern (9/82-7/95) with X = 4 and Y = 3 (conservative trades) for SScP-500 data with rollovers. Initial money management stop was $2,000 per contract.

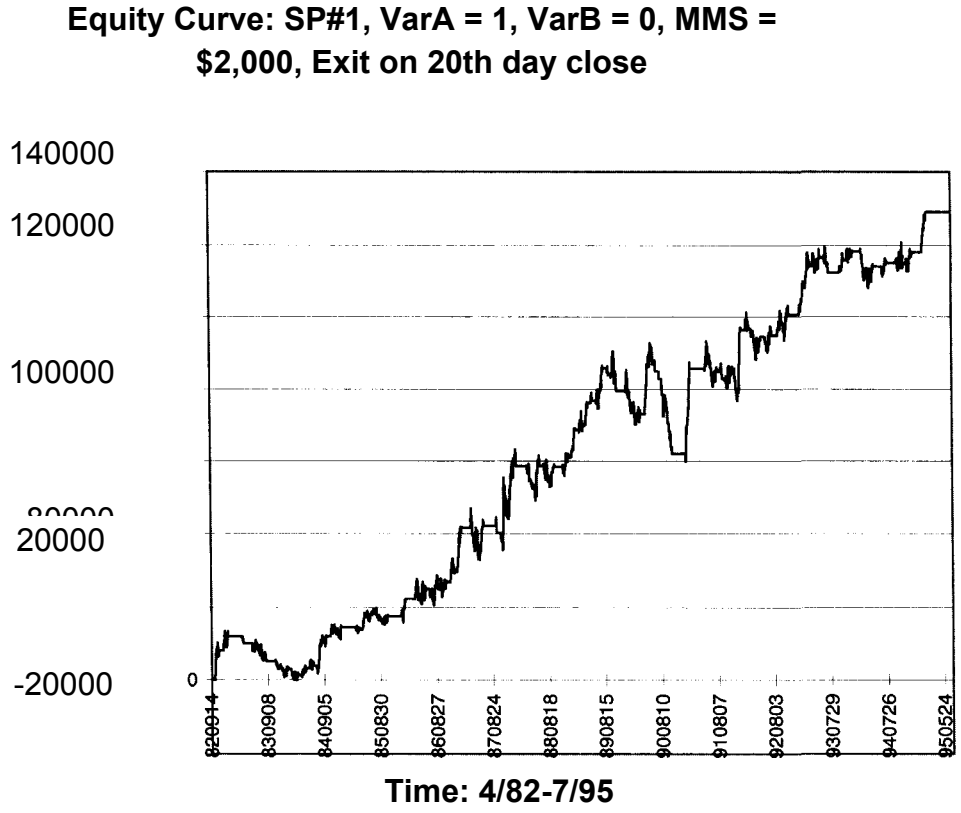


Figure 4.39 Equity curve for bottom-fishing pattern (9/82-7/95) with X = 1 and /= 0 (aggressive trades) for SScP-500 data with rollovers. Initial money management stop was $2,000.

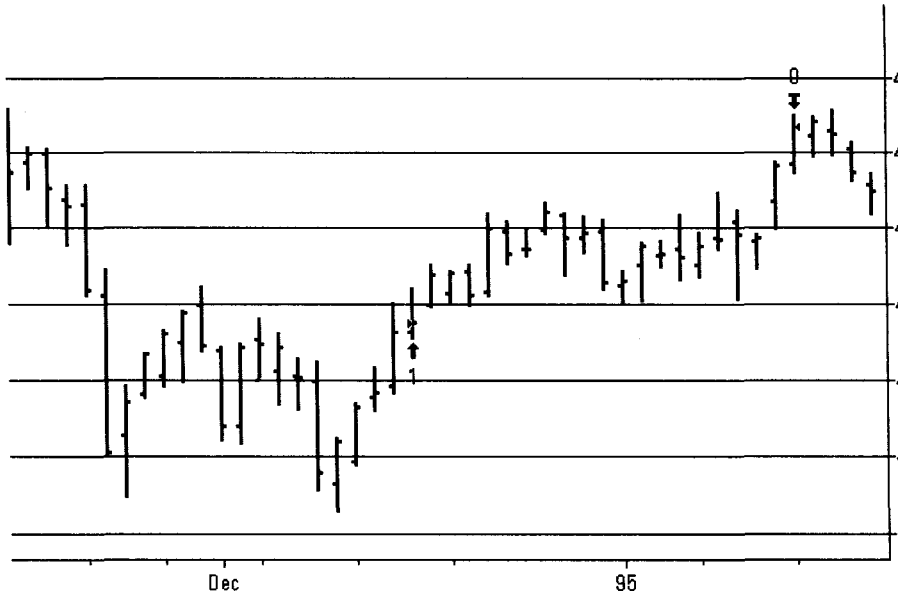


Figure 4.40 The bottom-fishing pattern with X = 4 and / = 3 picked off the important December 1994 bottom.

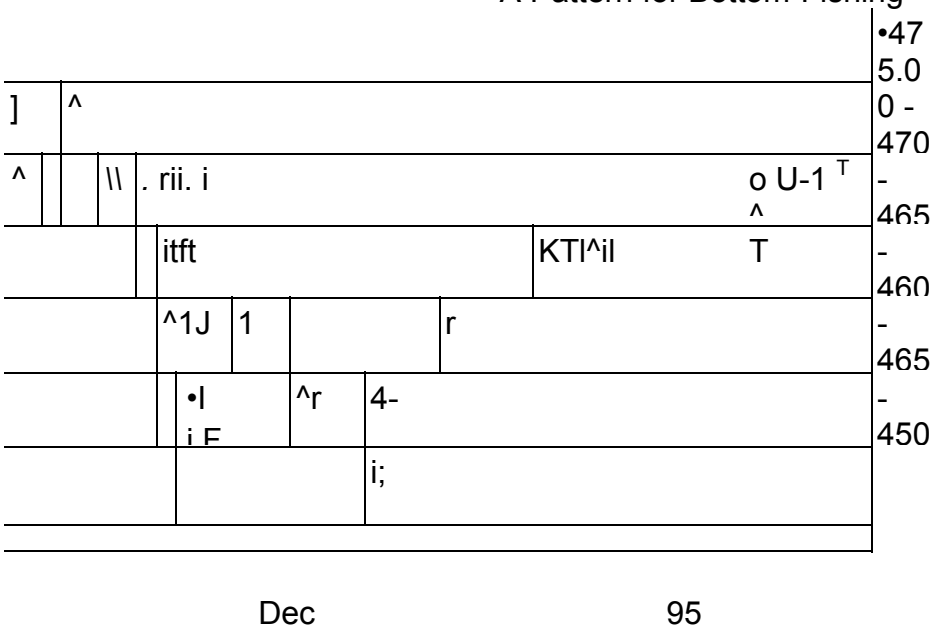


Figure 4.41 The bottom-fishing pattern with X = 1 and *Y = 0* entered the market closer to the December 1994 bottom.

You can try a variety of exit strategies. Instead of an exit on the close of the twentieth day (case 1), use a trailing stop on the 5-day low after a $1,000 profit on the trade (case 2). Case 2 with $X = 4$, $Y = 3$, a $2,000 initial stop, and $100 for slippage and commissions from February 12, 1988, through July 10, 1995, had a profit of $59,025 over 44 trades (45 percent winners) with a drawdown of-$7,625. You can compare these data to the second row in Table 4.20 (case 1). Thus, the new exit strategy produced approximately the same profits, but with a smaller drawdown and more winners. The equity curves for case 1 and case 2 are shown in Figure 4.42. You can see that case 2 has shallower drawdowns than case 1.

To check the basic validity of the bottom-fishing pattern on other markets, we must modify the pattern slightly to make it more general. Values ofX= 0.1 and $Y = 0$ are chosen in order to test across many markets. A trend-following exit, at the lowest low of the last 20 days, was chosen because not all markets are as dynamic as the S&P-500 market. The entry is switched to above the high of the signal day, instead of buying at the next days close, to reduce the number of entries in downtrends. The initial money management stop is $2,000, and as usual, $100 is deducted for slippage and commissions. The pattern uses all available data from January 1975 through July 1995 using continuous contracts on 17 markets. The results are for trading one contract at a time.

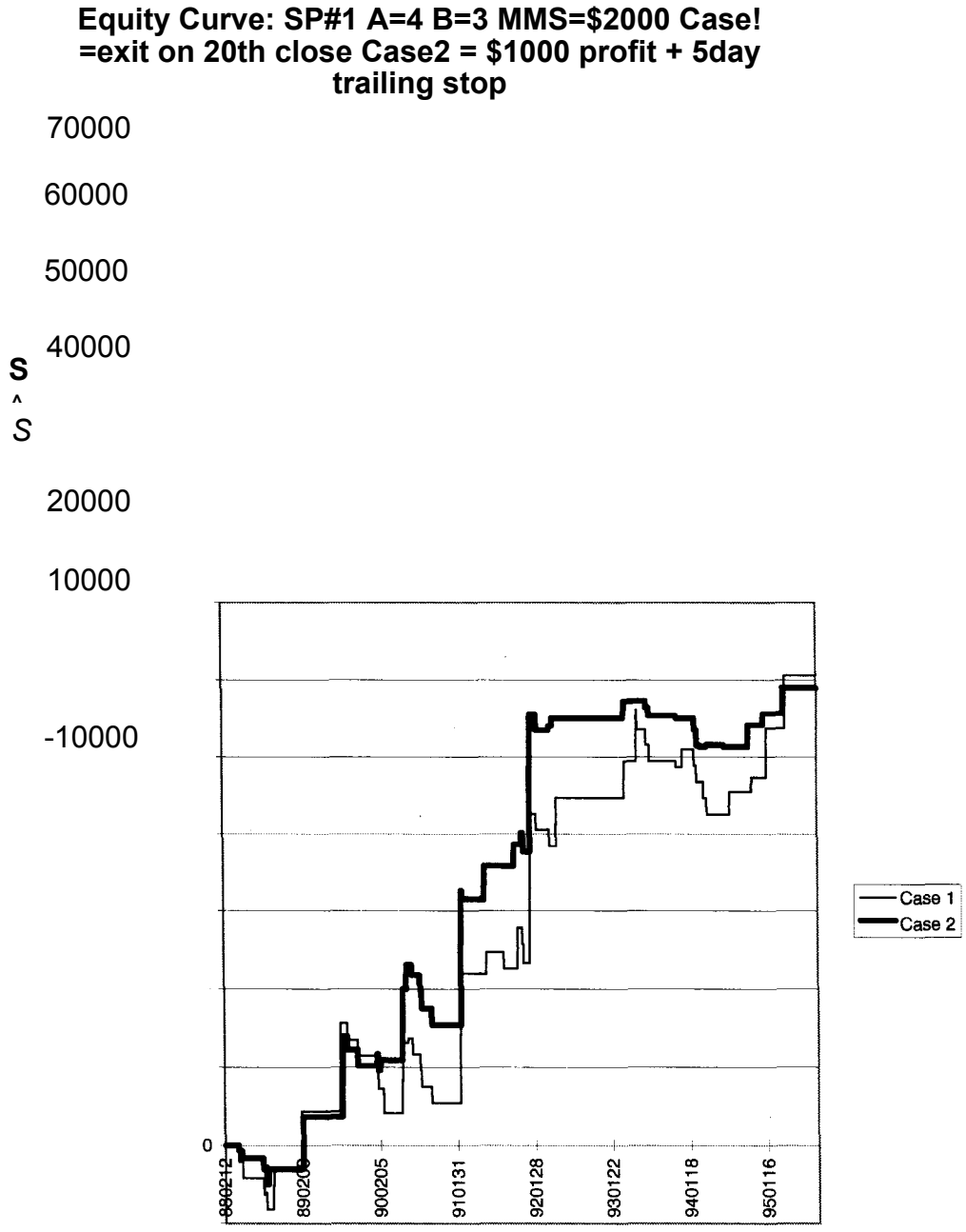


Figure 4.42 Equity curve for case 1 and case 2.

The generalized bottom-fishing pattern was profitable on 11 of 17 markets, including deutsche mark, Eurodollar, gold, Japanese yen, coffee, orange juice, Swiss franc, S&P-500, silver, 10-year T-notes, and the U.S. bond market. Thus the pattern also seems to work on markets that trend well or have good swing moves. The results are given in Table 4.21.

These data suggest that the bottom-fishing approach captures a basic trading pattern in the markets. The long test period and the profits on a variety of markets indicate that the idea is robust. The difference in performance between markets seems to be the amplitude of the movement after forming the pattern.

An extension of the test of the bottom-fishing pattern to stocks explores its performance over different time periods. Figures 4.43 (weekly) and 4.44 (monthly) illustrate how the generic bottom-fishing pattern works. Figure 4.43 has weekly data for Union Carbide showing how the pattern picked the bottoms in 1990 and 1991. The pattern also stayed long throughout the major uptrend. The pattern tests well with weekly data on stocks. Figure 4.44, page 140, has monthly data for Caterpillar

Table 4.21 Results of testing the generic bottom-fishing pattern on other markets

Market	Profit ($)	Number of Trades	Percentage of Wins	Maximum Intraday Drawdown ($)	Profit Factor
British	-17,694	195	21	-6,403	0.92
Coffee	86.740	200	20	-62.251	1.36
Crude oil	-35.660	117	22	-38.000	1.43
Eurodollar	20.650	45	36	-5.825	1.71
Gold	7.510	187	25	-40.000	1.06
Heating oil	-19.687	158	23	-50.124	0.88
Japanese	98.513	138	30	-15.188	1.95
Live hogs	-17.853	201	22	-22.1 76	0.83
Orange juice	12.653	194	21	-11.978	1.16
Silver	121.970	189	23	-54.550	1.81
Soybeans	-1 7.869	193	25	-35.719	0.86
S&P-500	127.925	111	30	^3.065	1.64
Sugar	-23.660	175	25	-34.166	0.75
Swiss franc	64,450	162	27	-28,387	1.48

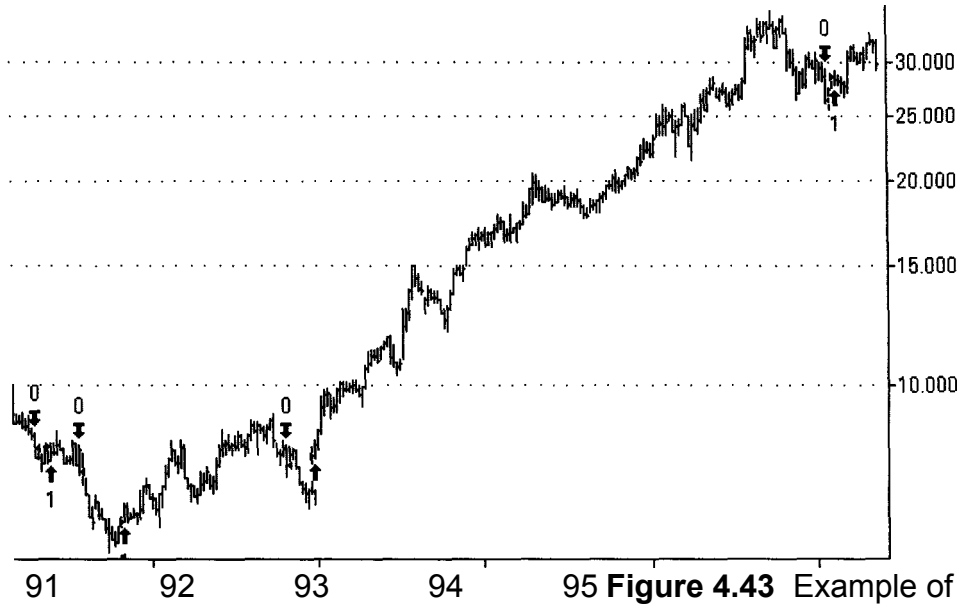


Figure 4.43 Example of generic bottom-fishing pattern on weekly stock data.

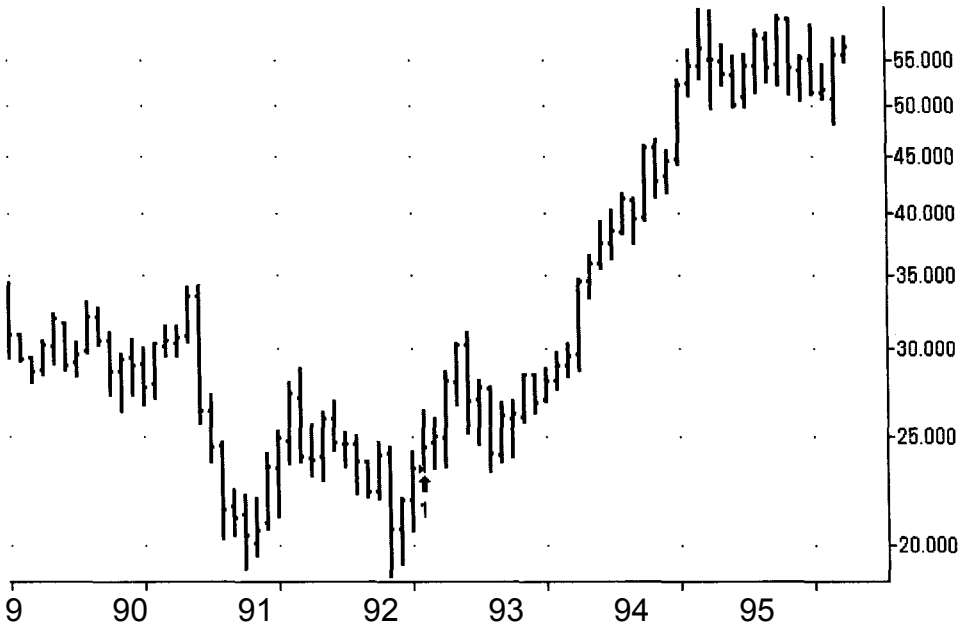


Figure 4.44 Example of generic bottom-fishing pattern on monthly stock data.

Tractor. The bottom-fishing pattern responded to the 1992 bottom and stayed with the stock throughout the rally.

In summary, the bottom-fishing pattern-based system is a good example of a market-specific system. You can use it as a model to develop other pattern-based systems on the S&P-500 market. The pattern can be generalized successfully to other markets, including stocks. The bottom-fishing pattern also works across time periods such as daily, weekly, or monthly. Thus, the bottom-fishing pattern captures a fundamental pattern of price evolution.

Identifying Extraordinary Opportunities

Once or twice a year, the futures markets provide extraordinary opportunities for exceptional profits, and if you can take advantage of these opportunities, your account performance will improve significantly. Ideally, you should try to increase position size in markets that present extraordinary opportunities. You can use a fixed formula or discretion in arriving at the increased exposure.

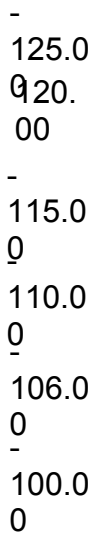
Figure 4.45 of the September 1995, Japanese yen contract illustrates such an extraordinary opportunity. If you had tripled your expo-

sure to the Japanese yen during these two awesome moves, you would have made an extra $40,000 with only moderate extra risk. These are the situations when you need "the courage to be a pig," as one famous money manager has said.

The challenge for system design is to find a consistent definition of an extraordinary opportunity. Once you have a consistent definition, you can use it any way you wish. In particular, you can use discretionary trading to adjust your exposure to the markets to exploit these situations.

The definition of an extraordinary opportunity as used here is simple. Use a 50-day SMA and plot a 3-percent trading band around it. Then a 7-day SMA must cross outside the upper or lower band to complete the identification of extraordinary markets. Thus, if the 7-day SMA. crosses above the upper 3-percent band, an upside extraordinary situation is declared (see Figure 4.45). A converse definition is applicable for bearish markets. The best scenario is that the market follows through vigorously in the direction of the established trend. The worst scenario is that the market teases you for a day or two before returning into a congestion zone. Then use an initial stop to close out the trade.

Be aware that a market can signal good opportunities for long and short trades within a few months. Some times a short-lived long signal can be a prelude to a strong down move, as the S&P-500 did in 1987



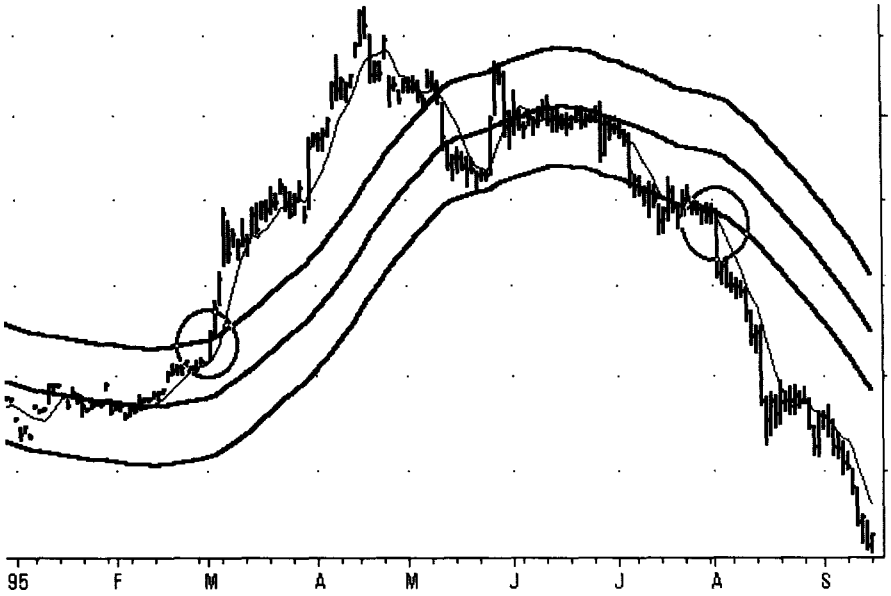


Figure 4.45 Extraordinary market opportunity identified by the 7-day SMA crossing beyond the 3 percent band around the 50-day SMA.

(Figure 4.46). Hence, be alert when you get the signal for an extraordinary market condition.

The next major challenge is an exit strategy. A simple strategy of exiting on the close of the twentieth day in the trade works well. Another exit strategy is to close out the trade when the 7-day SMA moves back inside the trading bands. You can imagine several other exit strategies, and I encourage you to test them all.

Table 4.22 summarizes a test for the extraordinary opportunity idea on all available data for several markets from January 1, 1975, through June 30, 1995. These calculations combined the usual 20-day channel breakout with the rules for declaring an extraordinary market opportunity. The long entry rule requires that the 7-day SMA be beyond 1.03 times the 50-day SMA in order to purchase just above the highest high of the last 20 days. The opposite conditions are needed for the short trades. The exit was on the close of the twientieth day, and as usual, a $3,000 stop and $100 for slippage and commissions were used, to allow for a more accurate test.

The long test period (20 years in some cases), the wide diversity of markets, and the relatively high proportion of winning trades suggests this strategy is a valid approach toward identifying extraordinary market opportunities. The MIDD numbers suggest that the exit strategy is

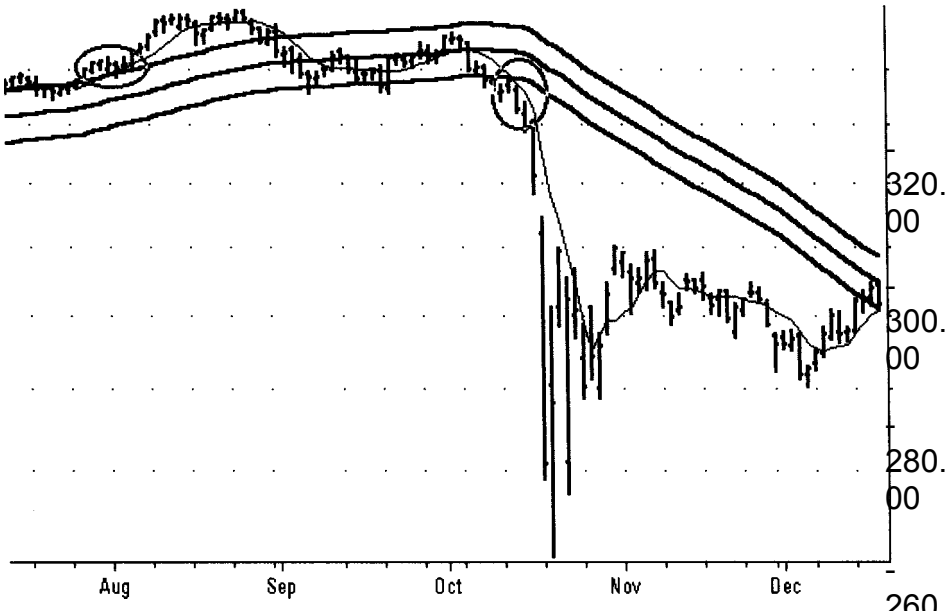


Figure 4.46 A market can signal extraordinary opportunities on the long and short side within a short period.

Table 4.22 Performance summary with 3-percent trading band, exit on close of twientieth day in trade

Market	Profit ($)	Winners; Total Trades	Percentage of Winners	Ratio: Average Win/	Profit Factor	Maximum Intraday Drawdown ($)
British	38,125	37; 62	60	1.08	1.60	-11,756
Coffee	122.273	69:157	44	1.94	1.52	-34.683
Cotton	48.255	66: 123	54	1.33	1.55	-11.505
Crude oil	12.610	40: 73	55	1.08	1.31	-7.800
Deutsche mark	9.963	36: 71	51	1.15	1.19	-10.688
Gold	46,310	42; 85	49	1.75	1.71	-21,520
Heating oil	19.220	59: 117	50	1.18	1.20	-17.822
Japanese	18.225	34: 71	48	1.42	1.31	-16.638
Live hogs	10.805	82:149	55	0.94	1.15	-11.832
Soybeans	25.756	49: 107	46	1.50	1.26	-25.675
S&P-500	28.040	22: 58	38	2.08	1.27	-27.932
Swiss Franc	19.187	44: 85	52	1.14	1.22	-15.050
10-year T-Note	3.918	88: 18	44	1.53	1.23	-7.506
U.S. bond	3,468	34; 65	54	0.89	1.04	-27,932
Average	29,011		50	1.36	1.33	-17,739

critical to the success of this system. As an example, the results of adding a trailing stop and narrowing the bands are shown in Table 4.2 3.

In our discussion of risk of ruin, we assumed the following constant parameters: probability of winning, payoff ratio, and fraction committed to trading. However, in actual trading, the probability of winning and payoff ratio change with time. Hence, you should consider changing your fraction of capital risked on a trade, especially if an extraordinary market opportunity is recognized.

The test results in this chapter are with just one contract; this is an opportunity to use discretion and increase your exposure to the markets. Hence, the potential impact on returns can be quite significant with multiple contracts, based on the one-contract results shown here. *You* also have the option of using discretionary exits, or other exits based on shorter term data, such as an hourly chart.

Remember that you can check fundamental developments to confirm the presence of extraordinary market conditions. For example, there may be an unusual weather pattern, a political development, or a