THE APPLICATION OF TECHNICAL ANALYSIS TO GRAIN MARKETS

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ABSTRACT

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Volatile prices for grain in the 1970's have increased the complexity of grain pricing decisions. Technical analysis is one type of price analysis that can be used in conjunction with hedging strategies to aid in pricing decisions.

According to theory, technical analysis does not provide any valuable information. However, previous studies show technical analysis can generate profits in volatile price periods. This work tests the relationship of profits from a speculative trading strategy with a measure of price volatility. The test is over wheat, corn, and soybean price data from the mid-1970's, using moving averages and point and figure charts as technical tools. In addition, a number of grain pricing strategies using technical tools are simulated and tested for the same period.

In general, technical analysis generated higher returns in years of greater price volatility. Also, selective hedging strategies using technical analysis increased net price received for soybeans and wheat.

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CHAPTER 1
INTRODUCTION

Grain prices have exhibited a high degree of variability over the past decade. Increased demand in combination with poor harvests around the world in the early and mid-1970's decreased grain stocks to near "pipeline" levels. When loan rates and CCC selling prices ceased to be market factors, prices fluctuated widely within crop years, as demonstrated in Table 1-1. Prices from 1972-78 were more volatile than those for the 1968-69 crop year, even when adjusting the price changes for the difference in absolute price levels. Prices and price ranges for the 1968-69 crop year were fairly representative of grain prices in the 1960's and were included as a contrast to the 1970's.

This variability in prices can cause grain producers' total revenue and net income to vary considerably with years of high profits intermingled with years of low or negative returns. However, with the amount of price variation present today and the high level of debt required to finance most farm operations, two or three consecutive years of poor prices may bring on bankruptcy for highly leveraged farmers. Furthermore, price variability affects marketing decisions in regard to the timing of grain sales. Grain producers must already incorporate storage costs and options, taxes, cash flow needs, risk preferences and other factors into their marketing strategy; volatility of grain prices adds to the difficulty of these decisions.

A sales management tool to aid in timing the pricing of grain might be of use to some producers. Goals for such a tool would be to:

Table 1-1. Range in the Monthly Prices Received by U.S. Farmers.

	Corn[1]			Wheat[2]			Soybeans[1]		
Year	Low	High	Range	Low	High	Range	Low	High	Range
1968-69	.96	1.19	.23	1.19	1.29	.10	2.28	2.56	.28
1972-73	1.19	2.68	1.49	1.32	2.43	1.11	3.13	10,00	6,87
1973-74	2.17	3.37	1.20	2.47	5.52	3.05	5.13	7.55	2.42
1974-75	2.66	3.45	.79	2.92	4.87	1.95	4.90	8.17	3.27
1975-76	2.33	2.82	.49	3.33	4.11	.78	4.28	6.73	2.45
1976-77	1.60	2.35	.75	2.03	3.33	1.30	5.42	9.21	3.79
1977-78	1.67	2.29	.62	2.04	2.82	.78	5.17	6.77	1.60

[1] Crop year from October 1 to September 30.

[2] Crop year from July 1 to June 30.

1) Increase the average net price received; and/or

2) Decrease the variability of net returns.

Forecasting tools such as econometric models are in general too sophisticated for use by individual producers. Also, producers are severely limited by the amount of time that can be devoted to market analysis, even though such time is normally a good investment. One tool that has attracted a considerable amount of attention in recent years for possible use in this area is technical analysis. It is relatively easy to use in terms of both time and quantitative skill.

The basic premise of technical analysis is that all the relevant information regarding a commodity is embodied in its' price, and by studying past price movements, changes, and patterns, one can know what prices will do in the future. Technical analysis has for the most part been developed for use in the stock markets. Commodity markets possess many of the same attributes as do the stock markets, and thus the application of the techniques to the commodity markets was inevitable.

Technical analysis takes its form in two general categories, charts and calculable tools. Most work using charts requires a good deal of skill and interpretation by the chartist, while the calculated tools for the most part are arbitrary and have a definite formula. However, there is some overlap, as simple signals given by point-and-figure charts can be reduced to mathematical formulas, and various mechanical tools provide nebulous output in regard to taking market positions (e.g., momentum indicators and oscillators).

Technical analysis has received a mixed response among both market participants and those who study market behavior. A large number of members of both the market community and academia disclaim technical analysis as having any value,pointing to the efficient market hypothesis and a large body of empirical tests. The efficient market hypothesis in its various forms claims that profits cannot be made by following a technical system, and a number of studies in both commodity and stock markets support this view.

On the other hand, there are some theories and empirical results that point out possible weaknesses in the efficient market hypothesis and leave room for technical tools. In trade publications, "hope springs eternal" in regard to technical analysis. Many authors claim they have found fame and fortune through technical systems, although many of these have undoubtedly made their fortune by writing about systems rather than using them. Unfortunately, many of these claims have not been backed up by empirical tests over large periods of time - at least results are not available anywhere, with a few exceptions.

Perhaps these two opposing views can best be represented by two quotations. Samuelson [48], in an article entitled "Proof that Properly Anticipated Prices Fluctuate Randomly," says that profits from speculative action cannot be increased by "chart or any other esoteric devices of magic or mathematics." A statement representing the other viewpoint of technical analysis is by Cootner [13]: "Like the Indian folk doctors who discovered tranquilizers, the Wall Street witch doctors, without the benefit of scientific method, have produced something with their magic, even if they can't tell you what it is or how it works."

The objective of this research is to determine if technical analysis provides useful information to a market participant, with useful information being defined as that which can be transformed into increased profit. This research can be outlined in several stages. Chapter Two involves looking at the existing body of theory and empirical studies to identify a framework concerning technical analysis. Then Chapters Three and Four develop and test a hypothesis concerning technical analysis and its niche in price behavior theory. Finally, the results from application of technical analysis to a number of marketing strategies for corn, wheat, and soybeans are presented in Chapter Five.

This study is not a direct test of the random walk hypothesis, although the results will have direct implications to that theory. The questions addressed in this research concern the performance of technical analysis: "Does it provide useful information?" "When does it do so?" and "Is there any theoretical basis to this 'witchcraft?'" Furthermore, it is assumed that the reader has already been exposed to the concepts and operations of futures markets, hedging, and technical analysis. If not, Teweles, Harlow, and Stone [54] and Purcell [43] (especially Chapter 8-10) should provide an adequate understanding of the terminology and techniques.

CHAPTER TWO
REVIEW OF THE LITERATURE

A large amount of research has been done in the general area of price behavior and futures markets. Teweles, Harlow, and Stone [54], Labys and Granger [33], and Kaufman [31] provide extensive bibliographies that are divided by topics. Cootner [14] and the Chicago Board of Trade [9, 10] are compilations of journal articles, proceedings, and research that present the major theoretical and empirical work done on these topics.

Four interrelated areas are involved in this study:

1. Futures Market Price Behavior
2. Technical Analysis
3. Hedging Theory
4. Selective Hedging Studies

Articles in each of these areas are reviewed in a topical fashion.

Futures Market Price Behavior

In general, the work done in this area centers around the question: "Are Futures Markets characterized by random walk behavior?" The hypothesis on which this question is based is that the futures markets are highly competitive and have a large number of participants. Furthermore, these participants have equal access to all current information and prices thus adjust to new levels immediately. Since new information is assumed to enter the market in a random fashion, price changes occur randomly. Therefore, past prices and past price changes shouldn't provide any useful information in estimating future prices or price direction. The best estimates of tomorrow's price is today's price.

Two different approaches have been used to test whether or not futures markets behave in a random fashion. The first set of tests is that of statistical analysis. Included here are analysis of runs, spectral analysis, autocorrelograms, and various other tests for serial correlation. The second type of analysis involved trading rules. If the market is truly random, any type of mechanical or mathematical trading system based on past prices or price changes will have an expected gross profit of zero, assuming price levels are the same at the beginning and end of the test. Results from both types of tests will be discussed below.

Keynes [32] was one of the first to lay claim to a systematic bias in futures prices. He contended that hedgers would sell contracts to speculators as a form of insurance against price movements. The speculators recognized this action by hedgers and would buy the contracts at a discount, causing a downward bias in futures prices. Keynes called this situation normal backwardation, and the bias was described as the risk premium, or the amount hedgers were willing to pay for their "insurance." Therefore, a speculator, according to Keynes, should be able to consistently take and hold long positions and expect prices to rise as the delivery date drew near, leading to profits. This led to a number of empirical investigations, most of which refute Keynes' claim. Gray [24] is one such article that does so empirically along with a discussion of previous tests of the same hypothesis.

Larson [34] investigated the impact of new information in the corn markets. He used data from two periods, 1922-31 and 1949-58, and found that market price does not adjust to new information immediately. Using a statistic called the index of continuity, he concludes that 81% of the price movement occurs on the day information is introduced to the market, followed by a counter-reaction of -8% over the next four days. The final adjustment of 27% occurs over the next forty-five days.

Brinegar [5] also developed a new statistic similar to standard serial correlation techniques and found a weak but statistically significant tendency toward continuity of a trend in wheat, corn, and rye prices. These trends ranged from 4 to 16 weeks in length. Furthermore, Brinegar concluded that continuity of prices occurs during periods of large price movements.

Smidt [50] uses soybean price data from 1952 to 1961 to test for random behavior. He used a type of moving average trading tool to test for positive and negative serial correlation in the price changes. In regard to the test for positive correlation, Smidt found significant profits for the period as a whole. However, these profits were generated in three years, the only ones with price ranges throughout the year being greater than $1.00. He concludes that if those years with larger price ranges could have been forecasted ex ante, there is evidence for positive serial correlation.

Conversely, Smidt tested a trading tool that "scalped" the market, selling after price increases and buying after price decreases. This rule also generated significant profits, causing Smidt to conclude that there definitely was negative serial correlation in the price data.

Stevenson and Bear [52] used both statistical tests and mechanical trading rules to test corn and soybean prices for random behavior.

They used probability distributions, serial correlation tests, and analysis of runs for a statistical analysis, and stop-loss orders and filter rules for a trading analysis. The tests were conducted over the data period of 1957-68. The tests suggested that the random walk hypothesis does not adequately explain the movement of the prices analyzed. The tests turned up evidence of negative price dependence in short periods, positive dependence in long periods, and significant profits generated by the trading systems.

The latest study has been conducted by Cargill and Rausser [7]. They used six different statistical tests over the period 1960-72 for corn, wheat, and soybeans among other commodities. They list two conditions for a price series to behave as a random walk:

1. The expected futures price increments are insignificantly different from zero.
2. The futures price increments are independent and thus uncorrelated over time.

Rejection of one or the other is a sufficient condition to reject the random walk model, although rejection of one condition does not cause the other to be false. Their results show most commodity contracts to exhibit random behavior. However, they feel enough contracts violate the second condition above and thus conclude: "Thus the random walk model must be rejected for the commodities considered in this paper," (p. 1052).

Before leaving the topic of futures market behavior, a look at possible causes and implications of the prospect of non-random price movement would be in line. In the empirical work, two types of tests have been used, statistical analysis and mechanical trading tools. Fama and Blume [18] point out that there isn't a simple relationship between the degree of serial correlation indicated by statistical tests and expected profits from trading rules. Also, Cargill and Rausser [7] also explain that rejection of the random walk model does not mean commodity markets are inefficient. An efficient market implies that profits cannot be generated by some mechanical trading system.

An excellent discussion of two theories that have been developed to explain possible correlation in prices is given in Moore [42]. One theory was first proposed by Taussig [53]. Perception of supply and demand conditions in the market is imperfect, and this allows for a range or "penumbra" around the equilibrium price. Prices can fluctuate within this penumbra due to the tug between forces in the market. These tugs gain momentum and thus prices swing back and forth within the range, causing correlation in the price series. The limits of the range are determined by a general consensus about the underlying conditions of supply and demand. These limits are similar to "resistance and support levels."

The second theory was developed by Holbrook Working and is called the theory of anticipatory prices [61]. He points out that the volume of information coming into the market is too large for any single trader to assimilate into price expectations. Therefore, truly new and important information may come into the market and be ignored by a considerable number of traders. The time required for all of the traders to adjust their positions to the new information causes a gradualness in the overall price change. This gradualness beings forth short term predictability of price movements and causes serial correlation in the series. Hoffman [26] attributes this gradualness of price changes to two factors: 1) some traders seek out information before others; and 2) some traders judge certain pieces of information better than others. Alexander [1] and Brinegar [5] also support Working's theory of anticipatory pricing.

Alexander [1],Leuthold [36],and Kaufman [31] raise another possible problem with statistical tests for the random walk model. They point out that almost all tests have an element of linear dependency with respect to time; i.e., prices are measured at uniform, discrete periods. Alexander claims that there are trends in stock market prices once the "move" is studied as a unit of measurement rather than weekly or monthly observations. Leuthold also comments on this problem of discrete measurements and further adds "One would have to question that acceptance of the random walk hypothesis using statistical tools implies that no profits can be generated from the data by chart or mathematical devices." Kaufman, while pointing out problems with using discrete measurements, adds a warning about data selection. Any mechanical tool or statistical test can be proven or disproven merely by choosing certain data bases. Thus any tests need to be interpreted in light of the characteristics of prices during that period.

Technical Analysis

A large number of articles and books have been written on the topic of technical analysis. The basic tenet of technical analysis is that all market information is incorporated into the price, volume, and open interest of the commodity in question, with the greatest attention given to price. Therefore, one could study market action by following past price changes and price history. Edwards and Magee [16] and Gotthelf [22] both explain this basic premise.

Technical analysis takes one of two general forms, charts and systems. Charting tools require a certain amount of subjective interpretation by the individual. Therefore, most signals generated by charts are not definitive. Systems or mathematical tools, on the other hand, generally provide output that is objective and exact, giving clear buy and sell signals. Within these two forms of analysis are three basic types of systems - trend-following, cyclical and seasonal analysis, and range trading.

Saslaw [49] and Gotthelf [22] discuss trend-following systems. These are based on the belief that once a price has begun to move in a certain direction it will continue to do so. A trend-following system doesn't predict price moves, turning points, tops or bottoms. Rather, it detects price moves and "hops on," hoping to close out the position soon enough after price direction reverses to make a profit.

Gotthelf [22] and Bressert [4] both discuss following the markets from a cyclical point of view. Price levels are assumed to be made by a number of cycles interacting with each other. The problem here is to identify all the relevant cycles and combine them properly to come up with forecasts as regards market direction in the near future. Finally, Steinberg [51] presents a trading range system. This type of technical tool assumes that prices move within a given range at any point in time. Therefore, price movements will be followed by subsequent movements in the opposite direction, and profits can be made by placing orders at the extremes of the range. This type of system is dependent upon negative serial correlation in the price series.

For the amount of literature written on technical analysis in futures markets and commodity trading, very little has been published in the area of empirical results. Only a few studies have been conducted on a broad base of data, both in terms of commodities and time period involved. Most studies conducted on the performance of technical analysis have involved trend-following techniques.

Donchian [15] presents the results from using 5 and 20 day moving averages on 28 commodities for over 13 years, 1961 to mid-1974. Decisions to buy and sell were made on the crossing action of the two moving averages with a number of modifications in the form of penetration rules. At first glance, his results for 1961-1973 look very good, with $183,552 made over the 13 years on a margin investment of $20-30,000. However. 71% of these profits were made in 1973, and 56% of the profits for the 13 year period were made by five contracts in 1973 alone. Furthermore, profits after commissions from these 28 commodities under the same system in the first half of 1974 were $73,311. From his results it appears that the 5- and 20-day moving average system works best in volatile markets that have wide swings in prices, which was characteristic of 1973-mid-1974.

Zieg and Kaufman [62] conducted a short term study on 23 commodities for the first half of 1974. They use point and figure charts with simple buy and sell signals as a decision mechanism. Using the standard box sizes and reversal numbers for this period, profits after commissions were $51,490.82. Using the best combination of box size and reversal number for all commodities increased the profit after commissions to $102,707.19. Although Zieg and Kaufman discuss their system and results with great enthusiasm, one would do well to remember their test was over a very short period of unusual price movements.

Franzmann and Lehenbauer [19, 20] conducted two studies on the use of technical analysis in the feeder cattle markets, one using point-and-figure charts and one using moving averages. Profits after commissions generated from these tools appeared to be significant on the average, but there was some variation from year to year. One interesting characteristic, even though not mentioned by the authors, is that the years with the greatest profits were those years with the widest range in prices (widest range being defined as the difference between the extreme high and low price during the contract year).

Hedging Theory

The initial concept of hedging was interrelated with the theory of normal backwardation. Hedging was the taking of an offsetting position in the futures markets as was held in the cash markets in order to transfer risk from the hedger to the speculator. However, Working [58] pioneered a new concept or definition of hedging: "Hedging in futures consists of making a contract to buy or sell on standard terms, established and supervised by a commodity exchange, as a temporary substitute for an intended later contract to buy or sell on other terms." This new concept points out that hedging is not just a risk transfer mechanism but creates a number of marketing opportunities.

In another paper, Working [59] delineates five kinds of hedges. These are the carrying-charge hedge, operational hedge, selective hedge, anticipatory hedge, and the risk-avoidance hedge, the last three of which apply to this piece of research. Selective hedging is based on making marketing decisions because of price expectations rather than to avoid risk. This type of hedging can well be used by firms with good price forecasting ability, and the performance of their selective hedging is best tested by the amount of losses precluded or profits gained. Anticipatory hedging is similar to selective hedging except it deals with the purchase or sale of commodities not yet needed or produced. The hedge is not offset by current stocks or needs of a commodity, but serves as a temporary substitute for a merchandising contract to be made at a later date. Finally, risk-avoidance hedging is done because the party involved is averse to the risk involved in their cash market position. Working feels this type of hedging is unimportant and practically non-existent.

Working [58] also lists four benefits of hedging. First of all, it aids in making buying and selling decisions. For certain situations, hedging reduces the decision problem from consideration of the absolute price level to consideration of price relationships. Second, it gives the entrepreneur greater freedom in his business decisions. For example, the time horizon within which the purchaser or seller can lock in a price is much greater. Third, use of futures markets in hedging provides a reliable basis for conducting orderly storage of commodity surpluses. Finally, hedging reduces business risks, although this may not be the primary motivation for hedging.

Selective Hedging Studies

This section will deal with empirical studies on the performance of selective hedging strategies. Most of the studies have been focused on the livestock industry, with particular attention given to fat cattle and feeder cattle. The studies generally utilize a simulation model of a farm or feedlot enterprise. Sometimes several production alternatives are tested along with the different marketing strategies.

Results are usually presented in a profit or cost per head figure with a corresponding variance statistic. Marketing decisions are made on the basis of econometric forecasts, comparison of basis and/or breakeven costs with actual prices, and technical analysis.

Most of the studies are evaluated by the mean-variance criterion explained by Holland, Purcell, and Hague [27]. This criterion was developed in portfolio theory and evaluates the hedging strategy by comparing the change in mean return and variance to a control strategy. The control strategy is usually a pure cash strategy (no hedging), or in some cases a hedge-and-hold strategy. The objectives are to: 1) increase the mean return while holding its variance constant; or 2) decrease the variance of mean returns while holding the mean constant; or 3) a combination of 1) and 2).

One study conducted on a non-livestock commodity was Lutgen [38]. He tested six strategies on soybeans for the period from 1971-76. Five of his strategies were arbitrary with respect to making cash sales or placing hedges at set times. The sixth strategy was a selective one where the marketer would either hedge or sell on the cash market, with the decision criterion being the basis. The hedges were to be lifted at pre-determined times if the basis was favorable. Lutgen found that the selective strategy performed best in what he felt were the volatile years, 1973-75. In the other years - 1971, 1972, and 1976 - the strategy that sold at normal seasonal highs performed best.

Lutgen concludes that a producer needs to be flexible in his marketing strategy from year to year, depending on the fundamental outlook. He recommends that producers watch fundamental indicators that are put out by the USDA very closely. A grain producer should vary his marketing strategies as the general world situation for grains changes if he desires to maximize his returns.

Leuthold [35] simulated a fat cattle operation that used hedging in its marketing practices. He tested eleven strategies which either placed the feeder in a hedged or non-hedged position for the entire feeding period. Decisions to hedge were made on the basis of seasonal price patterns or on various comparisons of cash, futures prices, and/or production costs. Four of the strategies increase the mean return and lower the variance of returns over the period from 1964 to late 1974. However, if the period from mid-1973 to the end are deleted - a period of volatile prices - none of the strategies are superior to the cash strategy. This points out the negative effect of extreme variability in prices on cash strategies and how hedging strategies aid in marketing in disruptive periods.

Brown and Purcell [6] developed econometric forecasting models for feeder cattle prices and used these in conjunction with moving averages to develop various hedging strategies. Data for 1972 to 1976 were used in a simulation model of a feeder cattle producer who could use one of four production alternatives. Decisions to hedge or not were made on the basis of fundamental forecasts and/or technical signals given by moving averages. The strategy using forecasts and moving averages increase return and decrease risk (measured in terms of standard deviation). However, the strategy using only moving averages to place and lift hedges during the production period has a higher return and lower standard deviation than those strategies using the price forecasts.

Franzmann and Lehenbauer [19, 20] conducted two studies on feeder cattle hedging using only technical analysis. Simulations were set up for both long and short hedges under various production plans and planning horizons, respectively. Price data was from the March, May, and October contracts for 1972-77. Decisions to place and lift hedges during the production or planning periods were based on moving averages [19] and point-and-figure charts [20]. For both studies in general, the returns are significantly higher and variance of returns is much lower for the selective hedging strategies as compared to the cash or no-hedge strategy. In comparison to the hedge and hold strategy, returns are much higher and the variance of returns is moderately higher in most cases for the selective hedging strategies.

The above studies present a good cross-section of those that have been done on selective hedging. Several others have particular features that bear mention. Riffe and Purcell [46] use a different criterion for strategy evaluation. They compared the performance of marketing strategies for fat cattle on the level of debt required to finance the operation through the period from 1965-1977. In another study Purcell and Richardson [45] used quantitative models and moving averages to selectively hedge corn as an input to a cattle feedlot. Other studies that have been conducted on selective hedging, each with a slightly different approach, are Hummer and Simpson [29], Erickson [17], Purcell, Hague, and Holland [44], McCoy and Price [40], and McCoy, Price, and Solomon [41].

Summary

Several conclusions can be drawn from the studies cited above:

1. Commodity prices do not behave randomly at all times. This has

been proven through the use of statistical tests for serial correlation and application of trading rules to price data. In addition, the departure from randomness usually occurs during periods of large adjustments in price levels.

2. There are existing theories to explain why commodity price behavior may not be random. In general, both theories are related to questioning the random walk assumption that information is immediately and exactly incorporated into the price level. Specifically, one theory claims market price is not determinate and can rise and fall as momentum changes, while the other theory points out that inequality of judgment ability and availability of information causes price changes to be gradual.

3. The use of various types of hedging should be viewed as marketing alternatives, not just as risk avoidance mechanisms. Conceptually, hedging is usually viewed as a method to reduce risk exposure. However, a greater benefit of hedging might be the expanded opportunities it provides a buyer or seller to price the commodity in consideration.

4. Technical analysis has been used in both a speculative and hedging framework to generate significant profits, although profits do not occur every year. In addition, the benefits of using technical analysis appear to be greatest when prices are volatile, with volatile defined as moving over large price ranges. This conclusion is similar to number 1 above in

that 1) markets may very well not be random, and 2) technical analysis provides profits during periods of large price adjustments.

CHAPTER THREE
HYPOTHESIS, TESTS, AND DATA

As stated in the introduction, the intent of this research is to determine 1) if there is a basis for expecting technical analysis to work and 2) under what market conditions it might work. As seen in theliterature review, previous studies conducted on commodities have shown that technical systems can generate profits, at least in certain years. The next step is to take theexisting body of theory regarding price behavior and compare it with the results from previous studies to check for any correlation between price action and the performance of technical analysis. From the studies cited, it appears that technical analysis generates profits in periods of volatile prices, where volatile is defined as moving over large ranges.

Hypothesis

The null hypothesis for this study can be stated as follows: Technical analysis does not provide any information concerning price movement that would allow a market participant to profit from trading in the futures markets. The alternative hypothesis is: Technical analysis does provide information about price movement that can be used to generate profits in futures markets transactions in years characterized by volatile (large) price movements.

This alternative hypothesis is different in two ways from those stated or implied in previous studies. First of all, the issue being investigated is the performance of technical analysis, not the randomness

of futures market prices. While the results will have definite and direct implications to the question of randomness or even efficiency in market price behavior, that is not the focus. Secondly, this hypothesis is not directed toward "blanket" conclusions concerning technical analysis. One of the limitations of studies done to date is that most of them dealt with the conclusion that prices are random or they are not random. This hypothesis focuses not on the conclusion "technical analysis does work or it doesn't work" but says "technical analysis is more likely to work under these conditions, but not under those."

The alternative hypothesis claims that technical analysis works in years containing large price movements, and this can be easily understood given the nature of the trend-following techniques. A better description of why technical analysis works might be given through explaining the process of price formation in terms of information flows. Equilibrium prices are determined by a number of market participants, and this equilibrium level is adjusted as new information enters the arena. There are two general ways in which this flow of information can be perceived, and these are discussed below. Either viewpoint allows for the possibility of technical analysis generating profits.

One perspective concerning information flow is that all information is not immediately available to all market participants and that not all market participants have equal skill in evaluating new information. This concept is backed up by the large number of reporting and forecasting services available, the number of in-house analysts for various companies, and the effort USDA takes to ensure equal access to their reports by all market participants. The combination of these two factors - inequality of availability and judgement ability of information - can cause price moves to be gradual changes rather than instantaneous jumps to new levels. This gradualness can take place in terms of minutes, days, or even weeks, depending on the "hiddenness" of the information to market participants, both in terms of availability and judgability. If the price adjustment is large enough and the adjustment period long enough, it is reasonable to suppose that trend-following trading strategies will generate profits.

The second perspective concerning information flow assumes that market participants have equal access and ability in terms of receiving and judging information. Instead, the issue concerned is the sequence of pieces of information that come into the market. The hypothesis claims that technical analysis performs well when there are large price movements. Movements of large magnitude are usually caused by major changes in supply or demand conditions - drouths or large increases in exports are examples. These large impacts generally occur over time, not instantaneously. For example, a drouth in the Corn Belt does not occur overnight, but the crop prospects change from good to fair to poor to disaster as time goes from June to September. This continual, gradual worsening of supply conditions can cause large gradual price changes that are extended over a period of time, and thus technical analysis can be used profitably.

Either or both of these two perspectives concerning information flows and price determination may be at work in the marketplace. The question pursued here is not which is at work, but can the results of the actual process be used by technical analysis to generate profits.

It also might be worthwhile at this time to note the general factors in the market that prevent large fluctuations in prices and thus limit potential profits to a technical system. Prices can move up or down, and both government or market system participants can intervene to set barriers on price movement. The upper boundary is often composed of excessive stocks in the world when grain is the commodity under consideration. These stocks, whether privately or publicly held, form a type of price ceiling. The lower boundary to prices is usually a price support level set by the governments of major grain producing nations. With these two factors in effect, prices are limited to a relatively small range and technical analysis will perform poorly, according to the hypothesis. The only room for large price movements arises when the ceiling is removed - i.e., when world grain stocks become low. Therefore, technical analysis should work in periods characterized by tight supplies of grain stocks.

At this point, an illustration may help clarify and summarize the alternative hypothesis. Assume there is an Agricultural Economics Department with a notoriously wealthy department chairperson and a number of jealous faculty members. In order to wrest the chairperson's money away from him, the faculty members devise a game. In this game the chairperson is blindfolded and placed at the eastern border of Kansas without his knowing his location, and he is told to walk in a westerly direction. While still blindfolded, anytime the chairperson detects that he is climbing or descending a grade he indicates so and pays $100 to the faculty members. However, the chairperson receives $1 per foot of altitude gained or lost in the direction he indicates he is going from the faculty members. Thus the game continues, with the chairperson paying $100 everytime he senses a change in direction, and receiving $1 per foot in net altitude gained or lost.

It is obvious that the chairperson isn't going to make money while walking across Kansas and eastern Colorado, even though there may be spots where he makes some profit. Once he is in the Rocky Mountains, however, he stands to make considerable gains. Assuming the game ends at the western border of Colorado, the net position of the chairperson and the faculty members depends on how many poor decisions were made in Kansas and eastern Colorado and how many and how large the good decisions were in the Rockies.

It should be clear that in this illustration the altitude is price level and the chairperson is a technical tool. Profits to the chairperson depend on the size of the grades he traverses. Two more analogies may be drawn from this illustration. First, the technical analysis tool may not be perfect. The chairperson may detect a change in slope when there isn't or vice versa. In the same way, technical tools can and do give false buy and sell signals. Secondly, while in the Rockies the chairperson may step off of a cliff and fall 1000 feet before he realizes what has happened. In like manner, technical analysis may not respond quickly enough to sudden price moves to benefit from them.

Summarizing the chapter to this point, the hypothesis regarding the performance of technical analysis has been presented and explained. Simply stated, it says that technical analysis will provide profits in a market where wide fluctuations in price occur. Attention will be focused next on the methods which will be used to test the hypothesis. Also, the technical tools to be used will be explained, and the data over which the tests will be conducted will be presented.

Tests

The first test will measure the value of technical tools in speculating in the futures markets. The net profits of two trading systems will be analyzed, one based on moving averages and one on point and figure charts. Each strategy will always maintain a long or short position in the market. That is, if a long position is held and a sell signal is given, two contracts will be sold, one to offset the long position and one to open a new short position. To test the alternative hypothesis, profits year by year will be compared to a measure of price volatility.

In addition, a check is made for any abnormalities in the price series that would cause expected gross profits to be greater than zero, such as having different levels of prices at the beginning and end of the trading period. Any bias should be eliminated by using the two-sided trading approach (both long and short). Furthermore, results from a random trading system for which gross profits should be zero are presented and analyzed. If there is any bias, it should show up in the returns to the random trading scheme.

The second test on the performance of technical analysis will be an application of technical tools to selective hedging strategies that could have been employed by grain producers. Several strategies will be designed that represent simple marketing plans. The results will be evaluated in terms of net price received for the entire test period and for each year.

Technical Tools

Two tools will be used to analyze futures prices in order to generate buy and sell decisions. These tools, or variations of them, are used by many commodity traders. For this study several general limitations were placed on these systems. First, they can only use past price data. Secondly, they must be simple to calculate to ensure their usability by a broad range of grain producers. Third, they must generate clear buy and sell signals. This allows no room for subjective judgment in the analysis and eliminates the possibility of bias resulting from use of hindsight. Following is a description of both of the tools and an explanation of how buy and sell signals are generated.

Moving Averages

This technique involves one or more averages that "move" through time with the price series. It is a trend following technique, giving signals when price movement indicates a change in direction. Depending on the types and lengths of averages used, the response of the moving averages in generating a signal from a price movement can be quick or rather belated. For this study, the crossing action of two simple moving averages will be used as a decision criteria. Mathematically, this criteria can be expressed as:

A = Value of the long moving average

B = Value of the short moving average

If $A > B$, take or maintain a short position

If $A < B$, take or maintain a long position

If $A = B$, maintain previous position

$$A = \frac{1}{q} \left[\sum_{i = t - q + 1}^{t} C_i \right]$$

$$B = \frac{1}{p} \left[\sum_{i = t - p + 1}^{t} C_i \right]$$

t = current time period

p = length in days of the short moving average

q = length in days of the long moving average

C = closing price of the commodity in question.

Consider an example where a short moving average of two days and a long moving average of four days is used. Hypothetical prices and resulting calculations are shown in Table 3-1. Assume no position is held at the beginning of the period; note that the averages are even on day 4. Then on day 5, the short moving average is greater than the long, and a contract is bought (a long position is taken in the market). Days 6 and 7 also have $A < B$; thus, the long position is maintained. However, on day 8, $A > B$ (i.e., the short moving average is less than the long) and the market position is reversed. Since A continues to be greater than B for days 9 and 10, the short position is maintained. Because the day's closing price is used for calculation of the moving averages, positions would be taken on the following open. Figure 3-1 is a graphical representation of the moving averages.

Moving averages are very simple to use and understand. The shorter moving average is calculated only on the most recent day's prices, making it more responsive to current price levels than the long average. Therefore, when it crosses above the long average, it indicates that prices are moving upward. Conversely, the short average crosses under the long average in response to a downward price move. Moving averages are often represented graphically, and the buy and sell decisions are

Table 3.1. Example of 2 X 4 Moving Averages.

Day	Futures Price Close	ΣL	ΣS	Long Average (A)	Short Average (B)	Speculative Position
1	1.00	---	---	---	---	---
2	1.00	---	---	---	---	---
3	1.00	---	---	---	---	---
4	1.00	4.00	2.00	1.00	1.00	None
5	1.10	4.10	2.10	1.025	1.05	Buy
6	1.20	4.30	2.30	1.075	1.15	Maintain long
7	1.10	4.40	2.30	1.10	1.15	Maintain long
8	1.00	4.40	2.10	1.10	1.05	Go Short
9	.90	4.20	1.90	1.05	.95	Maintain Short
10	.90	3.90	1.80	.975	.90	Maintain Short

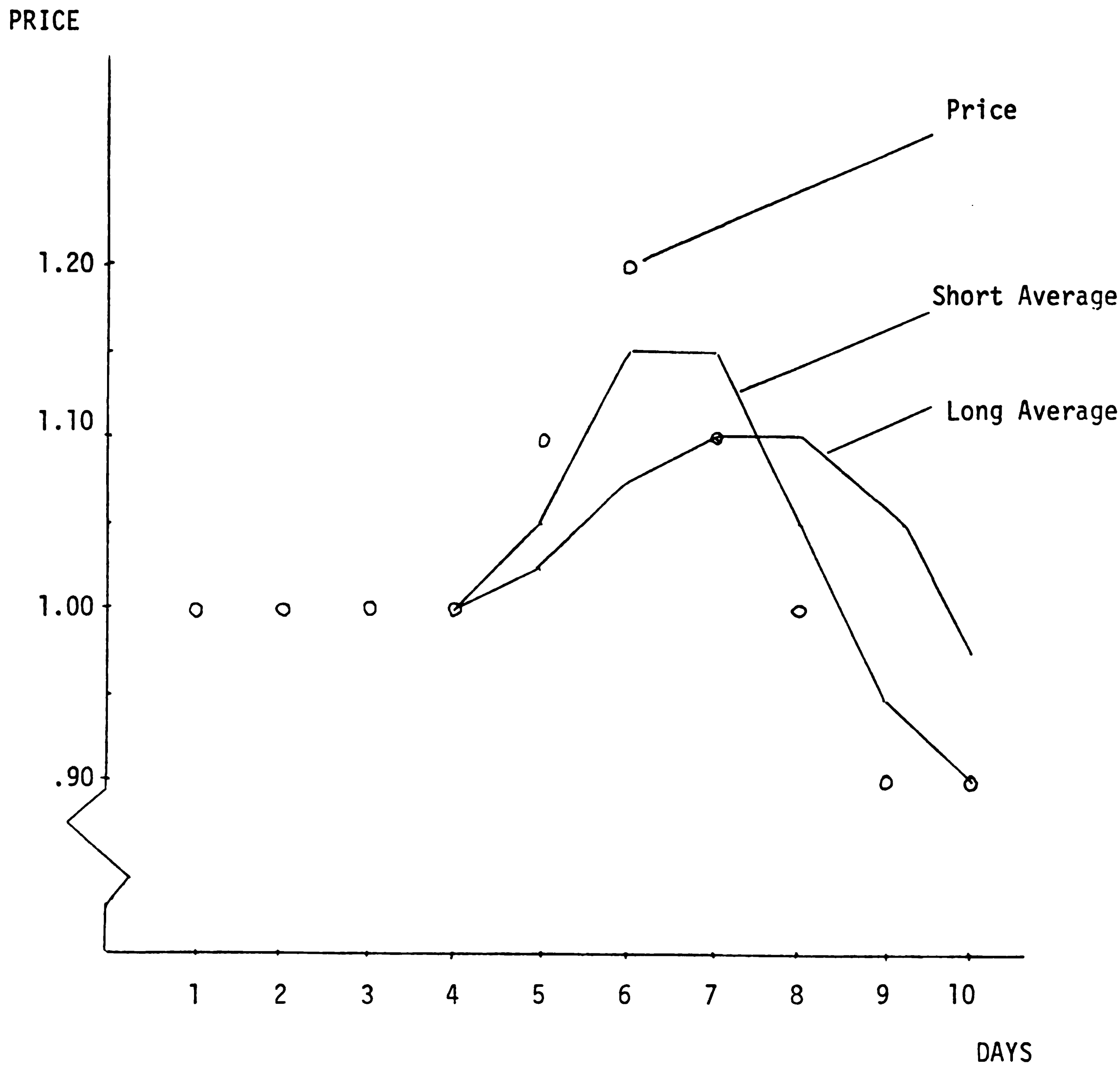

Figure 3-1. Plot of Hypothetical Corn Prices and 2 and 4 Day Moving Averages.

determined by the "crossing action" of the two averages. The position taken after the crossing occurs is maintained until they cross again in the opposite direction.[1]

There are three problems associated with using moving averages. First, one must decide what lengths of moving averages to use. Second, profitable use of moving averages requires that price moves be extended. Some time is required in identifying a trend with moving averages, and unless this price direction continues to some extent, losses will be taken. If prices are moving within a narrow range and bouncing back and forth between bottom and top ("support and resistance levels"), use of a moving average technique will result in being "whipsawed." This is when a large number of trades are generated with most of them showing a small positive or negative return before commissions. Third, a moving average system of the type described above does not deal with price levels, but with values calculated by the moving averages. Therefore, a fast moving market may have made it's major adjustment to new price levels before the moving averages can generate a signal.

Point and Figure Charts

Point and figure charts, like moving averages, were developed by stock market technicians, and they are one charting device that can be reduced to a mathematical formula. These charts are drawn on graph paper, with a vertical scale representing prices; there isn't any horizontal scale, eliminating the normal time dimension characteristic of most charts. The parameters to be decided by the user are the box size (the value of the commodity in question associated with one box on the vertical scale) and the reversal number, which indicates how many boxes prices must move in an opposite direction from the existing trend for a reversal to occur.

Point and figure charts are constructed by filling in the boxes in columns with X's when prices are rising and O's when prices are falling. If prices are in an uptrend, the chartist looks at the high first. If he can add one or more new X's to the chart, he does so and if finished with the chart for that day. Note that X's can only be added when the price level is equal to or greater than the price represented by the box in question. If the chartist cannot add any new X's, he checks the low to see if it is less than [the value of the highest X in the current uptrend - (box size * reversal number)]. If the low is above this level, no action is taken and prices are still in an uptrend. If the low is below this level, however, a reversal has occurred. This is represented on the chart by moving to the column to the right, dropping one box below the previous high X, and filling in with O's down to the new low. Then the chartist will watch for lows and continue the downtrend in the same fashion as he would an uptrend, until another reversal occurs.

Buy and sell signals are generated by breakouts of double top or double bottom formations. Another way this rule can be stated is "two open boxes to the left." However, these methods are both expressed in visual terms. In verbal terms, a buy signal is given when the price moves up to and fills the box above the highest box in the previous column of X's. Conversely, a sell signal is given when the price moves down to and fills the box below the lowest box in the previous column of O's. Note that a new buy signal point is formed when there is a reversal from an uptrend, and a new sell signal point is formed when there is a reversal from a downtrend.

As an example, consider the hypothetical corn prices listed in Table 3-2 and plotted in the point and figure chart in Figure 3-2. The point and figure chart utilizes a 2¢ box and a three box reversal. In addition, it is assumed that prices are in an uptrend, and the last box added was at \$2.70. Since an uptrend is in effect, the daily highs are evaluated first, and for each of the first three days, X's are added to the X column. However, on day 4, a new box cannot be added, so the low is evaluated: \$2.85 would only allow two O's, so no reversal occurs and no action is taken.

Since the uptrend still exists, the high price is checked again on day 5: no new boxes can be added. Checking the low shows that it is now low enough for a reversal. Therefore, the uptrend is ended and four O's are drawn in. For day 6, the low price is now checked first, and three O's are filled in down to \$2.76. Then on day 7, no new O's can be added to the chart, and a reversal occurs that requires six X's.

At this point, both a buy and sell signal can be located on the chart. The buy signal is at \$2.92, the box above the highest filled box in the previous X column. If price did hit \$2.92, there would be two open or empty boxes directly to the left of the plotted X. As regards the sell signal, it would be located at \$2.74, which is the box below the lowest O in the previous O column. Prices would have to reverse from the current uptrend in order for the sell signal to be hit, but it can be seen that there would be two open boxes to the left if price fell to \$2.74.

One should quickly see that a point and figure chart, when using the above buy and sell signals, is not so much a trend-following technique but trades more on breakouts of support and resistance levels. As used

Table 3-2. Hypothetical Corn Prices and Action Taken with a Point and Figure Chart.

Day	Price in $/bu. High	Low	Action Taken[a]
1	2.74	2.70	Add two X's at top of column
2	2.81	2.76	Add three X's at top of column
3	2.90	2.80	Add five X's at top of column
4	2.91	2.85	No Action
5	2.87	2.82	Reverse; move one column to right, add four O's to fill indicated boxes leaving the 2.90 box empty.
6	2.84	2.76	Add three O's at bottom of column, move one column to right
7	2.88	2.80	Reverse; add 6 X's to fill indicated boxes leaving the 2.76 box empty

[a]Assume a 2¢ box and three box reversal, an uptrending market with the last box added at 2.70 before day 1.

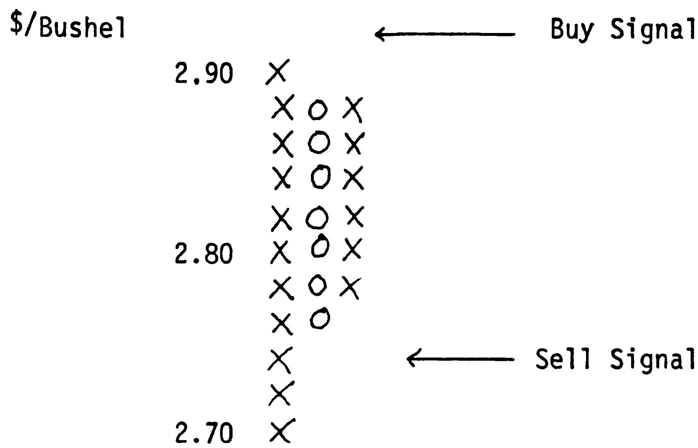

Figure 3-2. Point and Figure Chart Constructed from Hypothetical Corn Prices in Table 3-2.[a]

[a]Using a 2¢ box and three box reversal, starting with prices in an uptrend and the last box added was at $2.70.

here, support level means the price just below the previous market low, and a resistance level is the price just above the previous high. If the market makes any major moves, the point and figure chart will have the trader on the right side of the market. Another advantage of point and figure charts is that they work with absolute price levels. Unlike moving averages, buy and sell signals are given at specific points, allowing a trader to better take advantage of fast price moves.

The major weakness of point and figure charts is that buy and sell signals are often located at the "inside" of the price range. For example, assume wheat prices are trading in the 4.00 to 4.50 range and then break out and fall to the 3.50 to 3.75 range. The sell signal would generally be located around the 4.00 area, the "inside" or lower end of the total price range. A subsequent buy signal would be located around 3.75, or towards the top of the second range which is also on the "inside" of the price move. Thus, point and figure charts will tend to pick up only part of the total price move.[2]

Data

The commodities over which the previously mentioned tests will be conducted are corn, wheat, and soybeans. Two marketing periods are defined for each commodity, the first being a pre-harvest (production) period and the second being a post-harvest (storage) period. The particular contract month used is the one that best fits the entire marketing period (i.e., production or storage period). The data set covers six different years, and each marketing period was chosen to allow sufficient volume to develop before trading that contract to ensure a liquid market.

For corn, the six years being analyzed are for the crops harvested from 1972 to 1977. That is, a production period for the 1972 crop was tested along with a storage period for the same crop. The production period began January 2 and ran up through November 30. The December corn contract on the Chicago Board of Trade was used. The storage period began October 1 of the respective crop year and lasted until June 30 the following summer, using the July corn contract.

The soybean marketing periods represent the same years as those for corn. The production period began January 2 and ran through October 31, using the November soybean contract on the Chicago Board of Trade. The storage period began October 1 at harvest time and lasted until June 30 the following summer, using the July soybean contract.

The wheat marketing periods represent different years due to limitations of available data. The production period deals with the 1973 to 1978 crop years. It begins December 1 of the previous year and extends until August 31 of the year in which the crop is harvested. The September wheat contract on the Chicago Board of Trade is used. The storage period deals with the 1972 to 1977 crop years and uses the May wheat contract. The storage period begins August 1 of the year in which the wheat is harvested and lasts until April 30 of the following year. One exception to the data set involves the May wheat contract. The 1977 contract (concerning the 1976 harvest) didn't begin trading early enough to ensure adequate liquidity of the market by August 1 (the criterion was that 40 days of trading had to have occurred). Therefore the starting date for the storage period for that year was moved back to September 1 from the normal August 1 time.

ENDNOTES

[1]For a broader presentation on the use and calculation of moving averages, see Purcell [43], Chapter 9.

[2]More examples and information on construction of point and figure charts and buy and sell signals is given in Zieg and Kaufman [63] and Purcell [43], Chapter 9.

CHAPTER FOUR

TEST OF THE HYPOTHESIS

The null hypothesis is "Technical analysis does not provide any information to a market participant that would lead to profitable trading." The alternative hypothesis says that technical analysis does provide information that can be used to make profits providing markets are volatile, moving over large price ranges. This chapter presents the test of the hypothesis.

Simulation

The basis of the test is a simulation of a speculator in the futures markets. This speculator takes both long and short positions, making buy and sell decisions according to technical signals. The trader takes a position in the market on the first day of the trading period as determined by prior price movement and maintains that position until the technical tool indicates that prices are moving against his position. Then he closes out his initial position and takes one on the opposite side of the market. For example, assume the initial position is short -- he sells a contract. Then when an uptrend in prices is indicated by a buy signal, the trader buys two contracts, one to close out his short position and one to initiate a long position. This process of reversing his position continues until the last day of the period when the trader evens up his account. Note that at no time is the speculator more than one contract long or short.

The data set on which the two-sided trader operated is the same as that presented previously. Six periods of approximately 200 market days were tested for each of the six commodity contracts. The six contracts represented a production and storage period for corn, wheat, and soybeans. The periods were not begun until forty days of trading had taken place for that contract and ended approximately fiften market days before the contract expired. This limitation of the data period was done to ensure liquidity -- the ability to take and exit market positions.

Two technical tools were used to generate buy and sell signals, these tools being moving averages and point and figure charts. Their operation has already been explained. The use of these two tools in the simulation was made as realistic as possible by using the following rules.

Moving Averages

1. The values for the moving averages were calculated from the daily closing prices.

2. All positions were taken at the opening price of the day following the buy or sell signal.

3. No trades were made on locked limit days. The signalled position was taken as soon as the market allowed.

4. The initial position was taken on the basis of the moving averages calculated on the prices prior to the last trading day of the period.

5. The last position held was closed out on the last trading day of the period.

6. A commission of $50.00 per round turn was charged.

Point and Figure Charts

1. Highs and lows were used to construct the charts.

2. Simple buy and sell signals were used to make trading decisions.

3. Only one contract was held at a time; i.e., if two buy signals occurred consecutively, the second one was ignored.

4. No trades were conducted on locked limit days. The signalled position was taken as soon as the market allowed.

5. This system required the use of the order "buy if price hits \$X" or " sell if it hits \$X." This may cause a bias in results, as it assumes the market position could be taken at the signalled value. In reality, execution of the order may not occur at the exact order point.

6. If the market opened past the buy or sell signal, the positions were taken at the opening prices.

7. A commission of \$50.00 per round turn was charged.

Furthermore, a number of parameters were used for each technical tool. Tables 4-1 and 4-2 contain the parameters for the moving averages and point and figure charts, respectively. These parameters were chosen arbitrarily to represent a fairly even distribution of values. One problem may involve using the same values across all commodities for the point and figure charts. The same parameters were tested for all commodities, yet the daily volatility of prices varies between commodities.

For example, a 5¢ move in corn may be roughly equivalent to a 15¢ move in soybeans. The problem arises in that while these price moves are equivalent on a relative basis, the point and figure charts operate on an absolute basis. Given the above "equivalent" moves, a 3¢ box with a three-box reversal might signal a reversal in soybeans but not in corn. Any problem here should be detected by evaluation of the change in profits

Table 4-1. Parameters Used for Moving Averages

Combination Number	Short Moving Average (Days)	Long Moving Average (Days)
1	3	6
2	3	10
3	4	8
4	4	12
5	5	10
6	5	15
7	5	20
8	5	25
9	8	16
10	8	20
11	8	24
12	10	20
13	10	25
14	10	30
15	10	40
16	15	25
17	15	30
18	15	40
19	20	30
20	20	40

Table 4-2. Parameters Used for Point and Figure Charts.

Combination Number	Box Size (¢/bushel)	Reversal Number (boxes)
1	2	2
2	3	2
3	4	2
4	5	2
5	6	2
6	7	2
7	8	2
8	2	3
9	3	3
10	4	3
11	5	3
12	6	3
13	7	3
14	8	3
15	2	4
16	3	4
17	4	4
18	5	4
19	6	4
20	7	4
21	8	4
22	2	5
23	3	5
24	4	5
25	5	5
26	6	5
27	7	5
28	8	5

generated from the simulation as parameter values change.

The net profit (gross profit-commission costs) for each parameter combination was calculated for each commodity contract marketing period. However, because of the large volume of results, and because this is a test of technical analysis in general and not of specific parameter values, the means and standard deviations of the profits from various parameter sets were calculated for each commodity contract year. This should allow some type of conclusion to be drawn in general on the performance of technical analysis. The mean is the average profit from all of the parameter sets used, while the standard deviation should give some indication of the dispersion of profits as parameters change. In addition, the percent of parameter sets that returned a net profit greater than zero was calculated.

Random Trader

The two-sided trader was used rather than a one-sided test in order to eliminate any bias arising from differences between beginning and ending prices of the data periods. For example, if the trader were only to take short positions in the market -- initially selling and then buying back the contracts -- and never take a long position, expected gross profits would be greater than zero if the beginning price were greater than the ending price. Using the two-sided trader should eliminate any bias in the results from this source.

A broader test for peculiarities in the price data that might generate profits for some technical system would be to simulate a trader who makes buy and sell decisions at random. This would accomplish two goals, the first of which was just stated. A second benefit is that it can provide another benchmark against which to compare the results from technical analysis.

The random trader was structured to operate exactly the same as the two-sided trader except in regard to selection of buy and sell signals. First of all, the number of trades conducted for each parameter set under the technical tools were counted for each year. The random trader made the same number of trades as did the technical trader in order to avoid inequality of commission costs. Days upon which trades were made were selected by a random number generator. The random number generator was given a different seed -- chosen at random -- for each year of price data. Also, the random trader operated on a year of data twice as many times as the technical trader in order to improve the statistical properties and eliminate possible sampling errors.

Table 4-3 presents the relationship of the random trader to the technical trader, using moving averages on the 1976 September wheat contract. The left half of the table contains the number of trades made by the moving averages. There were twenty different combinations of moving averages, and four of these combinations generated five trades, four generated seven trades, etc. Multiplying the "number of times occurring" column under moving averages times two gives the number of times that the corresponding number of trades were conducted at random. This keeps the average commission costs the same for both traders, yet allows a larger number of iterations under the random trader to improve the accuracy of the results. The same procedure was used to compare results from point and figure trading and the random trader.

Other factors concerning the random trader include:

1. A position -- buy or sell -- was taken at random on the first

Table 4-3. Example of the Random Trader Compared to Moving Averages for the 1976 September Wheat Contract.

Moving Averages		Random	
Number of Trades	Number of Times Occurring	Number of Trades	Number of Times Occurring
5	4	5	8
7	4	7	8
9	3	9	6
13	3	13	6
19	1	19	2
20	3	20	6
28	1	28	2
40	1	40	2
	20		40

day of the period.

2. Trades were conducted at the opening prices of the day selected.

3. The trader always maintained a long or short position in the market, comparable to the technical systems.

4. Trades scheduled for locked limit days were conducted as soon as the market would allow.

5. A commission cost of $50.00 was charged per round turn.

6. The trader was closed out the last day of the period.

Expected gross profits from the random trader would be zero, while expected net profits would be a loss of the commission costs.

SPM Index

The null hypothesis says that technical analysis does not provide any information that can be used to make profits in futures markets, while the alternative hypothesis claims technical analysis provides valuable information during periods of volatile prices (prices moving over considerable ranges). Having generated the returns to a technically-based trader, some value for price volatility or price movement is required to conduct a test. One simple indicator of this would be the range of prices over the period -- the highest price minus the lowest price. However, this value may not pick up the amount of significant price moves within the limits of the range. Therefore, a new value was calculated which may be called the summation of price moves, denoted as the SPM index.

The SPM index can be easily calculated from a graph of closing prices. The high and low points are identified, and the differences between high and low points are calculated. If the difference or size of the price move is greater than an arbitrarily determined value, it is considered as a significant movement. The sum of the significant price movements becomes the SPM index, and dividing the SPM index by the number of price movements gives an "average move" value. The values considered as significant moves for corn, wheat, and soybeans were 25¢, 50¢, and 75¢, respectively, which is two and one-half times the limit move presently in effect on futures exchanges. These levels were decided upon arbitrarily.

Table 4-4 contains an example using actual closing prices for the 1976 September wheat contract. The price at the beginning of the period was $3.66. They rose shortly to $3.76 and then fell to $3.43. There was another rise and drop to $3.77 and $3.49, respectively. Note that prices are trading within a small range, with none of the price differences being over 50¢. For a price move to be counted as significant for wheat, it must move by at least 50¢. Thus prices would have to move up to $3.93 or down to $3.27, 50¢ from the high or low to date. Prices moved up to $4.13, which constituted a move of 70¢ from the base of $3.43. Then prices dropped to $3.45, a move of 68¢. Then prices rose and fell again, but neither move was significant according to the 50¢ rule. If prices on June 17 had fallen below $3.45, say to $3.33, the last move of 68¢ would be recalculated to be 80¢, with the move being from February 27 to June 17 and a price range of $4.13 to $3.33. Finally, prices rose to $4.00 and fell to $3.06, representing moves of 55¢ and 94¢.

The SPM index is calculated by summing up the significant price moves, which for this September wheat contract is 287. Dividing by the number of moves also gives an indication of the size of the moves within

Table 4-4. An Example of Calculating the SPM Index, using the 1976 September Wheat Contract.

Date	Closing Price $/bu.	Extreme Points	Significant Moves $/bu.
12/1	3.66		
12/4	3.76		
12/29	3.43	Low	
1/12	3.77		.70
1/26	3.49		
2/27	4.13	High	
4/30	3.45	Low	.68
6/10	3.91		.55
6/17	3.67		
7/6	4.00	High	
8/30	3.06	Low	.94

SPM Index = 287

Average Price Move = 71.8¢

the year. In the illustration above, the average move was almost 72¢.

One question in devising the SPM index concerned how to calculate the size of the move. For example, looking back to Table 4-4, $3.43 on 12/29 was used as the base for the first move rather than $3.49 on 1/26, which is the adjacent low to the high of $4.13. The reasoning for not using only the adjacent low was to avoid overstating price moves in a market period where prices are rising or falling in waves. For example, assume price started at $3.00 and rose to $3.60, fell to $3.30 and rose to $3.90. The SPM index as calculated in Table 4-4 would 90¢, which is the value of the overall move. If the SPM index had been calculated on adjacent prices, it would be 120¢, which overstates markets that have a number of short term reactions within a major price move.

As stated before, the SPM index (hereafter referred to as SPMI) will be used to evaluate the alternative hypothesis. The years will be ranked according to their volatility, and if the alternative hypothesis is true, profits should be greater in those years with a large SPMI and lower in those years with a small SPMI. If the null hypothesis is true, net profits should be less than zero by the amount of commission costs, and there shouldn't be any pattern from year to year. It would also be reasonable to expect the standard deviations to vary with the SPMI.

If profits are significantly different from zero in certain years but not necessarily in accordance with the SPM index, two possibilities exist. First, both the null and alternative hypotheses may be false. Second, the SPMI may not accurately represent those characteristics of price behavior within which technical analysis might work.

In addition to results of technical analysis on a year by year basis, the mean and standard deviation were calculated across each parameter set for the returns for the entire six years. Because the period is relatively short -- six years -- these values might give some feel for the performance of technical analysis in a period of generally volatile prices. One problem that should be noted is that the data set is too small. A better test might have been conducted if data from the mid-1960s on had been available, as this would have included a number of years with relatively stable prices for comparison.

Method of Analysis

The results from the technical trader and the random trader for each commodity contract are presented along with the SPMI. This is done so comparisons can be made between price volatility and the performance of the technical tools.

Two types of analysis will be brought to bear on the results. The first will be a general discussion of the means, standard deviations, and other factors generated from the technical random traders. Part of this discussion will be to classify the results into categories of 1) technical analysis provides valuable information; 2) marginal value from technical information; and 3) no value (possibly negative) from technical information. The criteria for each of the categories are as follows:

1. Profitable - the mean must be greater than the standard deviation and at least 85% of the parameter combinations must return a net profit.

2. Marginal - the net profit must be greater than zero and at least 70% of the parameter combinations must return a net profit.

3. Non-Profitable - the net profit is less than zero <u>or</u> less than 70% of the parameter combinations return a profit.

In addition to the categorization of the results and comparing them to the SPMI, some comments may be made concerning the price series that generated the results.

A second type of analysis that will be applied to the results is the Spearman's rank correlation test. This statistical procedure can be used to test for relationships between observations of two series, yet the relationship is not required to be linear. Spearman's rank correlation r_{sp} is calculated as follows:

$$r_{sp} = \frac{\sum_{i=1}^{n} (R_i - \frac{n+1}{2}) \; (S_i - \frac{n+1}{2})}{n(n^2 -1)/12}$$

where

a. $-1 \leq r_{sp} \leq 1$

b. r_{sp} near + 1 indicates a positive correlation of the ranks.

c. r_{sp} near - 1 indicates a negative correlation of the ranks.

For this problem, the two series R_i and S_i will be ranks of the SPMI and the mean returns from technical analysis from highest to lowest. The r_{sp} will be calculated for each commodity contract for both the moving average and point and figure technical tools.

A hypothesis test based on r_{sp} can be easily conducted for small samples. The above equation for r_{sp} is reduced by mathematically eliminating terms involving n, and probability distributions can be calculated give n equal to some integer (for this case, n=6). The null and alternative hypotheses and the test statistic are:

H_0 (null): The SPMI and mean returns to technical analysis are independent.

H_A (one-sided alternative): The SPMI and mean returns to technical analysis are positively correlated.

$$T = \sum_{i=1}^{n} R_i \, S_i$$

$$P\,[T] \leq \alpha$$

where:

P = Probability

R_i = rank of the SPMI

S_i = rank of the mean returns to technical analysis

n = number of years = 6

α = significance level of the test, read from calculated tables with $n = 6$

The above test was conducted on results from each commodity contract, allowing only six observations (and ranks) for each test. In order to make a broader statement about the commodities in general, the SPMI and profits from technical trading were ranked for both contract months -- e.g., May and September wheat -- giving twelve observations. With twelve observations, the calculation for r_{sp} is still the same, but the test statistic is generalized to:

$$T = \sqrt{n - 1} * r_{sp}$$

where:

Reject H_0 at α if $T > Z_\alpha$

This one-sided statistical test was conducted on wheat, corn, and soybeans for both moving averages and point and figure charts.

To this point, little attention has been given to individual parameter values for the technical tools. If it can be assumed that what has worked in the past will work in the future -- not necessarily a good assumption -- it would be profitable for future applications to know which parameter combinations perform best. In addition, the question of what happens to profit from a technical system as the parameters are adjusted over the entire range should be dealt with. For example, if changing the long moving average by two days causes any profits to disappear, the riskiness of choosing profitable parameter combinations increases.

To deal with these two issues, the total profit over the six year period for all commodity contracts were plotted. These plots are in Appendix A with Figures A1 - A6 representing moving averages and Figures A7 - A12 point and figure charts. The Y-axis is total net profit, and the X-axis is a function of the parameter combinations. For moving averages, the function is the sum of the two averages. For point and figure charts, the function is the product of the box size and reversal number which from now on will be referred to as the reversal factor. Three interesting questions not dealt with here are: 1) Is Y a function of X; 2) what would the plots look like on a yearly basis; and 3) does the functional form -- if there is one -- change over time?

DISCUSSION OF THE RESULTS

May Wheat

The May wheat contract (See Table 4-5) experienced several volatile price years as is evidenced by the SPMI being over 300 for years 2, 3 and 4.

Table 4-5. Results of Technical Analysis of the May Wheat Contract

	Years						
	1972-73 (1)	1973-74 (2)	1974-75 (3)	1975-76 (4)	1976-77 (5)	1977-78 (6)	Total
Point and Figure Charts							
Mean ($)	2406.25	6054.46	-7432.14	3617.86	742.86	871.43	6260.71
Standard Deviation ($)	1429.69	6285.40	4709.72	2279.89	1332.03	1560.24	7635.51
% Profitable Parameters	100	89.3	7.2	96.4	82.1	57.1	82.1
Random (PFC)							
Mean ($)	-786.61	-1787.05	-612.05	942.41	300.45	-615.18	-2558.03
Standard Deviation ($)	3476.51	9968.24	6463.01	5388.88	2766.19	2669.11	--
% Profitable Iterations	48.2	41.1	44.6	55.4	60.7	41.1	--
Average Commissions for PFC ($)	233.93	814.29	735.71	389.29	192.86	192.86	2558.94
Moving Averages							
Mean ($)	1326.25	11563.75	4666.25	4465.00	1506.25	346.25	23873.75
Standard Deviation ($)	1783.66	5455.14	4595.10	2934.60	2980.49	2105.20	9103.19
% Profitable Parameters	70	100	85	85	70	50	100
Random (MA)							
Mean ($)	-925.31	-1248.13	-1401.88	386.88	-345.00	-1166.25	-4699.69
Standard Deviation ($)	3510.21	13291.48	6733.82	5016.92	3111.45	2658.75	--
% Profitable Iterations	40	50	37.5	52.5	50	35	--
Average Commissions for MA ($)	562.50	515.00	570.00	642.50	550.00	572.50	3412.50
SPMI	153	888	315	363	105	93	--
Average Move of SPMI	77	148	158	91	105	93	--

The validity of the SPMI is backed up by the standard deviations of the random trader's profit. Since the random trader operates on the same data period a number of times, and since his trades are conducted at random, it would be reasonable to expect the standard deviation to represent a measure of the volatility of prices. The ranking of the SPMI matches the ranking of the standard deviations, with the exception of one pair being switched. Also, the profits from the random trader don't seem to indicate any one year as having a price series that would cause expected gross profits to be different from zero.

The profits from the technical trader also appear to be correlated with the SPMI for both point and figure charts and moving averages (from here on, point and figure charts will be referred to as PFCs and moving averages will be referred to as MAs). The one exception is year 3 under PFCs, where a large loss for the year is generated. Inspection of the trading results and the price series for that year shows that the PFCs were "whipsawed." Prices moved up and down very quickly and a number of trades with large losses were made, causing the large loss for the year.

The breakdown of the years into categories is in Table 4-6. Year 6 under both PFCs and MAs is classified as non-profitable even though the mean return was positive. The problem was that less than 70% of the parameter sets for both PFCs and MAs generated profits. From a simple visual inspection of the results, there appears to be evidence to support the alternative hypothesis, both in terms of correlation of profits and the SPMI, and in terms of positive net profits.

The results of the statistical test for the hypothesis are in Table 4-7. The r_{sp} for PFCs is .571 which indicates a positive correlation.

Table 4-6. Categorization of the Crop Years by Profit Levels in the Technical Analysis of May and September Wheat Contracts.

CROP YEARS

MAY WHEAT

Category	PFCs	MAs
Profitable	1972-73 (1), 1975-76 (4)	1973-74 (2), 1974-75 (3) 1975-76 (4)
Marginal	1973-74 (2), 1976-77 (5)	1972-73 (1), 1976-77 (5)
Non-Profitable	1974-75 (3), 1977-78 (6)	1977-78 (6)

SEPTEMBER WHEAT

Category	PFCs	MAs
Profitable	1972-73 (1), 1974-75 (3)	1972-73 (1) 1973-74 (2)
Marginal		1974-75 (3)
Non-Profitable	1973-74 (2), 1975-76 (4), 1976-77 (5), 1977-78 (6)	1975-76 (4), 1976-77 (5) 1977-78 (6)

Table 4-7. Ranks, Rank Correlations, and Calculated Probabilities for the May and September Wheat Contracts.

Years

	1972-73 (1)	1973-74 (2)	1974-75 (3)	1975-76 (4)	1976-77 (5)	1977-78 (6)
May Contract						
Rank of SPMI (R_i)	4	1	3	2	5	6
Rank of PFC (S_i)	3	1	6	2	5	4

r_{sp} (PFC) = .571

T = 84 P = .121

Rank of MA (S_i)	5	1	2	3	4	6

r_{sp} (MA) = .886

T = 89 P = .017

	(1)	(2)	(3)	(4)	(5)	(6)
Sept. Contract						
Rank of SPMI (R_i)	2	1	3	4	5	6
Rank of PFC (S_i)	1	6	2	4	3	5

r_{sp} (PFC) = .086

T = 75 P > .121

Rank of MA (S_i)	2	1	3	5	4	6

r_{sp} (MA) = .943

T = .90 P = .0083

However, the test statistic is such that the null hypothesis could only be rejected at $\alpha > .121$; therefore, on a strict statistical basis the null hypothesis is accepted. The r_{sp} for MAs is much higher, at .886. The null hypothesis can be rejected at a significance level of $\alpha > .017$.

Several other points should be noted for the May wheat contract. MAs tend to work better than PFCs. The mean of the total profits for the six year period is $23,873.75 for MAs and only $6,260.71 for PFCs. In addition, general conclusions can be made about the most profitable parameters by looking at Figures A1 and A7 in Appendix A. MAs combinations 1 to 4 in Table 4-1, the ones using short day lengths, were not very profitable. Also, PFCs with low reversal factors -- less than fifteen -- were not very profitable.

September Wheat

The September wheat contract (See Table 4-8) also had several volatile price years as indicated by the SPMI, and this volatility is confirmed by the standard deviations of the returns to the random trader. The order of the SPMI follows the order of the standard deviations except for the top pair being switched. Although the random trader corresponding to PFCs made a nice profit in year 5, it is not so far out of line to be considered unreasonable.

Profits from the technical traders appear to be connected with the SPMI in the case of MAs, but not PFCs. Year 2 was one major problem for the PFCs, as price action that year also whipsawed the technical trader, causing a large loss when the alternative hypothesis would expect the largest profit. One area where both the MAs and PFCs agree with the alternative hypothesis is year 6. This year has the lowest SPMI, and both technical traders performed poorly, generating losses

Table 4-8. Results of Technical Analysis of the September Wheat Contract

	Years						
	1972-73 (1)	1973-74 (2)	1974-75 (3)	1975-76 (4)	1976-77 (5)	1977-78 (6)	Total
Point and Figure Charts							
Mean ($)	7813.84	-3914.29	4371.43	-167.86	708.04	-2814.28	5996.88
Standard Deviation ($)	2729.88	2632.59	1919.56	2722.43	2231.07	1709.78	5180.98
% Profitable Parameters	100	7.1	100	50	53.6	0	92.9
Random (PFC)							
Mean ($)	-1952.23	-1598.21	450.45	-350.89	1411.61	-1078.57	-3117.84
Standard Deviation ($)	10908.40	7972.71	6467.39	3569.99	2461.99	2486.20	--
% Profitable Iterations	42.9	33.9	55.4	44.6	67.9	26.8	--
Average Commissions for PFC ($)	396.43	764.29	416.07	348.21	121.43	314.29	2360.72
Moving Averages							
Mean ($)	9188.13	9522.50	3352.50	671.25	675.00	-3091.25	20318.13
Standard Deviation ($)	2577.02	5037.22	5251.30	2382.19	2114.06	2824.75	7591.07
% Profitable Parameters	100	95	70	65	55	15	100
Random (MA)							
Mean ($)	698.13	-7.50	149.38	-1210.25	-387.50	-256.25	-1013.99
Standard Deviation ($)	11480.25	9798.49	6253.48	4204.91	2389.36	3059.12	--
% Profitable Iterations	55	57.5	45	35	42.5	47.5	--
Average Commissions for MA ($)	602.50	632.50	597.50	652.50	515.00	677.50	3677.50
SPMI	387	696	327	287	96	76	--
Average Move of SPMI	194	116	164	72	96	76	--

while only 15% and 0% of the parameter combinations were profitable.

The breakdown for the value of information provided is in Table 4-6. Year 4 for MAs and year 5 for both technical tools returned positive net profits, but were classified as non-profitable because less than 70% of the parameter combinations returned net profits.

The results of the Spearman rank correlation test are Table 4-7. For PFCs, the r_{sp} is .086 and the corresponding probability value was not included in the statistical tables. The bad year experienced in period 2 was mainly responsible for such a low r_{sp}, as one bad ranking can cause problems when only six data points are used. Therefore the null hypothesis is accepted. For MAs, the r_{sp} is .943, and the null hypothesis can be rejected at the $\alpha > .0083$ level. This value reveals a very strong relationship between price volatility and the performance of moving averages.

As for May wheat, MAs perform much better than PFCs on the September contract. Profits for the six year period under MAs were $20,318.13, while for PFCs they were only $5,996.88. In regard to parameter combinations, the most profitable PFC parameter combinations were those where the reversal factor is less than fifteen or greater than twenty-five. The most profitable MA parameter combinations were those where the sum of the short and long averages' days were between thirty and forty. The plots of the profits are in Figures A2 and A8 in Appendix A.

Wheat in General

In order to conduct a test on wheat in general, the mean net profits and SPMIs were ranked for both the May and September contracts, given one technical tool. That is, each year for both the May and September contracts was treated as a separate observation , giving twelve separate time periods for PFCs and twelve for MAs. These twelve time periods were ranked according to the SPMI and the average net profits. Then the Spearman rank correlation test was conducted on the ranks as a test of the null hypothesis. The results are presented in Table 4-9.

For wheat in general, the r_{sp} for PFCs was .385, and the corresponding α was .1003. Thus the null hypothesis could only be rejected in favor of a one-sided alternative if the significance level was greater than .1003. For α = .10, the null hypothesis is accepted. For MAs, r_{sp} is calculated to be .930, and the null hypothesis can be rejcted at α > .001.

It should be noted that the calculated α value may be biased downward. The values for the previous tests of the null hypothesis were taken from statistical tables, and these tables were only available for $n \geq 10$. Therefore, the large sample approximation as described earlier was used. For low values of n (just greater than 10), the approximation of the rejection region and its corresponding probability may be biased downward when r_{sp} is small. This should be kept in mind as the other results are presented.

Several other observations may be made on the wheat contracts in general. First of all, the best MA combinations when both contracts are taken into consideration are those whose sum is between twenty-five and forty. The most profitable combinations of parameters for PFCs for wheat in general is not as clear. The best overall range seems to be where the reversal factor is greater than twenty-five and less than thirty-five. In comparing PFCs with MAs, the MAs seem to perform much better as a technical tool. Finally, although the differences are small, the profits from the May contract -- representative of the storage period

Table 4-9. Results from the Spearman Rank Correlation Test by Commodity.

WHEAT

Point and Figure Charts

$r_{sp} = .385$

H_o can be rejected at $\propto > .1003$

Moving Averages

$r_{sp} = .930$

H_o can be rejected at $\propto > .0010$

CORN

Point and Figure Charts

$r_{sp} = -.154$

H_o is accepted

Moving Averages

$r_{sp} = .678$

H_o can be rejected at $\propto > .0122$

SOYBEANS

Point and Figure Charts

$r_{sp} = .434$

H_o can be rejected at $\propto > .0749$

Moving Averages

$r_{sp} = .490$

H_o can be rejected at $\propto > .0526$

for wheat -- are greater than the profits from the September contract which corresponds to the production period. This is true for both MAs and PFCs.

July Corn

The July corn contract (see Table 4-10) was most volatile in years 1, 2, and 3, with 2 being rated the highest according to the SPMI. The standard deviations calculated from the random trader verify this ranking for the most part, although two pairs of ranks are switched. Furthermore, there doesn't appear to be any major observations in the data that would cause expected gross profits to be different from zero. The random trader corresponding to the PFCs did have two good years, 3 and 5. On the strength of these years, total profits to the random trader were $532.82, about $1,700.00 higher than expected for the entire period (expected profits are negative total commission costs). Given the size of the dispersion of profits on a year by year basis, this value doesn't indicate any problems in the price series.

A visual inspection of the relationship between the SPMI and the profits from technical trading indicate a positive relationship on the part of the MAs and no relationship in reference to the PFCs. Categorizing the years according to value of information bears this out, remembering that years 1, 2, and 3 had the highest SPM index. The breakdowns are presented in Table 4-11. Year 3 for MAs had a fairly high mean return; the reason it is classified as non-profitable is that only 60% of the parameter combinations were profitable.

The results from the Spearman rank correlation coefficient are in Table 4-12. For the PFCs, r_{sp} is -.029. This indicates no relationship

Table 4-10. Results of Technical Analysis of the July Corn Contract

	Years						
	1972-73 (1)	1973-74 (2)	1974-75 (3)	1975-76 (4)	1976-77 (5)	1977-78 (6)	Total
Point and Figure Charts							
Mean ($)	258.93	-830.36	1050.89	-1203.57	2687.50	964.29	2927.68
Standard Deviation ($)	1210.76	2158.19	3063.21	1638.40	864.37	901.53	3400.87
% Profitable Parameters	60.7	35.7	71.4	17.9	100	85.7	71.4
Random (PFC)							
Mean ($)	70.76	-694.20	1081.25	-113.39	647.77	-459.37	532.82
Standard Deviation ($)	2948.79	3247.95	4217.40	1962.92	2784.82	1265.70	--
% Profitable Iterations	50	39.3	57.1	53.6	60.7	35.7	--
Average Commissions for PFC ($)	169.64	323.21	332.14	169.64	92.86	91.07	1178.56
Moving Averages							
Mean ($)	1105.63	1020.00	1020.00	-101.25	932.50	-410.00	3566.88
Standard Deviation ($)	1761.53	1890.86	2511.65	1329.66	1406.83	994.01	6885.45
% Profitable Parameters	75	75	60	50	80	45	70
Random (MA)							
Mean ($)	-1010.00	-840.00	-435.63	-620.00	-668.75	-1065.00	-4639.38
Standard Deviation ($)	2932.67	3063.70	4041.33	2589.15	2045.93	1744.53	--
% Profitable Iterations	42.5	35	52.5	40	32.5	25	--
Average Commissions for MA ($)	692.50	642.50	632.50	635.00	595.00	670.00	3867.50
SPMI	188	346	264	90	126	73	--
Average Move of SPMI	47	58	53	45	42	37	--

Table 4-11. Categorization of the Crop Years by Profit Levels in the Technical Analysis of July and December Corn Contracts.

CROP YEARS

JULY CORN

Category	PFCs	MAs
Profitable	1976-77 (5), 1977-78 (6)	
Marginal	1974-75 (3)	1972-73 (1), 1973-74 (2), 1976-77 (5)
Non-Profitable	1972-73 (1), 1973-74 (2), 1975-76 (4)	1974-75 (3) 1975-76 (4), (1977-78 (6)

DECEMBER CORN

Category	PFCs	MAs
Profitable	1972 (1), 1973 (2)	1974 (3)
Marginal		1973 (2), 1975 (4), 1977 (6)
Non-Profitable	1974 (3), 1975 (4), 1976 (5), 1977 (6)	1972 (1), 1976 (5)

Table 4-12. Ranks, Rank Correlations, and Calculated Probabilities for July and December Corn Contracts.

July Contract

Years	1972-73 (1)	1973-74 (2)	1974-75 (3)	1975-76 (4)	1976-77 (5)	1977-78 (6)
Rank of SPMI (R_i)	3	1	2	5	4	6
Rank of PFC (S_i)	4	5	2	6	1	3

r_{sp} (PFC) = -.029

T = 73 P > .121

Rank of MA (S_i)	1	2*	3*	5	4	6

r_{sp} (MA) = .829*

T = 88* P = .029*

Dec. Contract

	1972 (1)	1973 (2)	1974 (3)	1975 (4)	1976 (5)	1977 (6)
Rank of SPMI (R_i)	6	2	1	3	4	5
Rank of PFC (S_i)	2	1	6	5	4	3

r_{sp} (PFC) = -.429

T = 66 P > .121

Rank of MA (S_i)	5	3	1	4	6	2

r_{sp} (MA) = .543

T = 83 P > .121

* The mean returns for years 2 and 3 were identical, causing a tie in the ranks. Ranking them as listed above favors the alternative hypothesis. If they had been ranked the other way -- year 3 = rank of 2 and year 2 = rank of 3 -- the results would have been :

r_{sp} = .771 Accept Null Hypothesis at α = .05,

T = 87 P = .051 Reject Null Hypothesis at α = .10.

at all between the SPMI and returns to technical trading, as r_{sp} ranges from -1 to +1. Therefore, the null hypothesis is accepted. For MAs, r_{sp} is .829, and the null hypothesis can be rejected for $\alpha > .029$. However, this result is not entirely accurate, as noted in the footnote to Table 4-12. At worst, r_{sp} is .771 and the null hypothesis can be rejected for $\alpha > .051$.

In conclusion, no clear statements can be made as to the difference between profits from MAs and profits from PFCs. However, results from MAs tend to follow the alternative hypothesis closely while those from PFCs don't. A second point to be noted is the percent of profitable parameter combinations under MAs -- none exceed 80%. This is because the smaller numbered MAs -- combinations 1 to 6 in Table 4-1 -- all perform very poorly and have negative net profits for the total six year period.

The performance of high parameter combinations for PFCs on the December corn contracts fulfilled expectations. Profits were small or negative for those combinations where the reversal factor is greater than twenty-five. The best PFC combinations were those with a reversal factor greater than ten and less than twenty-four. The best MA combinations were those whose sum was greater than thirty and less than fifty. The plots are in Figures A3 and A9 in Appendix A.

December Corn

The most volatile years for the December corn contract (see Table 4-13) according to the SPMI are 3, 2, and 4, in that order. This ranking is confirmed by the standard deviations of the random trader. One year under the random trader is different than expected, that being year 6 connected to PFCs. The net profit is $2,143.75, which is greater than

Table 4-13. Results of Technical Analysis of the December Corn Contract

	Years						
	1972 (1)	1973 (2)	1974 (3)	1975 (4)	1976 (5)	1977 (6)	Total
Point and Figure Charts							
Mean ($)	441.96	2784.82	-1477.68	-1164.29	-933.04	-74.11	-422.34
Standard Deviation ($)	274.02	2669.84	3017.49	2526.41	1643.63	1866.65	6149.99
% Profitable Parameters	96.4	85.7	25	39.3	39.3	39.3	60.7
Random (PFC)							
Mean ($)	-211.83	-19.64	343.75	-90.62	-77.23	2143.75	2088.18
Standard Deviation ($)	482.52	5770.53	6500.34	4002.67	2261.73	1961.05	--
% Profitable Iterations	33.9	50	51.8	46.4	50	92.9	--
Average Commissions for PFC ($)	53.21	342.86	489.29	346.43	219.64	133.93	1585.36
Moving Averages							
Mean ($)	-735.63	1370.63	4485.00	1201.25	-820.00	1772.50	7273.75
Standard Deviation ($)	1010.89	3066.95	1943.84	2236.31	958.09	1953.36	4202.96
% Profitable Parameters	20	75	95	70	15	80	95
Random (MA)							
Mean ($)	-971.25	-2655.00	41.25	77.50	-793.75	-474.37	-4775.62
Standard Deviation ($)	1178.98	5474.16	6171.12	4047.09	2085.55	2527.44	--
% Profitable Iterations	17.5	25	47.5	52.5	32.5	40	--
Average Commissions for MA ($)	780.00	760.00	805.00	765.00	830.00	712.50	4652.50
SPMI	0	463	502	331	174	122	--
Average Move of SPMI	0	66	63	47	44	61	--

one standard deviation. However, a standard t-test with a one-sided alternative hypothesis and α = .10 would still not allow rejection of the null hypothesis that profit is different from zero. Therefore, it is not considered as a problem.

Visual inspection of a relationship between the SPMI and level of profits from technical analysis indicate the same conclusion as before -- no relationship for PFCs and a positive relationship for MAs. One of the problems with the PFC results is year 1 -- the SPMI is 0, yet 96.4% of the parameter combinations are profitable. This was caused by a slow smooth upward trend in prices over the entire period, which is also revealed by the average commission cost: $53.21. On average only one trade was made over the entire period. Categorization of the yearly results is in Table 4-11.

The results from the Spearman rank correlation test and the test of the hypothesis are in Table 4-12. The r_{sp} for PFCs is -.429, indicating a negative relationship of some degree. This may have been caused in part by the problem with year 1 and in part by problems with the higher parameter combinations. Regardless, the null hypothesis is accepted. For MAs, r_{sp} is .543 and α is beyond the tabulated values. Despite the relationship indicated by the r_{sp} for MAs, statistically the null hypothesis is accepted.

In summary, no statistically proven relationship exists between the SPMI and profits from technical trading for the December corn contract. Also, as with the previous contracts, there is a stronger relationship between the MAs and price volatility than with PFCs. Second, the expected problem in PFCs with high parameter values showed up much more vividly in the December contract than it did with the

July contract.

The plots of total net returns are in Figures A4 and A10 of Appendix A. Almost all combinations where the reversal factor was greater than seventeen experienced negative profits. The optimal parameters for PFCs are those with the reversal factor ranging between five and twelve, and the optimal parameters for MAs are those whose sum is greater than twenty. As before, those MAs with smaller averages are less profitable.

<u>Corn in General</u>

The same procedure used on the wheat contracts was used to combine the July and December contracts for both PFCs and MAs, and the results are presented in Table 4-9. For PFCs, r_{sp} is -.154 and the null hypothesis is accepted. For MAs, r_{sp} is .678 and the null hypothesis can be rejected at $\alpha > .0122$. These results are similar to those of wheat.

As regards the most profitable parameters for PFCs, the main conclusion is that parameter combinations with a reversal factor greater than twenty should not be used. Selection of the parameters with reversal factors less than twenty may depend on the contract month being considered. For MAs, those combinations with sums of the averages greater than thirty should be used. The smaller moving averages do not perform as well in terms of profitability. In comparing MAs with PFCs, MAs are better. This may not be a valid conclusion, however, because of the bias in PFC results caused by using large reversal factors. Finally, there isn't any clear cut difference between the profits generated from the storage period contract (July) and the production period contract (December).

<u>July Soybeans</u>

The July soybean contract's most volatile years according to the SPMI were 1, 3, and 5, in that order (see Table 4-14). The standard deviations from the random trader verify the ratings of the SPMI to a degree, but there is more disagreement between the two than just a switched pair. This may be a case where the SPMI doesn't measure price volatility as accurately, but that cannot be stated conclusively. Only one year under the random trader -- year 1 comparable to MAs -- shows any large profit at all. However, the $4,181.25 is dwarfed by the standard deviation for that period, leading to the conclusion that expected gross profits should still be zero.

From visual inspection, the profits from technical trading appear to be related in some manner to the SPMI for both PFCs and MAs. Of course the average profits for year 1 stand out -- $36,794.64 for PFCs and $23,055.63 for MAs. However, these aren't the only profits generated by the technical systems. Excluding year 1 still leaves approximate profits of $21,000 and $28,000 for PFCs and MAs, respectively. The only years where losses were made were 2 and 6 for PFCs and 6 for MAs. This isn't unreasonable, as the total price range for year 2 was $1.63 and for year 6 $2.06, while prices bounced around considerably during those periods. Given the "tightness" of the price range, the technical tools could have been whipsawed rather easily. The years are broken down into information value categories in Table 4-15.

The results from the Spearman rank correlation test are presented in Table 4-16. The r_{sp} for PFCs is .6, which shows a fairly high positive correlation. However, the corresponding test statistic only yields an $\alpha > .121$, so the null hypothesis is accepted. For MAs,

Table 4-14. Results for the July Soybean Contract

	Years						
	1972-73 (1)	1973-74 (2)	1974-75 (3)	1975-76 (4)	1976-77 (5)	1977-78 (6)	Total
Point and Figure Charts							
Mean ($)	36794.64	-2625.01	10432.14	9091.07	7594.64	-3628.58	57658.93
Standard Deviation ($)	3647.10	4808.87	5183.81	1093.50	5875.00	4213.60	8896.60
% Profitable Parameters	100	21.4	96.4	100	100	21.4	100
Random (PFC)							
Mean ($)	-3824.11	-1106.25	-1632.59	1226.79	-1831.25	-225.00	-7392.41
Standard Deviation ($)	25240.60	8195.64	9607.83	6787.08	12622.87	6976.27	--
% Profitable Iterations	44.6	53.6	44.6	55.4	50	44.6	--
Average Commissions for PFC ($)	321.43	728.57	592.86	310.71	687.50	719.64	3360.71
Moving Averages							
Mean ($)	23055.63	2410.00	7442.50	7637.50	13510.00	-2860.00	51195.63
Standard Deviation ($)	5781.02	3799.38	3817.94	3515.90	7581.12	2836.17	16785.25
% Profitable Parameters	100	80	95	100	90	10	100
Random (MA)							
Mean ($)	4181.25	-288.75	137.50	760.00	-321.25	866.25	5335.00
Standard Deviation ($)	21706.49	6939.39	10974.77	6802.59	14145.85	5754.88	--
% Profitable Iterations	55	50	55	60	47.5	52.5	--
Average Commissions for MA ($)	462.50	722.50	547.50	617.50	555.00	785.00	3690.00
SPMI	1960	444	924	338	913	450	--
Average Move	218	148	154	169	228	113	--

Table 4-15. Categorization of the Crop Years by Levels in the Technical Analysis of July and November Soybean Contracts.

CROP YEARS

JULY SOYBEANS

Category	PFCs	MAs
Profitable	1972-73 (1), 1974-75 (3), 1975-76 (4), 1976-77 (5)	1972-73 (1), 1974-75 (3), 1975-76 (4), 1976-77 (5)
Marginal		1973-74 (2)
Non-Profitable	1973-74 (2), 1977-78 (6)	1977-78 (6)

NOVEMBER SOYBEANS

Category	PFCs	MAs
Profitable	1974 (3), 1976 (5), 1977 (6)	1975 (4)
Marginal	1972 (1), 1975 (4)	1974 (3), 1977 (6)
Non-Profitable	1973 (2)	1972 (1), 1973 (2), 1976 (5)

Table 4-16. Ranks, Rank Correlations, and Calculated Probabilities for July and November Soybean Contracts.

July Contract	1972-73 (1)	1973-74 (2)	1974-75 (3)	1975-76 (4)	1976-77 (5)	1977-78 (6)
Rank of SPMI (R_i)	1	5	2	6	3	4
Rank of PFC (S_i)	1	5	2	3	4	6

r_{sp} (PFC) = .6

T = 84 P = .121

Rank of MA (S_i)	1	5	4	3	2	6

r_{sp} (MA) = .486

T = 82 P > .121

Nov. Contract	1972 (1)	1973 (2)	1974 (3)	1975 (4)	1976 (5)	1977 (6)
Rank of SPMI (R_i)	6	1	2	4	3	5
Rank of PFC (S_i)	5	6	1	4	2	3

r_{sp} (PFC) = .086

T = 75 P > .121

Rank of MA (S_i)	6	5	1	2	4	3

r_{sp} (MA) = .257

T = .78 P > .121

the r_{sp} is .486, also indicating a positive relationship. Nonetheless, the null hypothesis is again accepted, as the corresponding α value is greater than .121.

In summary for July soybeans, while a positive relationship between the SPMI and technical profits exists, it is not strong enough to be proven statistically significant. Secondly, it's not clear which technical tool performed better on the price series. Total profits for PFCs are greater due to a large advantage in year 1, but MAs only had one losing year to PFCs' two. The plots of profits are in Figures A5 and A11 of Appendix A. The most profitable MA parameters are those whose sum is greater than twenty days. For the PFCs, profitability is fairly well distributed over the span of the reversal factor, but the best values are those less than fifteen.

November Soybeans

The November soybean contract has two highly volatile years, 2 and 3, and three relatively volatile years -- 4, 5, and 6 (see Table 4-17). The ranking of the SPMI is verified by the standard deviations of the random traders, with only minor variations. No profits generated by the random trader were significantly large either, leaving intact the expectation of gross profits being zero.

From a casual inspection of the results, there seems to be a slight relationship between the SPMI and the profits from technical trading. However, one major problem involves year 2. While it has the highest SPMI, both the PFCs' and MAs' net profit for that year is negative. Prices were very volatile during that time period and moved over fairly large ranges. The problem arises from several places where prices jumped

Table 4-17. Results of Technical Analysis of the November Soybean Contract

	1972 (1)	1973 (2)	1974 (3)	1975 (4)	1976 (5)	1977 (6)	Total
Point and Figure Charts							
Mean ($)	1348.21	-6145.99	19085.71	2975.00	16525.00	4662.50	38450.45
Standard Deviation ($)	2095.07	5961.61	5463.25	4812.92	4059.98	4268.43	11846.68
% Profitable Parameters	78.6	10.7	100	71.4	100	89.3	100
Random (PFC)							
Mean ($)	-672.99	-3780.80	-196.87	1210.27	-562.95	1612.05	-2391.29
Standard Deviation ($)	2010.26	18145.55	15999.20	10199.85	10472.34	10488.45	--
% Profitable Iterations	37.5	37.5	48.2	51.8	44.6	57.1	--
Average Commissions for PFC ($)	128.57	767.86	705.36	771.43	423.21	646.43	3442.86
Moving Averages							
Mean ($)	-2160.00	-617.50	13302.50	9685.00	1795.00	3237.50	25242.50
Standard Deviation ($)	1482.18	17299.25	13040.78	3714.65	7428.62	3391.86	19644.48
% Profitable Parameters	15	45	80	100	50	80	90
Random (MA)							
Mean ($)	-425.00	473.75	-882.50	2387.50	-2513.75	-1130.56	-2090.56
Standard Deviation ($)	1836.43	16596.07	15948.50	8332.12	10370.51	10237.91	--
% Profitable Iterations	50	57.5	50	55	42.5	47.2	--
Average Commissions for MA ($)	832.50	695.00	785.00	575.00	707.50	665.00	4260.00
SPMI	0	1360	1128	692	706	598	--
Average Move of SPMI	0	227	226	138	177	150	--

significantly and fell back within a period of several days, causing the technical tools to take large losses. This occurred often enough to offset the profitable trades. The years are broken down into value of information categories in Table 4-15. Although the average net profit for year 5 under MAs is $1,795.00, it is classified as non-profitable because only 50% of the parameter combinations generated a net profit.

The results of the Spearman rank correlation test are presented in Table 4-16. The r_{sp}'s for PFCs and MAs are .086 and .257, respectively. Neither of these indicate a high positive correlation. This also shows up in the statistical test of the hypothesis; the null hypothesis is accepted for both PFCs and MAs.

Summarizing for the November soybean contract, no case can be made for the alternative hypothesis. Furthermore, PFCs out-perform MAs. The total profit is $13,000 higher, only one year is classified as non-profitable as compared to two for MAs, and the percent of profitable parameter sets is higher. In relation to the most profitable parameter sets, PFCs have two profitable areas -- one centered around a reversal factor of ten and the other around thirty-two. For MAs, the best combinations seem to be in the sum range of twenty-four to thirty-two. Also, this is one case where the shorter MAs -- combinations 1 to 5 in Table 4-1 -- outperform the longer averages. The profits are plotted in Figures A6 and A12 of Appendix A.

Soybeans in General

The procedure as described in the discussion on wheat was also applied to soybeans, and the results from the statistical tests are presented in Table 4-9. The r_{sp}'s for PFCs and MAs are .434 and .490, respectively. This indicates a positive correlation between the ranks of the SPMI and the ranks of profits from the technical tools. For PFCs, the null hypothesis can be rejected at $\alpha > .0749$, and for MAs, the null hypothesis can be rejected for $\alpha > .0526$.

When comparing the two technical tools, PFCs appear to perform better in terms of profitability. The best PFC reversal factors are in the lower end, probably between five and fifteen. For MAs, the larger sum values work better for the July contract and the smaller sum values work best for the November contract. A happy medium would be in the twenty-five to thirty-two range. Finally, when comparing the two contracts, the profit from using technical tools are larger on the storage period contract (July) than on the production period contract (November). This is even true after adjusting for year 1, which can be done by subtracting the most profitable year from the total profits over six years and comparing the remaining net profits.

Conclusions

The following conclusions can be drawn from this chapter:

1. The level of profits from technical analysis increases as the volatility of prices increase.

The null hypothesis, which states that technical analysis does not provide any information that can be used to make profits in the futures markets, has been rejected 1) at the .10 significance level for PFCs and MAs on soybeans; 2) at the .05 significance level for MAs on corn; and 3) at the .005 level for MAs on wheat. In terms of specific commodity contracts the null hypothesis can be rejected at the .05 significance level for MAs on May and September wheat and July corn.

Four other contract/technical tool combinations had r_{sp}'s greater than .45, indicating a positive correlation between volatility and profitability.

Several clarifying statements need to be made at this point. First, the above conclusion assumes that the SPMI represents volatility adequately. Volatility as used here refers to long term changes in price levels, not the amount of change from day to day. Secondly, technical analysis refers to only two tools that are commonly used, moving averages and point and figure charts. Therefore, the conclusions may not hold for all technical tools. Finally, the phrase "level of profits" does not mean that net profits are always made from technical tools. It means that expected profits are greater (or losses smaller) as the level of volatility of the price series increases.

2. Moving averages as a technical tool are more consistent with the expectations of the alternative hypothesis.

It is evident that the MAs performed better than did the PFCs as judged by r_{sp}'s and profit levels. However, the cause of this is not completely clear. Possibly it is related to the fact that MAs follow trends, where PFCs are tools that deal more with breakouts of resistance and support levels. As calculated, the SPMI is based on trends -- a change in price level over some period of time consisting of a number of small price changes in the same direction. This may give the calculated r_{sp}'s for MAs an advantage.

3. Profits from point and figure charts and moving averages follow a general functional form as parameter values change.

This is evidenced by Figures A1 to A12 in Appendix A. While the distribution is wide at certain points, and for a few commodity contracts there appears to be a random dispersion, it takes little imagination to to identify some distinct patterns. In general, the following parameter ranges apply as being the most profitable:

Commodity	PFCs - Reversal Factor	MAs - Sum of Days
Wheat	25 - 35	25 - 40
Corn	20	30
Soybeans	5 - 15	25 - 32

4. The profits from technical analysis are greater for storage periods than for production periods.

This statement is backed up by the fact that only for MAs in corn is the opposite true, although the margin is sometimes thin. If the alternative hypothesis for this chapter is true, the implication of this conclusion is that prices are more volatile for the storage period contracts. This implication is not borne out by the SPMI.

A hypothesis for this phenomena is that the price generating function for the production period contract is dominated by expected U.S. production, while price for the storage period contract is determined by expected ending stocks. The factors which affect ending stocks -- export demand, world growing conditions, political and economic variables -- are more volatile than the U.S. production factors. Therefore, prices for the storage period contract are more volatile. This is only conjecture; the conclusion is based more on observation than on theory.

Problems and Further Questions

There are a number of problems and questions arising from this piece of research that should be addressed briefly. Several of these issues will be mentioned again in the conclusion.

1. The hypothesis should be tested over a broader data set.

The data set is too small and only represents one period that was unique to the world grain economy. The data base should be expanded to include a number of years in which grain stocks were high and prices relatively stable. Also, a broader data set would improve the statistical properties of the hypothesis test. As a recommendation, fifteen crop years representing 1965-79 should be used.

2. More sophisticated technical tools should be tested.

The tools as used were as simple as possible, and in some cases naive. From studies done previously, it would be reasonable to expect the addition of stop-loss techniques and other simple modifications to improve the profitability of technical tools. Of course, this "enhancement" of the tools should not be overdone. The test of usability of the tools by everyday market participants should be applied.

3. Relationships between the performance of technical analysis and fundamental supply and demand statistics should be investigated.

Certain fundamental factors, such as world grain stock levels, are related to the volatility of grain prices. Given that the alternative hypothesis is true, evaluation of these fundamental factors might reveal periods in which technical analysis can be used profitably.

4. Other commodity groups need to be tested.

The alternative hypothesis should apply to other commodities as well. Tests conducted on other commodities might verify or refute the conclusions drawn in this work. Of particular interest might be the application to non-storable commodities such as livestock and meat products.

5. Deeper analysis of the results generated to present needs to be done.

One question that hasn't been asked yet concerns the level of commission costs from year to year and the number of trades conducted by the different tools. For example, the number of trades conducted (represented by average commission cost) by the MAs is generally higher and more stable than the number generated by PFCs. Why? Also, the functional form of profits as parameter combinations change could be investigated on a year by year basis with the data available. Perhaps the most profitable parameter sets change over time or as price volatility changes. These are just two possible questions yet to be investigated.

The problems and further questions listed above are by no means all of those present, but they do represent the foremost issues.

CHAPTER FIVE
TECHNICAL ANALYSIS APPLIED TO MARKETING DECISIONS

The previous tests dealt with a speculative trader in the futures markets; i.e., the markets were traded solely with the intention of profit. In addition, the technical trader traded both sides of the market, going either short or long to make a profit. Another method of testing for the value of technical information is to apply a number of grain producer pricing strategies to the data. This "what if ..." analysis does not easily lend itself to a test of a hypothesis. Instead, the results will be presented and discussed on a yearly and total six year marketing period basis.

Factors

The basis of this simulation is a grain producer who has in his possession a unit of 5,000 bushels of wheat, corn, or soybeans. The time period in which the producer is in possession of this grain is approximately 18 months, which includes the production period as well as the more generally acknowledged storage period. The production period was defined approximately as 9 to 11 months before harvest. The storage period was also arbitrarily defined as approximately nine months in length, beginning either one month before or after harvest. For convenience, the periods are presented in Table 5-1. The overlap by the storage period was allowed because the producer is able to estimate his production before harvest.

It is assumed that the producer's goal is to maximize the net price received for his grain. However, net price is not the price received for the cash sale of his grain. Other factors such as storage costs, interest for required capital or opportunity costs, and returns from futures market transactions need to be included. The formulas for calculation of net price received are presented by strategy type in Table 5-2.

Table 5-1. Marketing Periods for Wheat, Corn, and Soybeans.

Commodity	Production Period	Storage Period	Harvest Time
Wheat	December through August	August through April	July 15
Corn	January through November	October through June	November 1
Soybeans	January through October	October through June	November 1

The cash prices used in the simulation were for grain delivered by truck to Toledo, Ohio. The grades of grain were #2 Soft Red Winter Wheat, #2 Yellow Corn, and #1 Yellow Soybeans. Storage costs used were representative of commercial rates and were estimated at 2¢ per bushel and 2½¢ per bushel for the 1972-76 and 1977 harvested crops, respectively. The same rate was charged for all grains. Interest rates were standard annual PCA rates. The regular annual rates were used for the corn and soybean production periods, and rates adjusted to an October to September crop year were used for the other marketing periods. These rates are listed in Table 5-3.

The returns from futures trading were calculated by computer and represent gross profits minus commission costs. Buy and sell signals were generated by point and figure charts and moving averages. In general, all the rules used for the technical traders in Chapter Four were followed here, with one exception: only short positions were taken.

Table 5-2. Calculations for Net Price Received by Strategy Type.

Production Periods

Strategy Type	Calculation
1. Cash Sale	$NP = CP$
2. Hedging	$NP = CP + R - \frac{M}{5000} * \frac{T1}{12} * I$

Storage Periods

Strategy Type	Calculation
1. Cash Sale	$NP = CP - S * T2$
2. Sell Off	$NP = HP\ (1 + \frac{T2}{12} * I)$
3. Hedging	$NP = CP - S * T2 + R - \frac{M}{5000} * \frac{T1}{12} * I$

Where: NP = Net price received at the end of the marketing period

CP = Cash price received at the end of the marketing period

HP = Price at harvest

R = Net returns from futures trading (Gross Profit - Commission Cost)

M = Margin capital

I = Interest rates

T1 = Length in months of the marketing period

T2 = Length in months during which grain is stored

S = Storage costs, monthly rates

Table 5-3. Annual and Crop Year Adjusted PCA Interest Rates.

Annual		Adjusted to Crop Year	
Year	Rate (%)	Crop Year	Rate (%)
1972	7.02	1972-73	7.91
1973	8.09	1973-74	9.21
1974	9.43	1974-75	9.00
1975	8.91	1975-76	8.35
1976	8.24	1976-77	7.92
1977	7.88	1977-78	8.65

Since the problem involved is one where grain is being priced to be sold at a future point in time, a net long position is never required. The hedger only sells a contract to place his hedge and buys to lift the hedge.

The only component left in the net price equation is the margin capital required to participate in the futures markets. Previous studies have simply used the margin requirement for one contract and calculated the cost of providing this margin capital.

However, this approach is unrealistic for two reasons. First, most major brokerage houses require at least $2,000.00 to open an account, considerably more than $600.00 or $1,000.00 initial margin for corn and wheat, respectively (arbitrary values). Second, posting the initial margin is not the end of the matter. If the market moves against the position, margin calls--additional payments to protect the position--will need to be met. Conversely, the market can move in favor of the hedger. Under a selective hedging strategy, profits generated by moving in and out of the market could be removed from the account and invested elsewhere. Because of the difficulties inherent in calculating varying margin requirements, arbitrary levels were set at \$2,000.00 for wheat and corn and \$3,000.00 for soybeans. The relevant interest rates will be applied to this capital to estimate margin costs.

Pricing Strategies

A number of pricing strategies that could have been utilized by grain producers were developed and tested over the production and storage periods. Most of these strategies involved one form or another of hedging, and a cash sales strategy was used as a benchmark value. Note that these are grain pricing strategies, not marketing strategies. A marketing strategy entails storage plans, delivery locations, and other factors. The only concern here is the price received by the grain producer.

Each of the following selective hedging strategies utilizes either point and figure charts or moving averages. A problem arises in determining what combination of parameters should be used. Since using the most profitable parameters as found in Chapter Four might bias the results, commonly accepted values were used in both tools. For moving averages, 5 and 20 day lengths were used, the same as in Donchian's study [15]. A standard 3 box reversal and boxes of 5¢, 2¢, and 8¢ were used for wheat, corn, and soybeans. In addition, some of the strategies used stop loss orders or trailing stops to limit losses. The stop values were arbitrarily set at one and one-half times the current daily move limits. These values are all found in Table 5-4.

The different strategies are listed below. An explanation of any specific rules concerning placing and lifting hedges is included with each strategy.

Table 5-4. Parameters Used in Technical Analysis Tools.

Commodity	Moving Averages	Point and Figure Charts	Stop Levels
Wheat	5 x 20	5¢ x 3 boxes	30¢
Corn	5 x 20	2¢ x 3 boxes	15¢
Soybeans	5 x 20	8¢ x 3 boxes	45¢

#1 - CASH

This is the benchmark value for the analysis. It assumes the grain producer sells his grain at the end of the marketing period. For the production period, this value is simply the price received upon sale of the grain. For the storage period, the value is cash price received minus storage costs for the period.

#2 - SELLOFF

This strategy is only available under the storage period. By following this strategy the grain producer sells his grain at harvest time (not at the beginning of the storage period), which is listed in Table 5-1. Then the producer invests the proceeds over the remainder of the market period, and the net price quoted is the sale price plus the accrued interest.

#3 - HEDGE

This strategy is a strict hedge. The hedge is placed on the first day of the marketing period and is held until the end. The net price is the cash price received from the sale of the grain at the end of the period plus the return from the hedge net of margin costs (and storage costs, if applicable).

#4 - PFHH

This strategy is a delayed hedge using point and figure charts. The grain producer enters the period without any hedging commitment. Upon the first sell signal, the hedge is placed and held until the end of the period. Net price is the cash price plus the return from the hedge net of margin costs (minus storage costs for the storage period).

#5 - MAHH

This strategy is identical to #4, except moving averages are used to place the hedge.

#6 - PF

This strategy is a selective hedging strategy using only buy and sell signals from point and figure charts. The hedges are placed when sell signals are given and not lifted until a buy signal is generated. The net price is the cash price plus the returns from trading the markets net of margin cost (minus storage costs for the storage period).

#7 - PFST

This strategy is a variant of #6. Buy and sell signals are still used to place and lift hedges, but this strategy also uses a stop loss technique. A stop loss order is placed above the hedged price by the amount of the stop. This is to protect against quick moves against the hedged position and will lift the hedge if such a move hits the stop level. Net price is calculated as in #6.

#8 - PFSTRA

This strategy is also a variant of #6. The differing factor in this strategy is that a trailing stop is used. Buy and sell signals are still generated by the point and figure charts. However, a stop order is placed above the previous day's close by the amount of the stop if the price is lower than before. Once placed, the stop cannot be adjusted upward as prices rise; the stop can only move down as prices fall. The reason for using this type of technique is to be able to 1) protect against quick price moves against the initial position, or 2) to protect any profit that the current market position presents. Net price is calculated as in #6.

#9 - MA

This strategy is the same as #6, except moving averages are used to generate buy and sell signals.

#10 - MAST

This strategy is similar to #7, with the major difference being the use of moving averages. Another difference is the addition of the following rule: after being stopped out, a new hedge cannot be placed until 1) the short moving average crosses above the long moving average, or 2) the closing price is below the price at which the hedge was originally placed. Costs are calculated as in strategy #6.

#11 - MASTRA

This strategy is similar to #8, except moving averages are used. Also, the rule presented in #10 is included in this strategy.

#12 - PFSC

This strategy is a selective hedging strategy that includes a "scale-up" feature. Buy and sell signals are still generated by point and figure charts, but only those buy signals are heeded whose price level is greater than the currently hedged price. For example, if soybeans were hedged at $7.00, the hedge would not be lifted until a buy signal was given with the previous day's closing price above $7.00. The goal is to price the grain at the highest level, scaling up the hedge as price rises, but letting it remain when prices are lower. The net price is calculated the same as in #6.

#13 - MASC

This strategy is the same as #12 except moving averages are used.

Results

The results for the production and marketing periods for wheat, corn, and soybeans are presented in Tables 5-5 to 5-10, respectively. The results are presented on a yearly basis and as an average of the six year periods. The strategies will be discussed by their groupings--cash, straight hedges, selective hedges, and scale-up hedges. In addition, the average net prices developed from the four selective strategies for both point and figure charts (strategies #6, #7, #8, and #12) and moving averages (strategies #9, #10, #11, and #13) are presented. Finally, each table has the corresponding SPMI index to represent the volatility of prices for that year. Each marketing period will be discussed briefly and then conclusions will be listed.

Wheat

For the wheat production period (see Table 5-5) the best strategy appears to be one of the selective hedging strategies using moving averages. On the average, the MA selective strategies made 22¢ per year more than simply selling the crop at harvest. This advantage occurred mainly in years 2 through 5, with the increased profitability seemingly related to the SPMI. The only surprise in relation to the SPMI is that in year 1 the technical tool can't match the cash profits. The probable cause for this is that the highest cash price of the year occurred at harvest time.

Strategies #3 through #5 performed about as expected. Being more conservative, their net price received is expected to be lower. One surprising area is the results of the point and figure selective strategies, which are out-performed by the cash strategy. A priori, it would be reasonable to expect them to be similar to the MA selective strategies. One possible reason is that the parameters used for the point and figure chart were not as good relative to the 5 x 20 moving averages. This could only be tested through running this simulation many times with different parameters for the technical tools.

As regards the storage period for wheat, the selective strategies using both point and figure charts and moving averages were better than the cash strategy (see Table 5-6). The average return from the four strategies for the six year period using moving averages was 49¢ per bushel higher than the cash strategy, and the point and figure chart strategies were 24¢ higher. Again the moving averages out-performed the point and figure charts. The hedging strategies increased the net price received over the cash strategy mainly in years 2 through 5, which also possess the largest SPMIs.

Another interesting result is that the SELLOFF strategy generates a good profit, on the average 53¢ per bushel greater than the CASH strategy. Also, the strict and delayed hedge strategies, #3 through #5, had a greater dispersion of net prices as is evidenced by the standard deviation. While HEDGE and PFHH had low net prices, MAHH had a value of \$3.19, 48¢ above the CASH strategy. This also indicates moving averages are better technical indicators.

Corn

The best overall strategy for the corn production period (see Table 5-7) is CASH, performing 8¢ and 9¢ better than the selective moving average and point and figure chart strategies, respectively. The CASH strategy builds its advantage in years 1, 2, and 3 and only has one bad year relatively speaking, year 6. Comparing the results from the selective strategies with the SPMI seems to indicate a negative relationship in terms of the SPMI and the advantage of the technical systems over the CASH strategy. That is, the higher the SPMI, the more poorly strategies #6 through #13 perform compared to CASH.

As expected, the returns to strategies #3 through #5 are lower than either the CASH or selective strategies. Also of interest is the relationship of the results from the strategies using different stops--PF, PFST, and PFSTRA for point and figure charts and MA, MAST, and MASTRA for moving averages. For the three marketing periods discussed to this point, the increased complexity of the stop technique lowers the net price under moving averages and gives mixed results for point and figure charts. There may not be any benefit to using stop loss techniques in hedging strategies, or possibly the wrong size of stop may have been used. To this point, it's difficult to draw a conclusion.

For the corn storage period, the selective strategies on the average out-perform the CASH strategy by 5¢ and 8¢ for point and figure charts and moving averages, respectively (see Table 5-8). However, neither of these averages of selective strategies out-perform the SELLOFF strategy, which was also the case with wheat. The selective strategies gain their

Table 5-5. Net Price Received for Wheat under Alternative Marketing Strategies by Production Period ($/bu).

Strategy	Years 1972-73 (1)	1973-74 (2)	1974-75 (3)	1975-76 (4)	1976-77 (5)	1977-78 (6)	Total Average	Total Standard Deviation
Cash								
1. CASH	4.91	4.26	3.86	2.95	1.97	3.32	3.55	1.04
2. SELLOFF	----	----	----	----	----	----	----	----
Hedge								
3. HEDGE	2.12	3.91	4.52	3.53	2.56	2.84	3.25	.90
4. PFHH	2.17	4.38	4.32	3.46	2.21	2.71	3.21	1.00
5. MAHH	2.26	4.95	4.52	3.53	2.56	2.84	3.44	1.09
Selective								
6. PF	4.03	3.96	4.44	3.44	2.21	2.61	3.45	.87
7. PFST	3.77	4.01	4.44	3.44	2.21	2.61	3.41	.85
8. PFSTRA	3.88	4.25	4.48	3.51	2.21	2.73	3.51	.89
9. MA	4.44	5.54	4.46	3.38	2.40	2.85	3.85	1.17
10. MAST	4.44	5.59	4.53	3.38	2.40	2.85	3.87	1.20
11. MASTRA	4.45	4.22	4.53	3.30	2.40	2.85	3.63	.90
Scale Up								
12. PFSC	4.31	4.56	4.32	3.55	2.21	2.51	3.58	1.01
13. MASC	4.44	4.89	4.52	3.22	2.55	2.30	3.74	1.00
Averages								
PFC (Selective & Scale Up)	4.00	4.20	4.42	3.49	2.21	2.62	3.49	
MA (Selective & Scale Up)	4.44	5.06	4.51	4.51	2.44	2.84	3.77	
SPMI	387	696	327	327	96	76		

Table 5-6. Net Price Received for Wheat under Alternative Marketing Strategies by Storage Period ($/bu).

Strategy	Years 1972-73 (1)	1973-74 (2)	1974-75 (3)	1975-76 (4)	1976-77 (5)	1977-78 (6)	Total Average	Total Standard Deviation
Cash								
1. CASH	2.24	3.29	2.92	2.90	2.23	2.68	2.71	.42
2. SELLOFF	1.57	4.28	4.63	3.56	3.14	2.23	3.24	1.19
Hedge								
3. HEDGE	1.43	2.81	4.31	3.56	3.07	2.05	2.22	1.17
4. PFHH	2.14	3.71	4.06	3.93	2.82	2.20	2.55	1.32
5. MAHH	1.89	4.04	4.10	4.00	3.07	2.05	3.19	1.02
Selective								
6. PF	1.90	3.22	3.31	3.81	2.82	2.34	2.90	.70
7. PFST	1.90	3.25	3.32	3.81	2.82	2.34	2.91	.70
8. PFSTRA	1.95	3.37	3.29	3.91	2.82	2.38	2.95	.71
9. MA	1.79	4.75	4.42	3.78	2.74	2.29	3.30	1.20
10. MAST	1.79	4.63	4.42	3.78	2.74	2.29	3.28	1.17
11. MASTRA	1.76	3.44	4.06	3.62	2.74	2.29	2.99	.87
Scale Up								
12. PFSC	2.14	3.58	3.52	3.77	2.82	2.34	3.03	.69
13. MASC	1.82	3.89	4.64	3.81	2.90	2.29	3.23	1.07
Averages								
PFS (Selective & Scale Up)	1.97	3.36	3.36	3.83	2.82	2.35	2.95	
MA (Selective & Scale Up)	1.79	4.18	5.39	3.75	2.78	2.29	3.20	
SPMI	153	888	315	363	105	93		

Table 5-7. Net Price Received for Corn Under Alternative Marketing Strategies, by Production Period ($/bu).

Strategy	Years: 1972 (1)	1973 (2)	1974 (3)	1975 (4)	1976 (5)	1977 (6)	Total: Average	Standard Deviation
Cash								
1. CASH	1.40	2.57	3.46	2.64	2.26	2.12	2.41	.68
2. SELLOFF	----	----	----	----	----	----	----	---
Hedge								
3. HEDGE	1.25	1.39	2.26	2.77	2.46	2.49	2.10	.63
4. PFHH	1.37	1.31	2.65	2.67	2.66	2.53	2.20	.67
5. MAHH	1.25	1.39	2.31	2.77	2.46	2.55	2.12	.64
Selective								
6. PF	1.37	2.41	2.99	2.79	2.35	2.36	2.38	.56
7. PFST	1.37	2.27	2.90	2.78	2.35	2.36	2.34	.54
8. PFSTRA	1.37	2.27	2.79	2.56	2.35	2.40	2.29	.49
9. MA	1.27	2.34	3.18	2.70	2.28	2.39	2.36	.63
10. MAST	1.27	2.34	3.24	2.66	2.35	2.39	2.38	.64
11. MASTRA	1.27	2.00	3.04	2.30	2.30	2.39	2.22	.58
Scale Up								
12. PFSC	1.37	2.62	2.72	2.41	2.16	2.38	2.28	.49
13. MASC	1.25	2.48	2.97	2.78	2.17	2.37	2.34	.60
Averages								
PFS (Selective & Scale Up)	1.37	2.39	2.85	2.64	2.30	2.38	2.32	
MA (Selective & Scale Up)	1.27	2.29	3.11	2.61	2.29	2.39	2.53	
SPMI	188	346	2.64	90	126	73		

Table 5-8. Net Price Received for Corn under Alternative Marketing Strategies, by Storage Period ($/bu).

Strategy	Years 1972-73 (1)	1973-74 (2)	1974-75 (3)	1975-76 (4)	1976-77 (5)	1977-78 (6)	Total Average	Total Standard Deviation
Cash								
1. CASH	1.71	2.86	2.58	2.72	1.92	2.14	2.32	.47
2. SELLOFF	1.40	2.42	3.80	2.56	2.35	1.91	2.41	.80
Hedge								
3. HEDGE	1.02	2.45	3.80	2.95	2.52	1.82	2.43	.95
4. PFHH	1.07	2.35	3.65	2.86	2.48	1.92	2.39	.87
5. MAHH	1.00	2.43	3.68	2.89	2.52	1.88	2.40	.91
Selective								
6. PF	1.64	2.51	2.85	2.97	2.32	1.90	2.37	.52
7. PFST	1.64	2.56	2.67	2.97	2.32	1.90	2.34	.50
8. PFSTRA	1.64	2.61	2.73	2.75	2.33	1.92	2.33	.46
9. MA	1.54	2.60	3.33	2.73	2.25	2.01	2.41	.62
10. MAST	1.54	2.62	3.33	2.70	2.25	2.01	2.41	.62
11. MASTRA	1.54	2.51	2.95	2.62	2.23	2.01	2.31	.50
Scale Up								
12. PFSC	1.54	2.37	3.50	2.86	2.48	1.90	2.44	.69
13. MASC	1.44	2.71	3.52	2.56	2.52	2.05	2.47	.69
Averages								
PFC (Selective & Scale Up)	1.62	2.51	2.94	2.89	2.36	1.91	2.37	
MA (Selective & Scale Up)	1.52	2.61	3.28	2.65	2.31	2.02	2.40	
SPMI	0	463	502	331	174	122		

advantage over CASH in years 3 and 5. Year 3 is the most volatile according to the SPMI, but there doesn't appear to be any significant pattern between volatility and an advantage of selective hedging strategies using technical analysis over cash marketing alternatives.

The best strategies overall in terms of net price received were the scale up strategies, PFSC and MASC. They did best in years 3, 4, and 5 in terms of performing relative to CASH. Also, the hedging strategies--#3 through #5--did very well over the entire period. HEDGE, PFHH, and MAHH all generated net prices greater than the CASH strategy.

Soybeans

The selective hedging strategies using moving averages were better than CASH for the soybean production period, but the strategies driven by point and figure charts were not (see Table 5-9). The moving average family was on the average 37¢ per bushel better, with MA being the best. Using stops hurts the performance for this marketing period, and this can also be said in general for the commodities previously discussed. Point and figure chart selective strategies perform comparably to CASH. The years in which the technically driven strategies work best relative to CASH are 4, 6, and 3. This doesn't follow any pattern as indicated by the SPMI.

The scale up strategies PFSC and MASC performed well again, with each one doing better than the CASH strategy. Also, the hedging strategies did rather well when the delayed hedge was used--PFHH or MAHH. The straight hedge, HEDGE, returned a net price considerably lower than CASH.

The storage period for soybeans (see Table 5-10) is different from the corresponding periods for wheat and corn in that CASH out-performs

Table 6.2. Net Price Required for Systems

Table 5-9. Net Price Received for Soybeans under Alternative Marketing Strategies, by Production Period ($/bu).

Strategy	Years 1972 (1)	1973 (2)	1974 (3)	1975 (4)	1976 (5)	1977 (6)	Total Average	Total Standard Deviation
Cash								
1. CASH	3.64	5.31	7.80	4.60	6.57	5.30	5.54	1.47
2. SELLOFF	----	----	----	----	----	----	----	----
Hedge								
3. HEDGE	3.10	3.52	5.73	6.44	4.67	6.31	4.96	1.43
4. PFHH	3.61	3.87	5.97	6.23	6.96	7.13	5.63	1.53
5. MAHH	3.10	3.52	5.73	6.44	6.57	7.07	5.41	1.68
Selective								
6. PF	3.61	3.10	8.37	6.04	6.40	5.85	5.56	1.94
7. PFST	3.61	3.52	8.37	6.04	6.36	5.85	5.63	1.83
8. PFSTRA	3.61	2.77	8.56	5.57	6.73	5.10	5.39	2.10
9. MA	3.12	5.21	8.12	6.80	6.24	6.66	6.03	1.71
10. MAST	3.12	5.19	8.02	6.80	6.24	6.66	6.01	1.68
11. MASTRA	3.12	4.99	7.86	6.37	6.16	5.92	5.74	1.58
Scale Up								
12. PFSC	3.61	4.04	6.55	6.23	6.96	6.64	5.67	1.46
13. MASC	3.09	5.45	7.58	6.44	5.78	6.88	5.87	1.56
Averages								
PFC (Selective & Scale Up)	3.61	3.36	7.96	5.97	6.61	5.86	5.56	
MA (Selective & Scale Up)	3.11	5.21	7.90	6.60	6.11	6.53	5.91	
SPMI	0	1360	1128	692	706	598		

Table 5-10. Net Price Received for Soybeans under Alternative Marketing Strategies, by Storage Period ($/bu).

Strategy	Years 1972-73 (1)	1973-74 (2)	1974-75 (3)	1975-76 (4)	1976-77 (5)	1977-78 (6)	Total Average	Total Standard Deviation
Cash								
1. CASH	5.32	5.87	4.92	6.53	7.08	6.48	6.03	.81
2. SELLOFF	3.83	5.64	8.27	4.86	6.92	5.61	5.86	1.56
Hedge								
3. HEDGE	-1.14	6.78	9.10	5.82	5.93	5.24	5.29	3.42
4. PFHH	.47	6.25	8.44	5.47	5.75	5.11	5.25	2.62
5. MAHH	-1.24	6.43	8.72	5.61	5.93	5.04	5.08	3.35
Selective								
6. PF	5.42	6.53	7.62	7.03	7.86	4.66	6.52	1.26
7. PFST	5.66	5.85	5.84	7.03	6.70	4.66	5.96	.84
8. PFSTRA	5.75	5.63	6.55	7.03	6.94	4.89	6.13	.85
9. MA	4.87	6.48	7.82	6.79	8.55	5.53	6.67	1.37
10. MAST	4.87	5.69	7.82	6.79	8.55	5.64	6.56	1.41
11. MASTRA	4.93	6.06	7.77	6.79	8.08	5.64	6.55	1.23
Scale Up								
12. PFSC	5.42	6.07	8.44	5.99	8.73	5.32	6.66	1.52
13. MASC	4.77	5.92	7.93	6.34	9.00	5.35	6.55	1.61
Averages								
PFC (Selective & Scale Up)	5.56	6.02	7.11	6.77	7.56	4.88	6.32	
MA (Selective & Scale Up)	4.86	6.04	7.84	6.68	8.55	5.54	6.59	
SPMI	1960	444	924	338	913	450		

SELLOFF. If a producer were not to use hedging in some form, it would have paid to store the soybeans and sell at the end of the period. However, the average net price to the selective hedging strategies is greater than CASH by 29¢ and 56¢ for point and figure charts and moving averages, respectively. The scale up strategies also performed very well.

The years in which the technically driven strategies did best relative to CASH are 3, 5, 4, and 2, in that order. There might be a slight relationship between the performance of technical strategies relative to CASH and the SPMI. However, the year with the largest SPMI doesn't show any significant advantages to the selective strategies.

The hedging strategies performed as expected--lower than cash. However, if the results from year 1 are discarded--when net price was negative for HEDGE and MAHH--they perform rather well. Finally, these results also indicate that using stops in selective hedging tends to reduce the net price received. The PF and MA strategies are better, in general.

Conclusions and Questions

The following conclusions and comments are gathered from the results presented in this chapter.

1. Selective hedging strategies using technical analysis performed better than a simple cash marketing strategy.

This statement is only in reference to the time period tested. It is true for all of the storage periods and for the production period for 1) soybeans under both technical tools and 2) wheat using moving averages.

2. There isn't any evidence from this simulation to support the alternative hypothesis of Chapter Four.

This conclusion is based on visual inspection of the results. For support to be given to the alternative hypothesis, one would expect the net price from technically driven strategies to vary relative to the cash marketing strategy as the SPMI varies. Although in some cases there appeared to be a relationship, no general supporting statements can be made.

3. Moving averages performed better than point and figure charts in the pricing strategies, given the parameters used.

This statement must be qualified by the phrase that is underlined. However, when considering the results from Chapter Four, this conclusion may not need to be qualified.

4. Selective hedging strategies are more profitable than a strict or delayed hedge.

5. Selective hedging strategies that utilize stops are less profitable than those that don't, given the values used in this analysis.

Once again, this conclusion needs to be qualified by the fact that only one set of stops were used. Future work needs to be done using the same strategies while varying the stop-loss levels and the parameters used for the technical tools. This conclusion seems to be much more evident for moving averages than for point and figure charts.

6. More cash strategies need to be developed and tested against the strategies using technical analysis.

Some type of systematic sales strategy where the producer sells a certain percent of his grain at periodic intervals should be the first addition. Also, hedging or cash sales strategies based upon other criteria such as basis, cost of production, and fundamental forecasts should be tested.

CHAPTER SIX
CONCLUSIONS

The objective of this study has been to look at technical analysis and determine if and why it would provide valuable information to a market participant. Evaluation of past theoretical and empirical work indicated that technical analysis could and did work under certain market conditions. A hypothesis was then developed and tested. The hypothesis stated that technical analysis provides information that can be used to generate profits in commodity futures markets during periods of volatile prices, with volatile being defined as moving over a large range. In addition, a number of grain pricing strategies were developed and tested, with many of these strategies using technical analysis as a timing mechanism.

Findings

The results have been presented and summarized throughout the study. As a grand summary, the major findings are:

** The greater the volatility of prices, the greater is the expected net profit from using technical analysis in grain futures markets.

This statement uses volatility in the sense of change in price levels over time, rather than the size of daily price moves. Secondly, it makes no claims as to what level of volatility is required before profits can be generated. It only states that greater volatility increases the expected level of returns from using a technical trading system.

** Technical analysis performs better in the soybean and wheat markets than in the corn market.

This conclusion follows from the first one, because in absolute terms, soybean and wheat prices move over larger ranges than those for corn. Volatility among all three commodities may be equivalent on a relative basis. However, the technical tools used in this study operate on an absolute basis. Therefore, soybeans and wheat, which move over larger absolute price ranges, should expect to obtain higher per unit profits.

** Moving averages work better than point and figure charts.

This statement is based upon observations from both Chapter Four and Chapter Five. It is a risky conclusion given that 1) the data period is so short (1972-77) and 2) the same parameter values for point and figure charts were used on all grains. The second problem is the more serious of the two, as the reversal factor of the parameters used should be somewhat relative to the commodity's absolute price volatility. Nonetheless, the moving average-based tools performed better in terms of profitability.

** Net price received by grain producers for their products could have been increased by use of selective hedging techniques.

The terminology "could have been" was used because 1) the data period was so short; 2) only one set of parameters was used for all the strategies; and 3) the analysis was ex post. The first two problems can be solved by further testing with more data and parameter combinations. The third issue involves making the heroic assumption that what has happened in the past will occur in the future in reference to price behavior.

Future Work

There are a number of issues and research areas that have yet to be investigated on this topic. The foremost issue is the question of randomness of commodity prices since significant profits have been generated by a technical system in this study. This question has been ignored to this point, yet the profits generated by the technical trader in Chapter Four clearly contradict the random walk.

Several arguments can be presented concerning the results in this study in order to justify the random walk explanation of price behavior. First, the limited time period over which the tests were conducted can be pointed out as one flaw. Also, random-walkers can claim that the information flows that entered the market were correlated due to unusual market conditions. Thus, large price adjustments occurring over a period of time would be expected, generating profits to the technical systems used in this study.

Perhaps a more realistic view is that world grain stocks were lowered to the point where considerable uncertainty existed in the market place. This uncertainty lent itself to periods where prices would adjust to a new equilibrium level in a gradual fashion as perceptions of world supply and demand conditions firmed up. This gradualness of price adjustment violates the assumptions of equal access to information and immediate adjustment of prices to new information - very strong assumptions - and thus negates the random walk theory.

Further research in this area might be centered around a hypothesis that recognizes the possibility of prices behaving randomly at certain times and non-randomly under other market conditions. Then statistical tests for random behavior can be applied and evaluated. It appears to be a narrow-minded approach to test the hypothesis that prices always behave randomly. Considerable evidence exists that they don't. The next step must be to determine when prices behave randomly and when they don't, and why.

A second area for further work is that of testing more sophisticated technical tools. Use of stops, combinations of various tools, and broader ranges of parameters broken into smaller increments should be analyzed. Further work can be done to analyze the effects on returns to a technical system as parameters are changed in order to determine if there is some functional form between profits and parameters.

Third, additional grain pricing strategies should be developed and tested. For example, cost of production could be used as a criterion for production hedges, or a comparison of basis to storage costs may be used as a decision rule for storage hedges. Furthermore, cash pricing strategies should be expanded. An obvious one would be to sell a certain percent of the grain at set time intervals. Other cash strategies could utilize fundamental outlook, opportunity cost analysis, and other factors for decision rules.

A fourth expansion of and improvement on this work would be accomplished by lengthening the time frame and commodity base over which the hypothesis was tested. Data back to the mid-1960's would be a substantial improvement, as that would include a number of years in which prices were stable relative to the 1970's. It would also be interesting to test the alternative hypothesis on non-storable commodities such as livestock and meat products. In this area, prices might behave in a different fashion than for the grains, because stocks are controlled by a different market mechanism.

Fifth, the relationship between technical analysis performance and fundamental supply and demand characteristics should be evaluated. For example, grain stocks tend to serve as a ceiling for grain prices. As these stocks are drawn down, prices can rise further. The relationship between expected ending stocks and volatility of grain prices should be investigated to see if lower stocks expectations leads to greater volatility. If so, the level of expected ending stocks might be used as an indicator of when to use technical analysis.

Finally, the pricing strategies as used in Chapter Five need to be integrated across the production and storage periods. This would allow evaluation of various strategies across the entire time continuum of eighteen months and not just for pre-harvest or post-harvest periods. The net prices received should be converted to a value at a constant point in time for comparison. Converting the prices to this basis would allow for 1) easy evaluation, and 2) integration of the pricing strategies into the broader framework of a total marketing strategy.

APPENDICES

APPENDIX A

RELATIONSHIP OF PROFITS TO PARAMETER VALUES

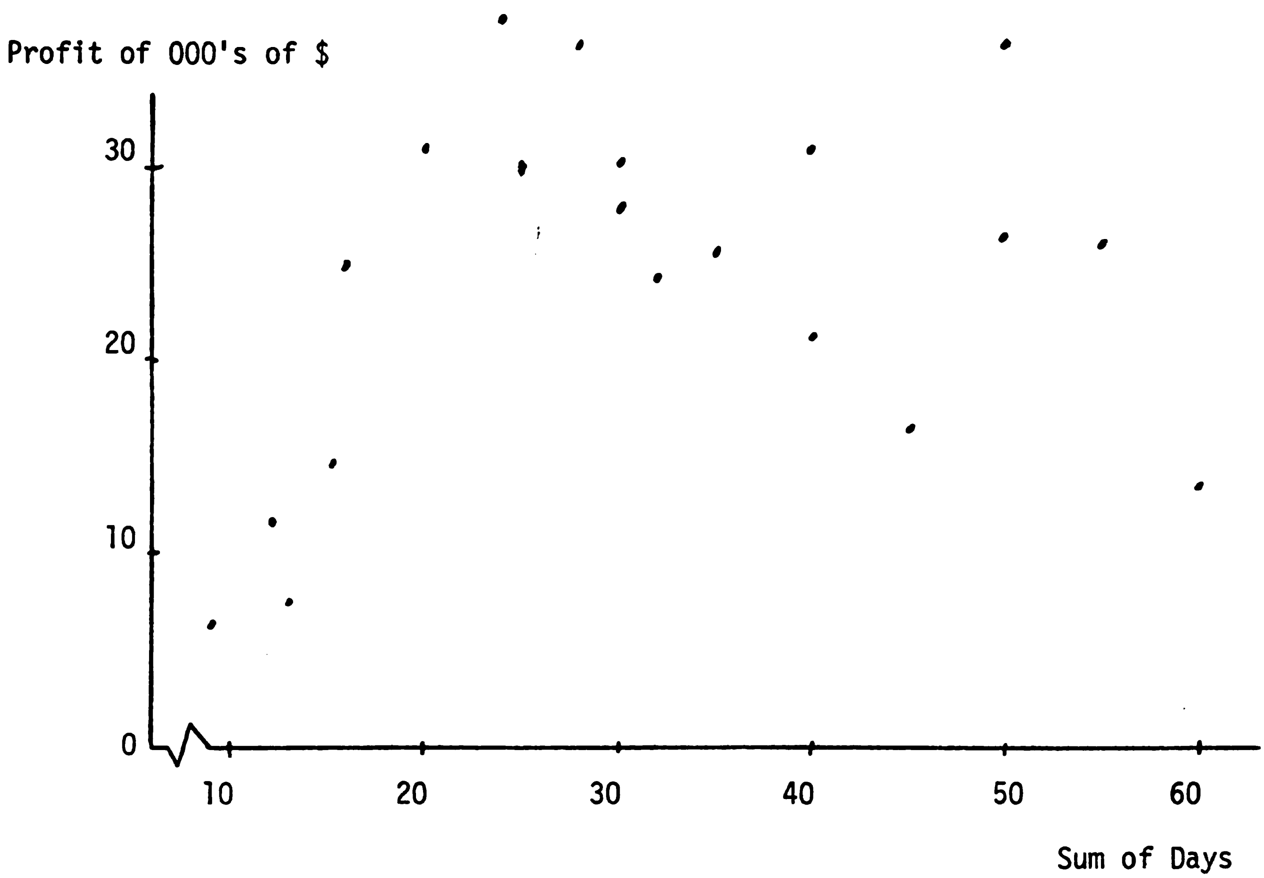

Figure A1. Distribution of Profits to Moving Averages as Parameters Change, May Wheat Contract.

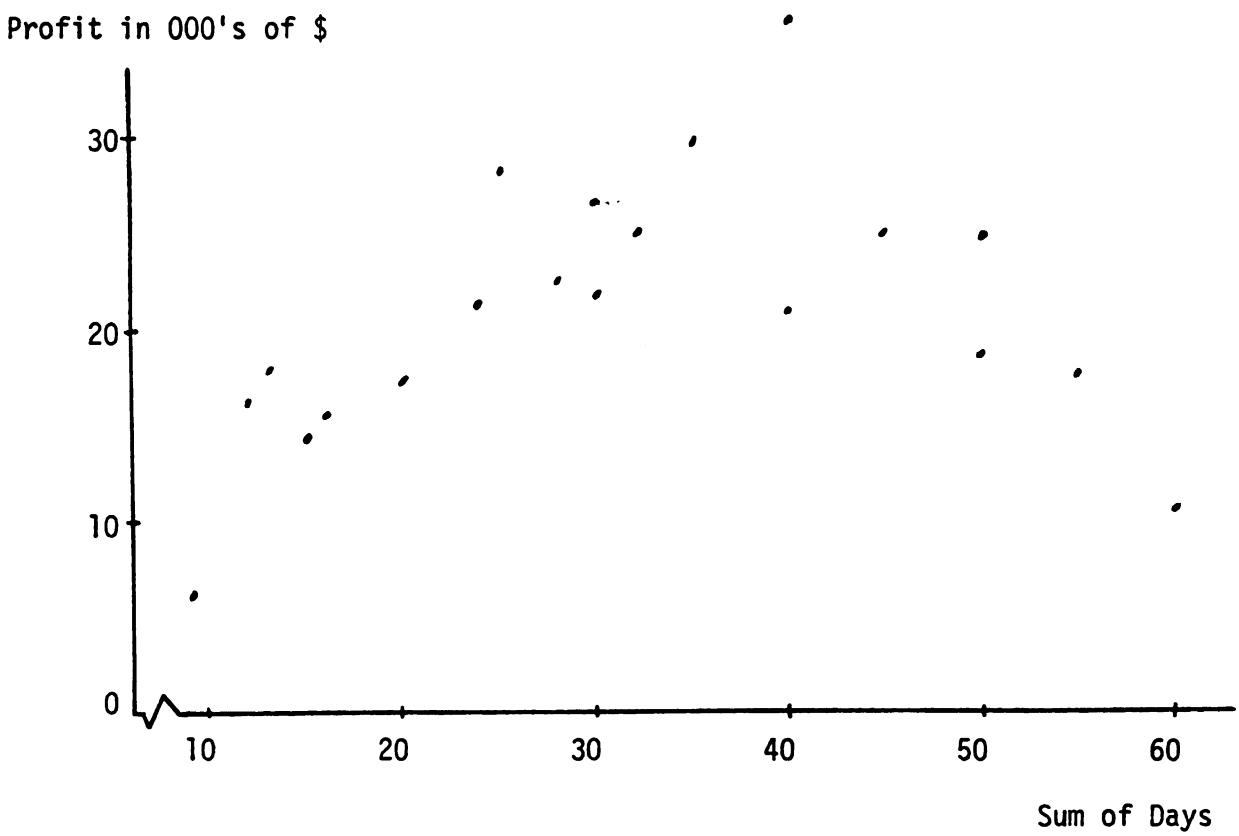

Figure A2. Distribution of Profits to Moving Averages as Parameters Change, September Wheat Contract.

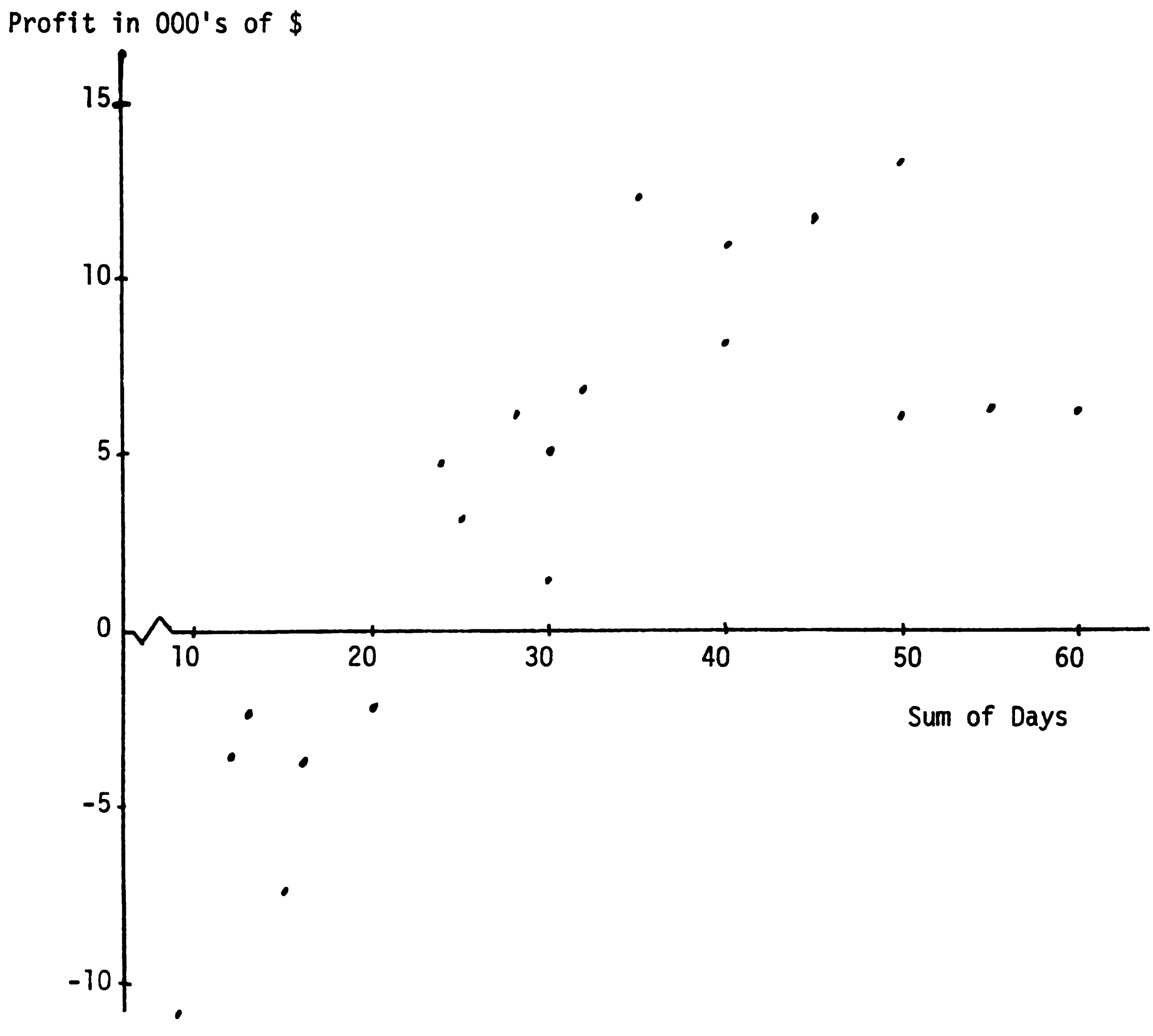

Figure A3. Distribution of Profits to Moving Averages as Parameters Change, July Corn Contract.

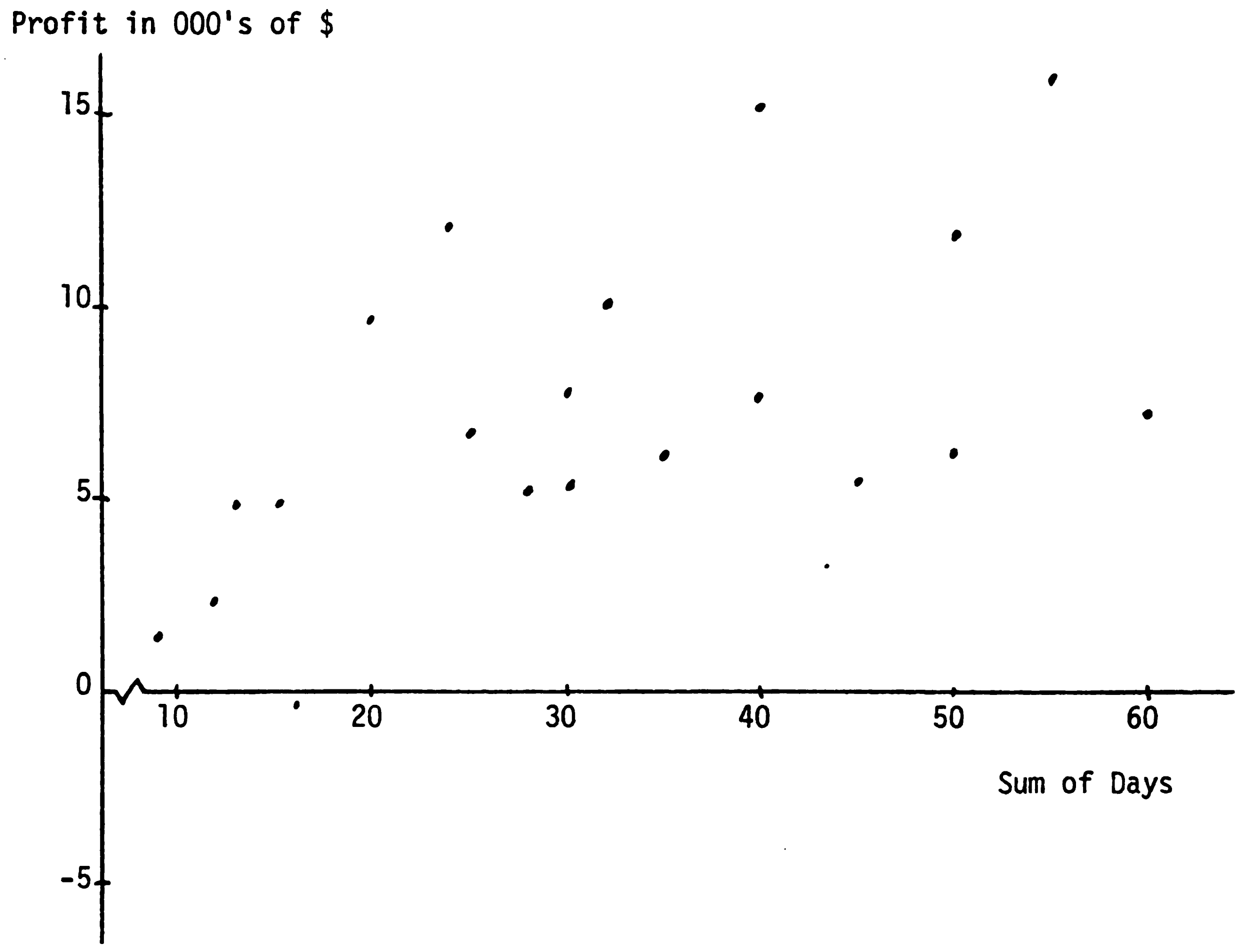

Figure A4. Distribution of Profits to Moving Averages as Parameters Change, December Corn Contract.

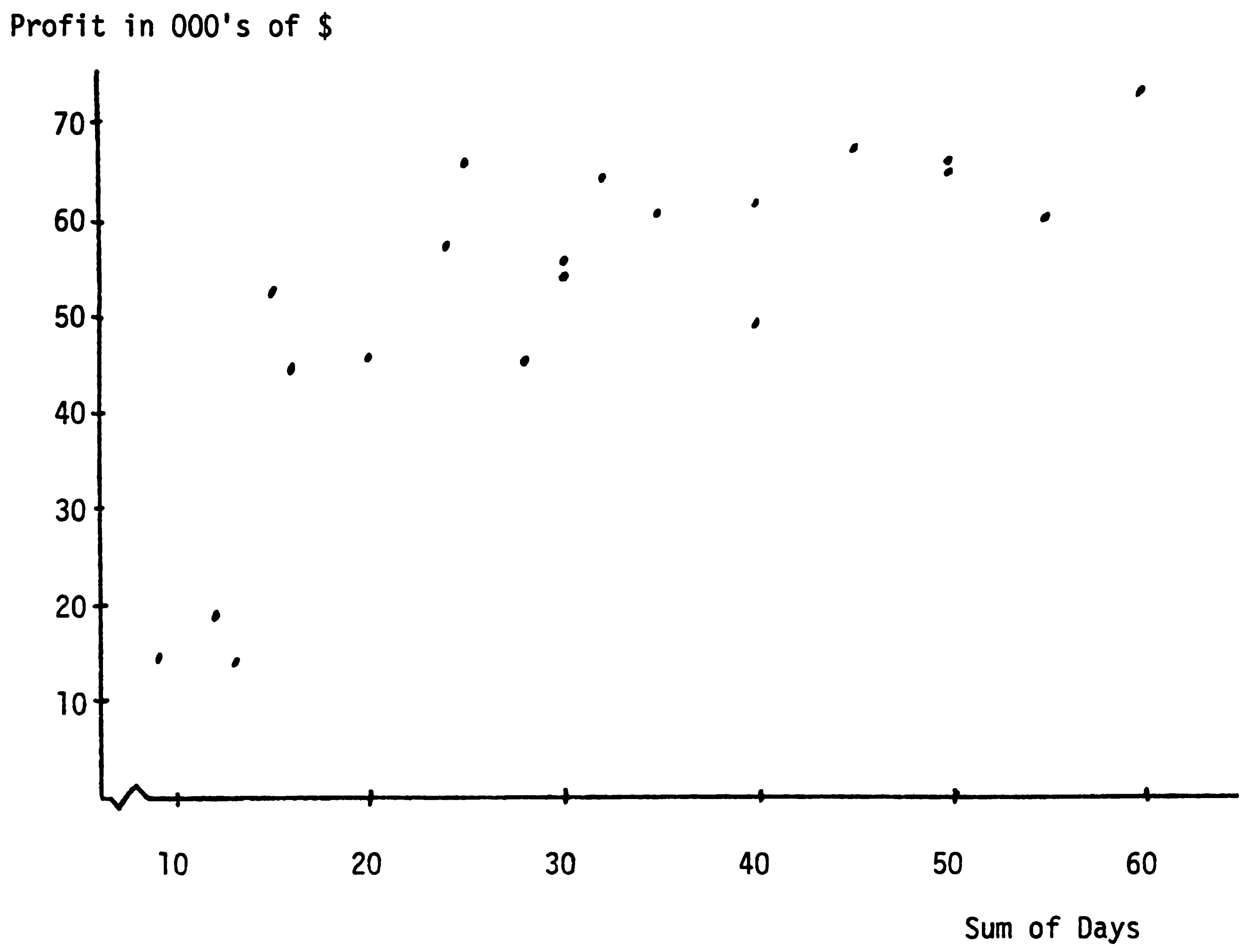

Figure A5. Distribution of Profits to Moving Averages as Parameters Change, July Soybean Contract.

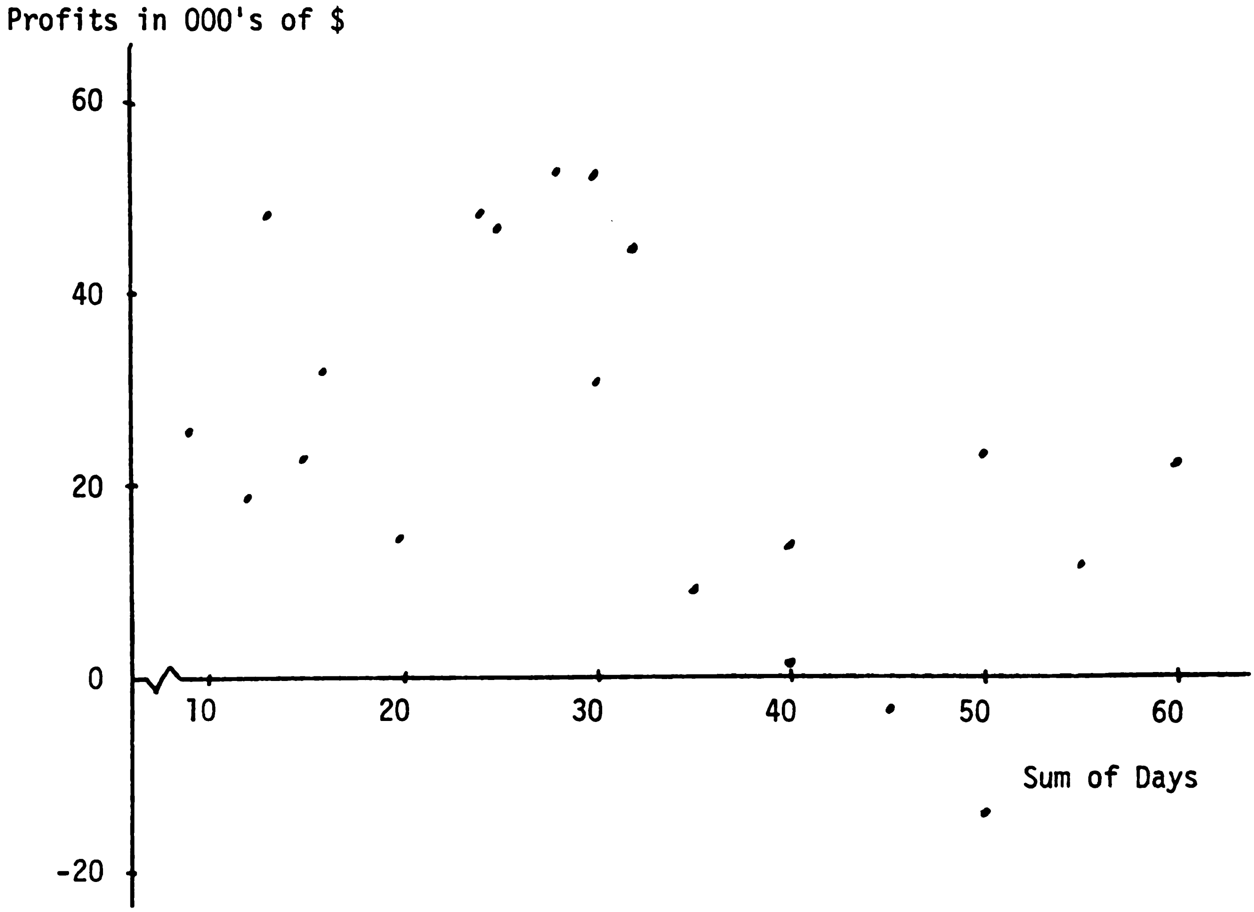

Figure A6. Distribution of Profits to Moving Averages as Parameters Change, November Soybean Contract.

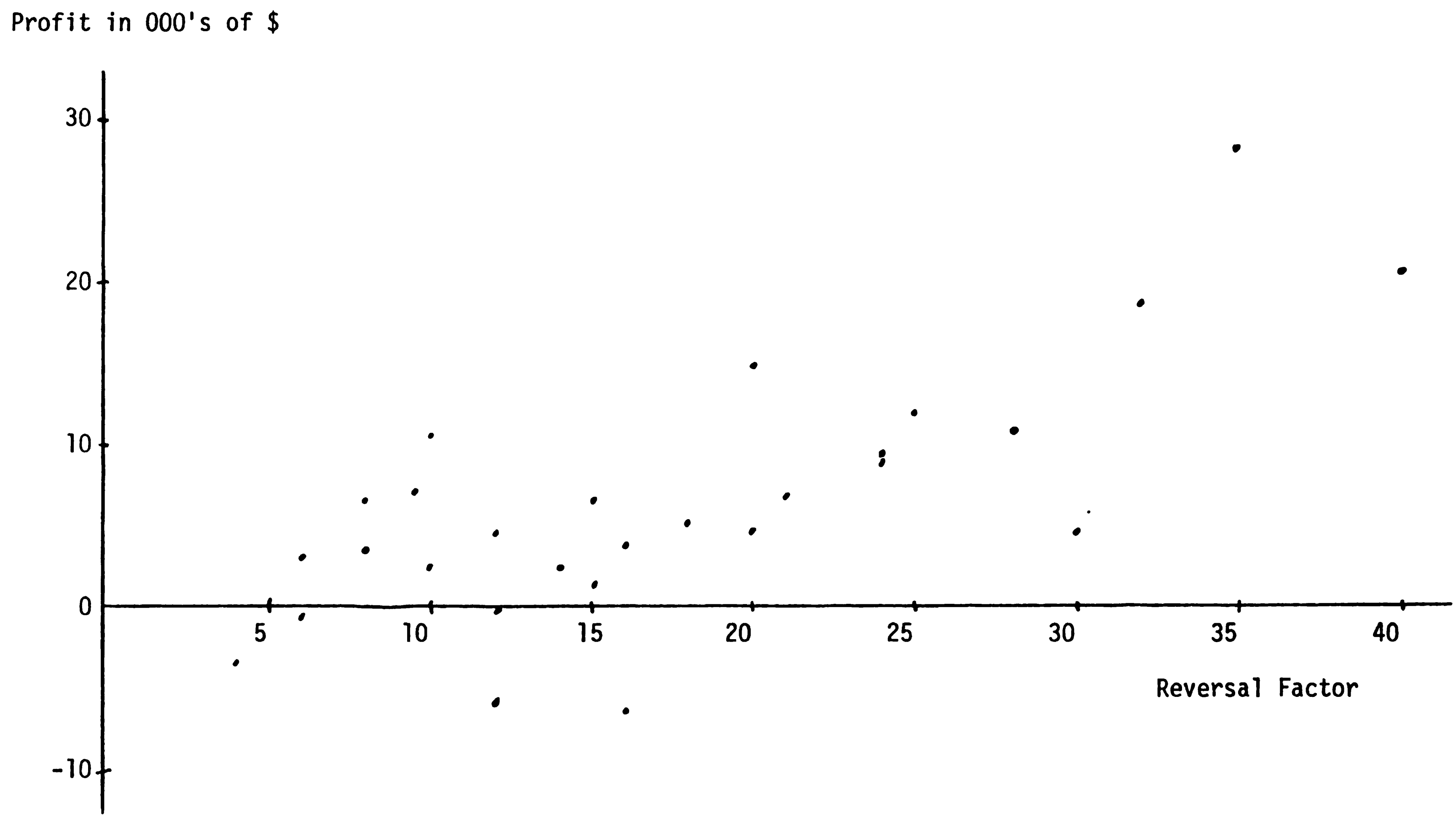

Figure A7. Distribution of Profits to Point and Figure Charts as Parameters Change, May Wheat Contract.

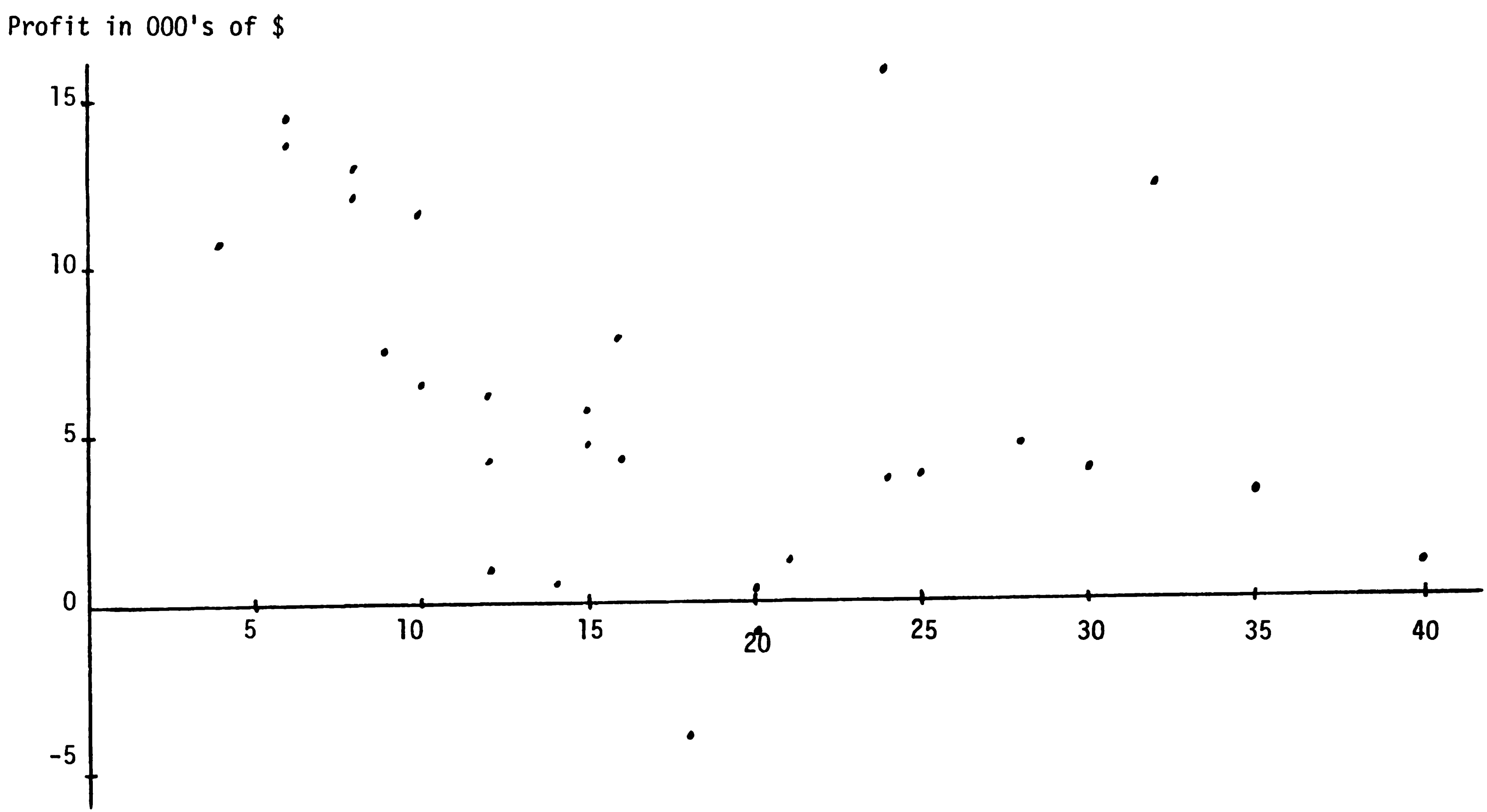

Figure A8. Distribution of Profits to Point and Figure Charts as Parameters Change, September Wheat Contract.

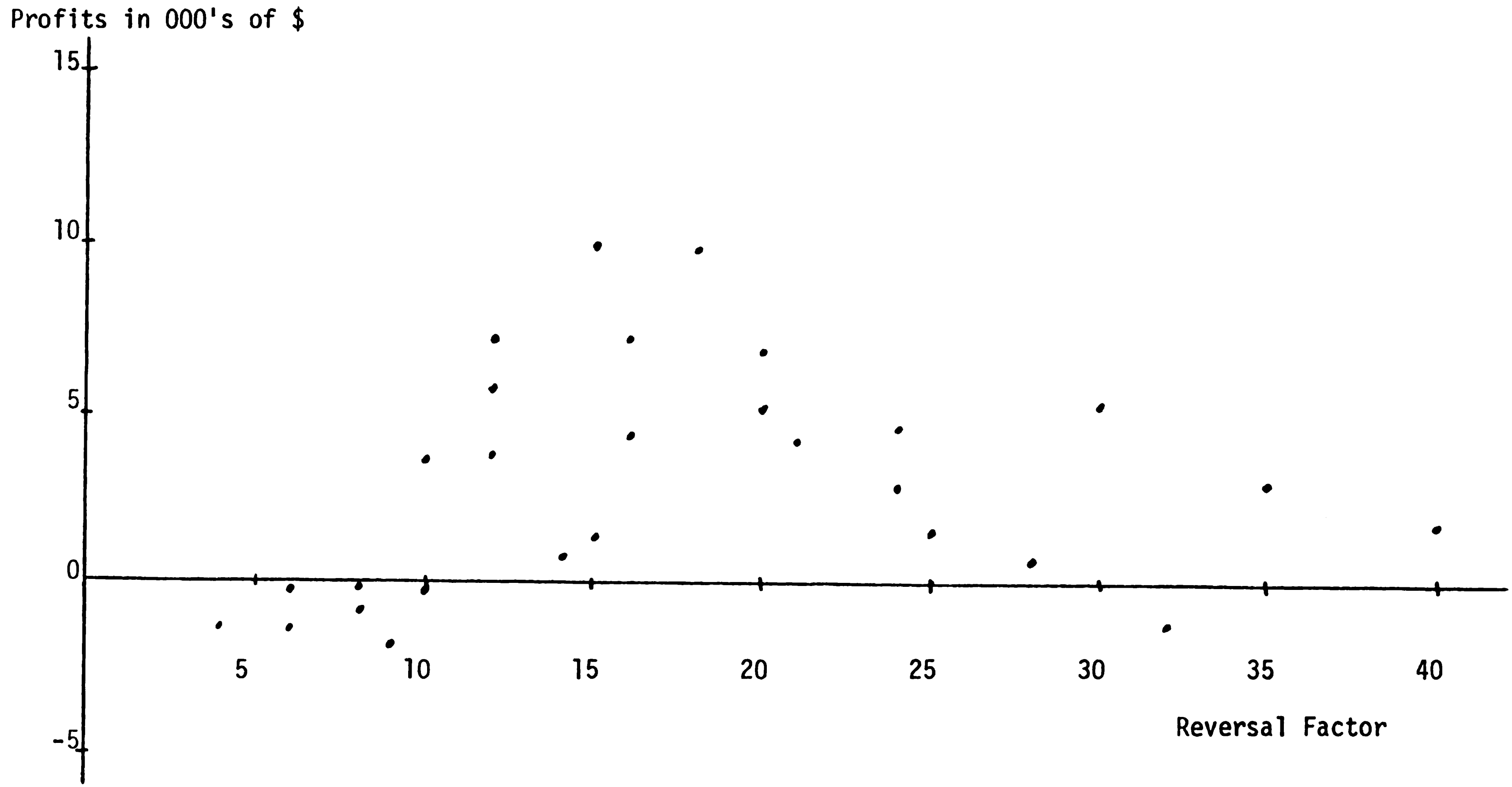

Figure A9. Distribution of Profits to Point and Figure Charts as Parameters Change, July Corn Contract.

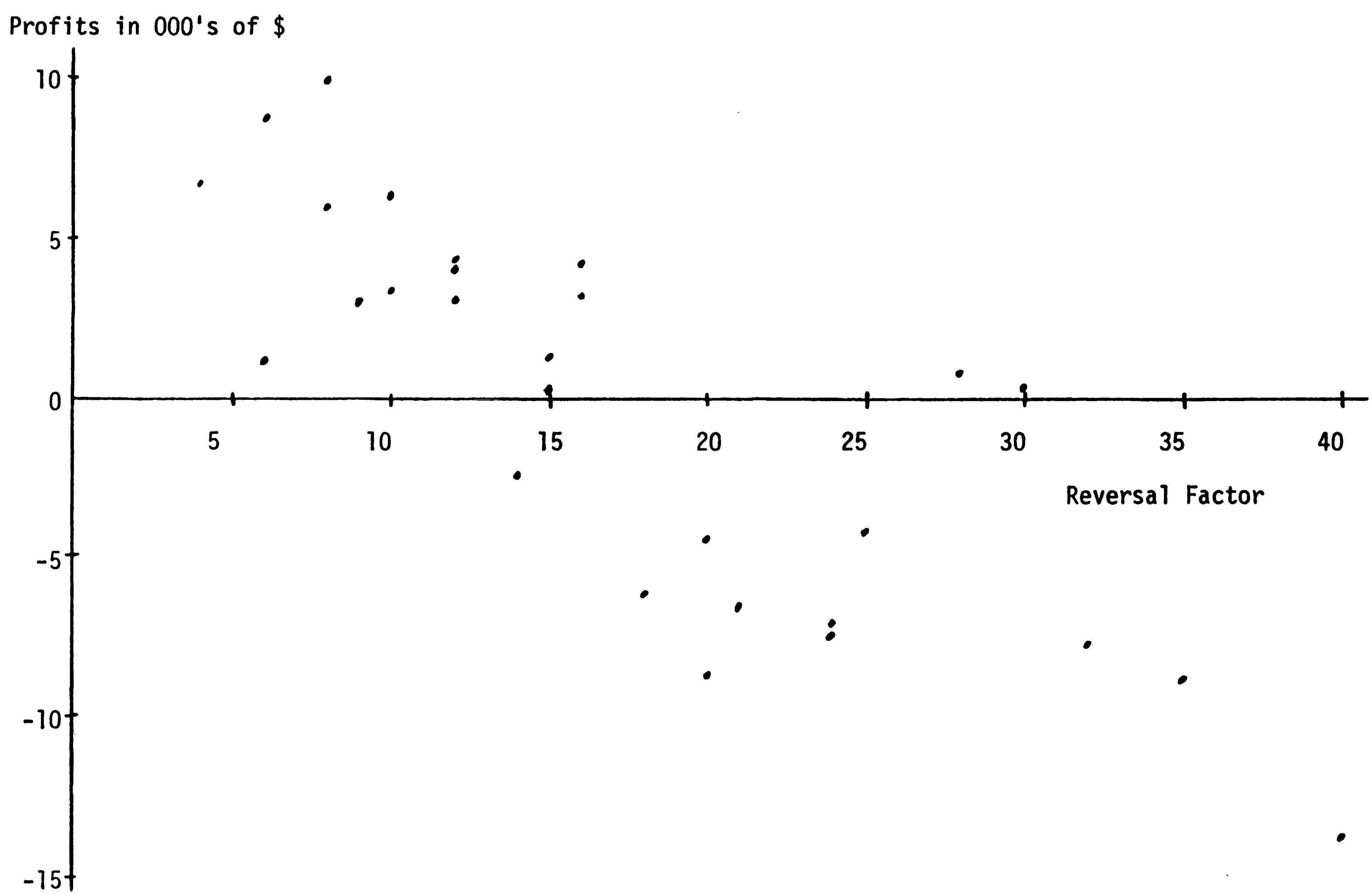

Figure A10. Distribution of Profits to Point and Figure Charts as Parameters Change, December Corn Contract.

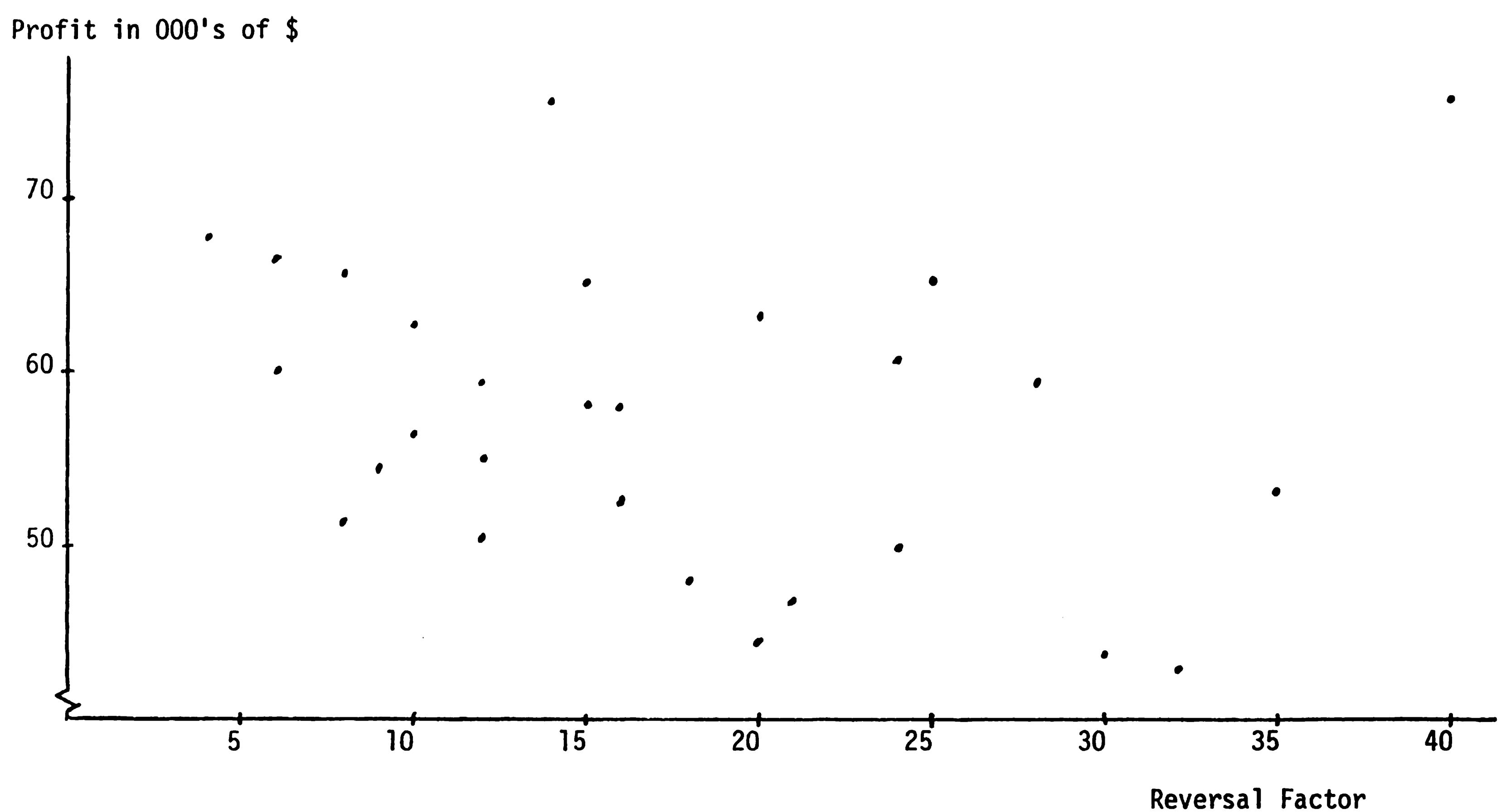

Figure A11. Distribution of Profits to Point and Figure Charts as Parameters Change, July Soybean Contract.

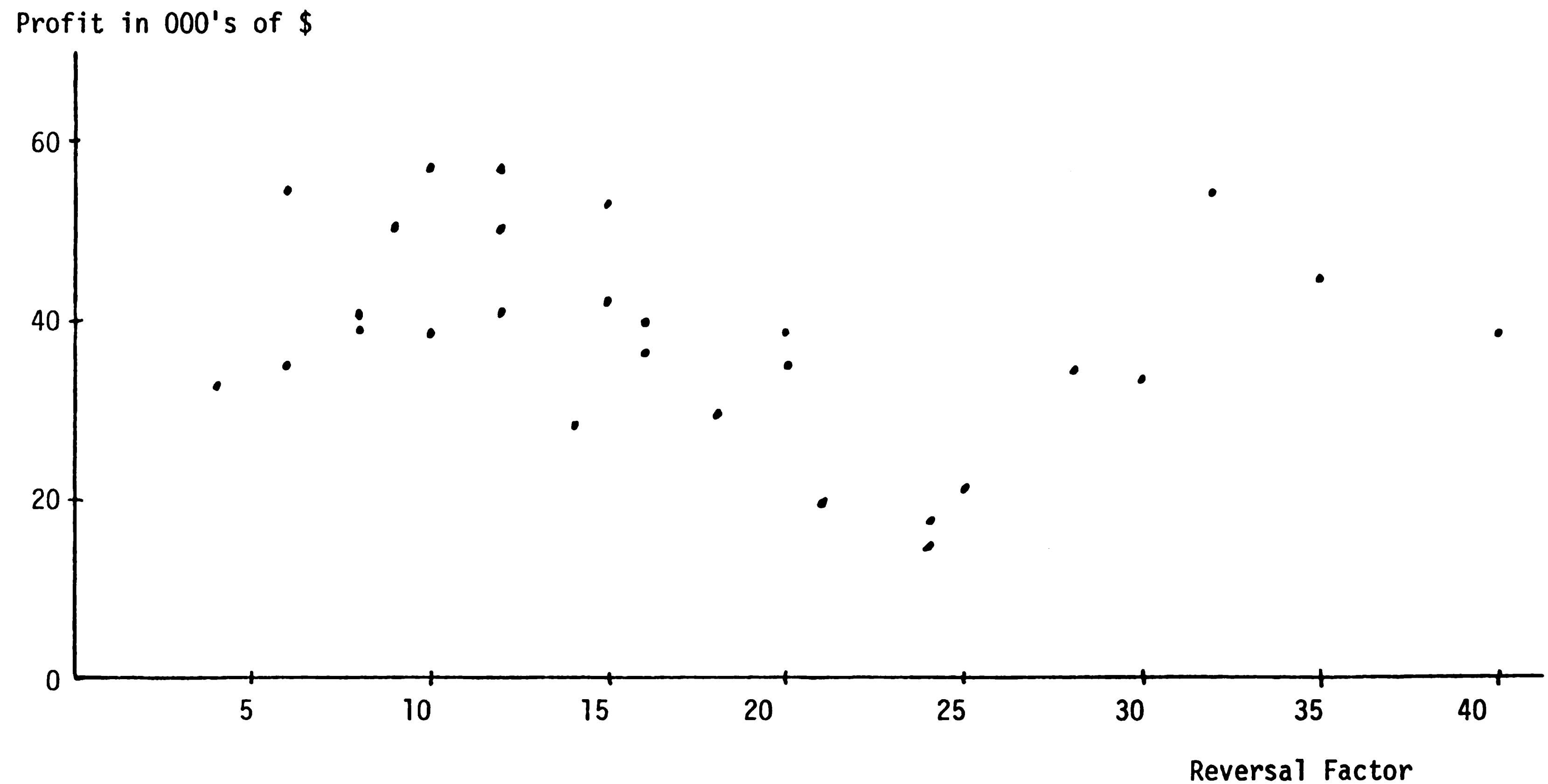

Figure A12. Distribution of Profits to Point and Figure Charts as Parameters Change, November Soybean Contract.

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