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In the Pacific Northwest (PNW) soft white wheat market, the post 1971-72 marketing year has been characterized by volatile and uncertain price movements within and between crop years. For example, during September of 1972 the Portland price of wheat was $2.00/bu.; February 1974 - $6.20/bu.; September 1977 - $2.80/bu.; and September 1979 - $4.20/bu. The financial risk associated with fluctuating PNW white wheat prices has created uncertainty about future cash flows which disrupts long-run management plans for PNW white wheat producers. It was proposed, therefore to determine to what extent, if any, market performance by producers can be improved given the range of marketing alternatives and strategies currently available for the marketing years 1972-73 through 1979-80. This objective was to be realized by testing the hypothesis that there is no significant difference between the performance of the alternative PNW white wheat marketing strategies.

Seventy-two different marketing strategies were ultimately specified. These strategies were divided into five classifications including: (1) cash sale strategies, (2) forward contracting

strategies, (3) quadratic programming - portfolio strategies, (4) mixed strategies, and (5) benchmark strategies. The cash sale strategies utilized different types of sales on the spot market. The forward contracting strategies were hedging strategies using the futures market. A quadratic programming algorithm was used to generate portfolios of the cash sale and forward contracting strategies. For the mixed strategies, U.S. and PNW wheat market variables were used to determine, in each of the eight marketing years evaluated, which one of the cash sale or forward contracting strategies to use. Finally, the benchmark strategies were used to give an indication of the value of perfect information and the value of average returns.

The strategies were evaluated according to a utility maximization performance criterion. This was accomplished by assuming the producer possessed an expected value (mean) - standard deviation, ES, utility function. The mean and standard deviation of returns for each marketing strategy were computed and mapped into ES space. The strategies were then evaluated in terms of their dominance and statistical significance of the differences between the means and standard deviations.

Using sample t and F statistics to test for significant differences between the means and standard deviations of the various strategies, it was found that a producer can effect significant changes in market performance if he is willing to move far enough along a given ES efficient frontier. Whether this would be an improvement in performance would depend on the producers degree of risk

aversion.

Absolute improvements in performance were possible, but not in all cases. Market performance by producers selling their wheat in the PNW can be improved; however, as the differences between the means and standard deviations of alternative strategies becomes relatively smaller, their statistical significance decreases.

An Evaluation of Alternative Wheat Marketing Strategies for Pacific Northwest Soft White Wheat Producers

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CHAPTER I

INTRODUCTION

U.S. Wheat Market Situation

The U.S. wheat marketing situation prior to and after the 1972-73 marketing year (June-May) is dramatically different. Prior to 1972-73, a predictable positive return to storage was available during the course of a marketing year; however, the post 1972-73 period has been much different. Wheat prices increased 120 percent in 1974, declined 25 percent in 1975, declined another 32 percent in 1976, increased 7 percent in 1977, increased another 23 percent in 1978, increased another 30 percent, and then subsequently declined 15 percent in 1979.

There are several factors contributing to the higher and more volatile prices the U.S. wheat market has exhibited since 1972-73. On an international scale, the oil cartel development and the change from a fixed to a floating exchange rate have created uncertain pressures on the production and distribution of agricultural products. Domestically, the post 1972-73 period has been characterized by a removal of protectionist policies related to U.S. grains. The U.S. government eliminated export subsidies and greatly reduced production constraints. Exports as a percentage of total wheat production have risen significantly. Wheat stocks, both total year end stocks and those controlled by the U.S. government, have decreased. And finally,

government authorized wheat purchases under the P.L. 480 program have decreased [Dewbre, 1977].

In summary, wheat market conditions since 1972-73 have changed considerably on an international and national scale; consequently, the relatively stable pattern of prices which existed prior to 1972-73 no longer exists.

Pacific Northwest White Wheat Market Situation

The Pacific Northwest (PNW) --Oregon, Washington, and Idaho-- white wheat market and the U.S. wheat market have reacted similarly to post 1972-73 changes in wheat market conditions. Prior to 1972-73, PNW white wheat prices moved independently of other U.S. wheat prices; however, this was not true after 1972-73. According to Wirak [1977], the major factors influencing PNW white wheat within-season prices prior to 1972-73 were the number, size, and timing of P.L. 480 authorizations and the amount of the export subsidy. Before 1972-73, P.L. 480 authorizations and the export subsidy level were fairly stable. After 1972-73, the export subsidy was terminated and P.L. 480 authorizations were greatly reduced; consequently, the PNW white wheat market became subject to many of the same factors affecting other classes of U.S. wheat. The correlation between Portland cash prices (soft white wheat) and Chicago and Kansas City cash prices (soft red and hard red wheat respectively) has increased significantly since the 1971-72 marketing year [USDA, Wheat Situation, various issues].

Problem Statement

The financial risk associated with fluctuations in produce prices

is a major concern of agricultural producers. PNW wheat farmers have periodically experienced financial losses and gains due to the instability of wheat prices since 1972. During September of 1972 the Portland price of wheat was $2.00/bu.; February 1974 - $6.20/bu; September 1977 - $2.80/bu; and September 1979 - $4.20/bu. The wheat situation and outlook for the coming years is similarly clouded by uncertain market conditions.

Over the long-run (1972-1980), the net worth of Oregon white wheat farmers generally has not declined due to off-setting gains and losses and the appreciation of land values; however, within and between crop years, wheat price fluctuations have created cash flow instability for farming enterprises. This creates general uncertainly about future cash flows which disrupts long-run management plans and financial commitments. Individual wheat producers as well as marketing institutions are interested in information which would minimize the cash flow problems created by the instability of wheat prices.

This concern over marketing performance can be appreciated in perspective by noting the value of the product being marketed. In terms of gross farm income, Oregon wheat accounted for approximately $240 million of the state's agricultural economy in 1979. This is relative to $906 million for all crops and $1,515 million for all crops, livestock, and livestock products [Oregon, 1979]. Over the years 1972-73 through 1979-80, PNW white wheat production has averaged 174 million bushels annually. On average, 94 percent of this has entered the export market [USDA, Pacific Northwest Wheat Summary, various issues].

The sophistication of the production technology for many wheat producers appears to surpass, in many cases, the capabilities of exist-

ing marketing techniques. Thus, although producers recognize the importance of the marketing function, they are frustrated by their seeming inability to effect more desirable outcomes through their traditional marketing decisions.

Objectives and Procedures

The objective of this research is to determine to what extent, if any, market performance by producers can be improved given the range of marketing alternatives and strategies available for the marketing years 1972-73 through 1979-80. In addition, the potential for developing new or different combinations of strategies to improve market performance will also be explored.

The above objective will be realized by testing the hypothesis that there is no significant difference between the performance of alternative marketing strategies. The marketing performance appraisal will be directed towards the PNW white wheat producing region, Oregon, Washington, and Idaho. Necessary yield or cost of production data will be taken from wheat production and marketing studies directed towards the dryland summer-fallow wheat farming region of the Oregon Columbia plateau [Cook et al., 1972-1979].

Specification of marketing alternatives will be directed towards two categories. The first category will include the existing traditional market alternatives available to producers. These would include such techniques as sale at harvest, storage at harvest for sale at a later date, storage at harvest for sale at specified intervals, and various combinations thereof. The second category will combine the traditional marketing alternatives with more sophisticated strategies

such as hedging and the use of moving averages to determine market trends. Other strategies will be formulated that incorporate key market variables (grain stocks, exports, production, market outlook and situation, etc.) into a series of more complex but hopefully more efficient marketing plans.

These traditional marketing alternatives will be evaluated in terms of a risk-efficient performance criterion. The returns associated with the alternatives are not evenly distributed over time. They are distributed around some expected value; consequently, a measure of risk will be used in addition to expected value in appriasing the performance criterion.

Both categories of marketing alternatives will be simulated over time using computer modeling. The simulation will incorporate decision rules to specify sales. Performance of the specified marketing alternatives and strategies will be evaluated in terms of the previously mentioned risk-efficiency criterion as well as the relative sophistications of marketing expertise required, and the likelihood that Oregon white wheat producers will be able to use the most desirable strategies identified.

The thrust of this research is not to change the market-determined price of wheat. Rather, the emphasis is one of improving the market performance of individual producers through the strategies by which marketing decisions are made. Inefficient marketing management erodes the financial position of the producer as well as the associated marketing entities, and may misallocate society's resources in general. Thus, to the extent that white wheat producers and other agricultural clientele can acheive more efficient marketing through improved marketing

strategies, these losses can be reduced.

Organization

The remainder of this thesis will be devoted to achieving the aforementioned objective. Chapter two will evaluate the literature relavent to market and price analysis, evaluation of market performance, and the choise of an appropriate decision framework to use when choosing among marketing strategies. Chapter three will discuss the choice of an appropriate decision framework and its design, analyze the strategies employed, and list the specific data sources. The results will be presented and interpreted in Chapter four. Finally, an overall summary, conclusions, limitations of this research, and suggestions for future research are presented in Chapter five.

CHAPTER II

THEORY - LITERATURE REVIEW

Introduction

Chapter II addresses some of the economic issues relevant to the objective of the thesis. The first section reviews some of the salient theory of market and price analysis as it applies to the U.S. and Pacific Northwest (PNW) white wheat market. Also, empirical research which has evaluated alternative marketing strategies is reviewed. The first section provides a basis for developing effective marketing strategies. The second section reviews literature relevant to measures of market performance and postualtes a general performance criterion that is consistent with actual decision-maker's behavior. Finally, the third section discusses a decision framework that will facilitate choosing a risk-efficient strategy from among several alternative marketing strategies.

Market and Price Analysis

Price formation in the U.S. wheat market is a process of equating the amount of wheat demanded by all users with the amount producers and inventory holders are willing to supply. Any changes in wheat prices, whether from day to day or year to year, are a result of changes in the factors which affect supply and demand and the relative elasticities.

Those factors which contribute to fluctuations in price can be categorized as either trend, cyclical, seasonal, or random. Trends are long-run price patterns. Whether increasing, decreasing, or neutral,

trends are influenced by basic factors affecting changes in supply and demand. Examples are changes in production cost, yield, tastes and preferences, and population. Price cycles are generated by lagged responses, generally in production, to changes in prices or other external events. In the case of hogs and cattle, a complete cycle is spread out over a period of years. Wheat price cycles are characterized by differences between yearly average prices as one year is the time required for wheat producers to make substantial changes in production plans. Seasonality (within season price patterns) arises because of seasonal production and marketing patterns. For wheat, the crop is harvested during a brief period of time and then sold throughout the year. Prices rise throughout the season to cover the cost of storage, and as the next crop year approaches, prices decline to the next seasonal low. Random shifts in supply and demand are not entirely in a category of their own. Rather, random shocks (weather, large changes in exports, government intervention, etc.) contribute to changes in cyclical and seasonal price patterns and long-run price trends [Tomek and Robinson, 1972].

U.S. Wheat Market Situation: In recent years, there does not appear to be any discernible long-run trend in real U.S. wheat prices (see table 1). Table 1 suggests cycles of varying periods for both nominal and real prices, e.g., 1962-63 to 1966-67, 1966-67 to 1974-75, and 1974-75 to 1979-80 for nominal prices.[1/] This research has not explored the causes or predictability of these cycles as this is not the

1/ The latter period may be longer depending on the season average price of subsequent years.

Table 1. Nominal and Real U.S. Season Average Wheat Price Per Bushel Received by Farmers.

Crop Year	Nominal	Real (1967 = 100)[a/]
1961-1962	1.83	2.06
1962-1963	2.04	2.25
1963-1964	1.85	2.02
1964-1965	1.37	1.47
1965-1966	1.35	1.40
1966-1967	1.63	1.64
1967-1968	1.39	1.36
1968-1969	1.24	1.16
1969-1970	1.25	1.13
1970-1971	1.33	1.15
1971-1972	1.34	1.10
1972-1973	1.76	1.28
1973-1974	3.95	2.52
1974-1975	4.09	2.33
1975-1976	3.56	1.88
1976-1977	2.73	1.37
1977-1978	2.33	1.10
1978-1979	2.98	1.25
1979-1980	3.82	1.42

[a/] The nominal prices were adjusted by the index of prices paid by U.S. farmers.

SOURCES: (1) USDA, Agricultural Statistics, 1974 and 1980.

(2) USDA, Monthly Agricultural Prices, Crop Reporting Board, SRS, Washington, D.C., 1961-1980.

problem being addressed herein. To the extent that these cycles could be predicted, a general direction of price changes could be discerned; however, the major problem facing wheat producers is the increased variability of interseasonal and intraseasonal wheat prices since 1971-72.[2/]

Prior to 1972-73, the market price of wheat would generally advance sufficiently, by late winter, to cover the cost of storage and provide a small additional return. Since then, however, the U.S. government has removed protectionist policies which shielded domestic wheat producers from the vagrancies of the international wheat market. As a consequence, the variability of between year prices has increased, and there is no longer a predictable return to storage as seasonal price patterns vary from one year to the next (see figure 1) [Heid et al., 1974].

Since 71-72, random changes in world production and carryover stocks have contributed significantly to the volatility of U.S. wheat prices as a large percentage of U.S. wheat moves into the export market (see table 2). An example, frequently referenced, is the "Russian grain deal" of 1972. During the five years prior to 1972-73, the U.S.S.R. purchased no wheat from the U.S. Then, from July to December of 1972, they purchased 105,000 million bushels of wheat out of 460,000 million bushels exported -- 23 percent. The Soviets had experienced disastrous grain production at home and thus entered the market as importers. They purchased, from the U.S. and other exporting countries,

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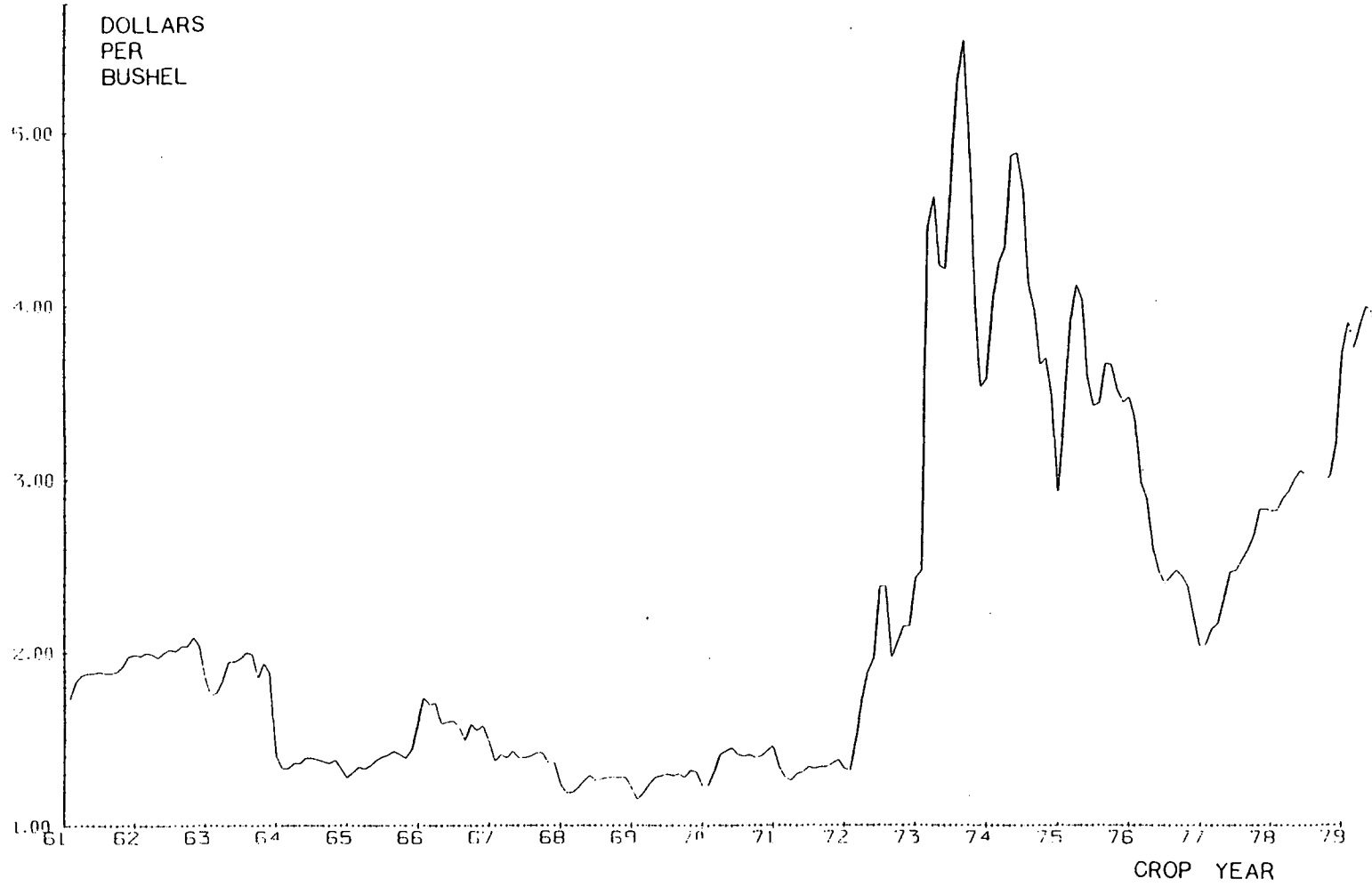
2/ For example, the coefficient of variation for nominal and real U.S. average wheat prices are 0.18 and 0.27 respectively for the years 1961-62 through 1971-72. Similar statistics for the 1972-73 through 1979-80 crop years are 0.27 and 0.33.

Figure 1. U.S. Wheat: Monthly average farm price received.



SOURCE: USDA, Wheat Situation, various issues,1961-1980.

Table 2. U.S. Wheat: Supply and Exports.

Crop Year	Supply[a/]	Exports[b/]	Exports / Supply
	1,000 bushels		
1961-1962	2,740,662	715,655	.26
1962-1963	2,517,845	649,350	.26
1963-1964	2,420,595	845,620	.35
1964-1965	2,278,704	722,698	.32
1965-1966	2,237,612	851,772	.38
1966-1967	1,967,212	771,268	.39
1967-1968	2,021,290	765,304	.38
1968-1969	2,187,889	544,191	.25
1969-1970	2,349,471	603,041	.26
1970-1971	2,335,602	740,783	.32
1971-1972	2,441,638	609,746	.25
1972-1973	2,529,641	1,135,030	.45
1973-1974	2,304,922	1,216,958	.53
1974-1975	2,125,000	1,018,000	.48
1975-1976	2,559,800	1,172,900	.46
1976-1977	2,817,100	949,500	.34
1977-1978	3,160,700	1,123,900	.36
1978-1979	2,955,200	1,194,100	.40
1979-1980[c/]	3,060,300	1,375,200	.45

[a/] Supply is the sum of carryover, production, and imports.

[b/] Imports and exports include flour and other products expressed in wheat equivalents.

[c/] Preliminary.

SOURCE: Compiled by the Extension Economic Information Office, Oregon State University, from Wheat, Outlook and Situation, WS-255, ERS, USDA.

wheat and other grains in quantities large enough to contribute to a substantial reduction in world grain stocks [USDA, Wheat Situation, various issues]. Thus, not only did 1972-73 U.S. wheat prices rise from $1.70/bu to $3.00/bu. because of increased Soviet export demand, 1973-74 prices also increased from $3.00/bu. in June to $6.20/bu. in February. This latter reaction was influenced by relatively small carry-over stocks resulting from large export sales the previous year, tight supplies in major producing and exporting countries, and continued strong export demand [Heid et al., 1974].

PNW White Wheat Market Situation The price of PNW white wheat is influenced by factors which affect the supply and demand of all wheat and grains, because various classes of wheat are substitutable as are different grains, and secondly, by factors which contribute to white wheat selling at a premium or a discount to other wheats [Heid et al., 1974]. The relationship between PNW white wheat and other U.S. wheat classes can be appreciated by noting the correlation between the Portland price of white wheat and the Chicago and Kansas City price of soft red winter wheat and hard red winter wheat, respectively (see table 3).[3/] For the marketing years 1962-63 through 1971-72 the average correlation between Portland cash prices and Chicago and Kansas City prices was 0.55 and 0.62, respectively. Similar statistics for the

3/ Chicago soft red winter wheat and Kansas City hard red winter wheat are used for comparison because they are subject to similar market forces as Portland white wheat. Hard red winter wheat and PNW white wheat have long been major U.S. export wheat, and the two wheats are exported to many of the same destinations. Also, the potential for substitution between PNW white wheat and hard red winter wheat exists while PNW white wheat and soft red winter wheat are almost direct substitutes [Wirak, 1979].

Table 3. Product-Moment Correlation Coefficients Between Montly Average Portland Cash Prices and Chicago and Kansas City Cash Prices by Marketing Year.

Marketing Year	Chicago	Kansas City
1962-1963	.945	.708
1963-1964	.854	.865
1964-1965	-.152	.016
1965-1966	.737	.501
1966-1967	.624	.704
1967-1968	.607	.806
1968-1969	.193	.703
1969-1970	.858	.682
1970-1971	.608	.711
1971-1972	.187	.523
1972-1973	.979	.981
1973-1974	.976	.991
1974-1975	.982	.968
1975-1976	.716	.999
1976-1977	.918	.951
1977-1978	.914	.887
1978-1979	.291	.409
1979-1980	.642	.130

SOURCE: USDA, Wheat Situation, various issues, 1962-1980.

NOTE: Cash prices are for number one soft white or western white, Chicago number two soft red winter ,and Kansas number one ordinary protein hard red winter.

1972-73 through 1979-80 marketing years are 0.80 and 0.79. These figures convey the increased interdependence of the PNW white wheat market with other U.S. wheat markets.

PNW white wheat selling at a premium or a discount to other U.S. wheat occurs, to a large extent, because the PNW white wheat producing area is geographically separated from the other major U.S. wheat producing areas, and because it is primarily produced for export demand (see table 4).[4/] Factors independently affecting the supply of PNW white wheat are weather, expected prices, expected premium or discount over other wheat, and the availability and price of alternative crops. On the demand side, domestic demand for PNW white wheat has been relatively constant, and thus, has not had a destablizing influence on prices. Middle and East Asian grain requirements, soft white wheat stocks and crop prospects in Australia, cash prices of other wheat, and quality of the crop are the primary movers of export demand which are independent of other U.S. wheat [Heid et al., 1974].

As an example of PNW white wheat supply effects, reduced yields in 1973-74 and 1977-78, due to disease and winterkill and drought respectively, contributed to PNW white wheat selling at a premium to Kansas City hard red wheat. An example of how changes in PNW white wheat export demand affect the premium or discount of PNW white wheat relative to other U.S. wheats occurred in 1978-79. During 1978-79, Iran ceased purchasing PNW white wheat because of political differences

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4/ To some extent, it is an independent export market because many PNW white wheat importers have cultivated tastes for products made using only soft white wheat.

Table 4. Pacific Northwest Wheat Production and Exports.

Crop Year	All Wheat Production	White Wheat	
		Production	Exports
	----------Million bushels----------		
1960-1961	101.6	Not Available	114.2
1961-1962	85.5	NA	85.1
1962-1963	102.9	NA	96.8
1963-1964	111/3	NA	105.2
1964-1965	124.5	NA	93.9
1965-1966	134.5	NA	94.7
1966-1967	130.3	125.2	118.7
1967-1968	169.2	162.6	143.1
1968-1969	139.1	128.9	90.3
1969-1970	140.6	129.3	109.1
1970-1971	134.0	126.2	105.4
1971-1972	164.9	139.1	100.3
1972-1973	178.5	158.8	147.9
1973-1974	142.5	126.1	114.8
1974-1975	197.7	179.7	178.8
1975-1976	224.9	201.4	191.2
1976-1977	224.7	204.8	172.6
1977-1978	160.9	147.3	158.3
1978-1979	206.1	189.1	172.4
1979-1980	192.3	181.3	177.5

SORUCE: Pacific Northwest Wheat Summary, ESS, USDA, various issues.

with the U.S. Prior to that time, Iran was purchasing approximately 25 percent of PNW white wheat exports. This decreased export demand was an important factor contributing to white wheat selling at a discount to Chicago soft red winter wheat during the middle of the crop year. A substantial premium had existed at the beginning of the crop year. Later in 1978-79, Iran partially resumed imports and Yemen and Pakistan began purchasing enough wheat such that PNW white wheat once again sold at a premium to Chicago soft red winter wheat [USDA, Wheat Situation, various issues]. To summarize, PNW white wheat price usually responds to variables affecting the U.S. wheat market, but demand and supply considerations peculiar to PNW white wheat may cushion or exaggerate the other effects.

Marketing Strategies The PNW white wheat market may be evaluated in terms of the expectations of a perfectly competitive market since its structure approximates the following conditions. The number of final buyers (domestic millers and importing countries) and primary sellers (farmers) is sufficiently large so that no individual (or individual firm) can perceptively (or for a sustained period of time) influence price by his decision to buy or sell. The product (soft white wheat) is sufficiently homogeneous so that the product of one farm is essentially a perfect substitute for that of another. There are minimal artificial restrictions on demand, supply, or prices, e.g., P.L. 480 sales, Commodity Credit Corporation (CCC) stocks, and effective price supports. And, market information is readily accessible [Tomek and Robinson, 1972]. In a perfectly competitive market, producers are price takers; consequently, the key factors affecting price are some-

what external to individual producers, and they "must work within the overall price structure and attempt to make marketing decisions within the existing framework" [Luft and Griffith, 1978, pg. 3].

In their marketing decisions, PNW white wheat producers have control of two variables. First, they can choose a single or a combination of institutional marketing alternatives, and secondly, they can effect different marketing outcomes by the timing of their sales. The institutional marketing alternatives available to PNW white wheat producers are cash sales on the spot market, forward contracting (cash or hedging on the futures market), and participation in government programs promulgated in 1970, 1973, and 1977 farm legislation. The timing of the sale together with various combinations of these alternatives used is what is referred to in this thesis as marketing strategies.

Several research efforts have been undertaken in an attempt to evaluate effective marketing strategies given the apparent random nature of price changes in wheat and other similar commodities. Luft and Griffith [1979] evaluated alternative wheat marketing strategies to determine an optimal fixed marketing strategy to follow from year to year. Similar studies for soybeans were conducted by Kenyon [1979] and Eddleman and Moya-Rodriguez [1979]. These studies analyzed various marketing alternatives including pre-harvest cash contracting, sale at harvest, storage at harvest for sale at a later date, hedging at harvest to be offset at a later date, or combinations of these alternatives. Luft and Griffith found that no single strategy consistently generates higher total revenues; however, those strategies which were more management intensive performed better on average, e.g., conditional hedging and selling portions of the crop at various times during the

marketing year. Kenyon's and Eddleman's and Moya-Rodriguez's results were similar. In addition, these authors found that spreading sales over the marketing year and diversifying among different marketing alternatives reduced risk, as measured by the standard deviation of returns, relative to strategies which sell the entire production at one time using one marketing alternative. These results would indicate that some marketing strategies do perform better than others, and the strategies employed in the above studies will serve as a basis for the marketing strategies to be analyzed in this research.

Evaluation of Market Performance

Traditionally, market performance has been discussed in the context of industrial organization. Bain [1968, pg. 10] describes market performance as "the composite of end results which firms in any market arrive at by pursuing whatever lines of conduct they espouse - end results in the dimensions of price, output, production and selling cost, product design, and so forth." These dimensions are usually evaluated according to efficiency and equity criteria at the industry level; however, in the context of this research, the concern is measuring marketing performance at the firm level. Changes in industry performance are secondary consequences of improving individual firms' marketing performance.[5/] What then is an appropriate measure of performance at the firm level?

5/ Indeed as Samuelson [1967] has pointed out, what is true of a part may not be true of the whole. In other words, if a significant number of individual firms were to improve their marketing performance, i.e., reduce the uncertainty associated with output price, the aggregate level of output may increase enough to alter the industry's equilibrium price [Sandmo, 1971].

Performance measures of interest to the farmer should provide information that reveals the "strong" and "weak" points of the farming business. Castle, Becker, and Smith [1972] present several such measures including (1) financial success, (2) capital position, (3) size, and (4) efficiency. These measures are used to evaluate the viability of the farm as an economic unit which is strongly influenced by managerial input and market performance. A very important variable in the case of the latter is the price received for the sale of the output. The price received by the firm for product sales, thus, becomes a key factor in evaluating market and overall farm performance. Returns by themselves, however, are insufficient as a measure of overall farm performance.

"Risk and the decision maker's attitude towards risk have long been perceived to play a role in the decision process. In this context, risk is defined as the pehnomenon that the observed, actual value of the decision variable may be different from its expected value" [Klinefelter, 1979, pg. 1]. Several researchers have demonstrated the superiority of utility maximization in explaining farmers' choice among alternative actions characterized by risk. Lin,Dean, and Moore [1974] conclude that maximizing expected utility is superior, as a predictive tool for researchers, to deterministic profit maximization when decision makers choose among alternative production plans. Also, Anderson, Dillon, and Hardaker [1977] suggest that expected utility maximixation, which allows for subjective risk considerations, provides a realistic basis for explaining decisions under uncertainty. Thus, to the extent that the expected price received from a marketing alternative may deviate from the price actually realized, a measure of mar-

keting performance should be consistent with expected utility maximization.

Decision Framework

Given that a choice between alternatives is based on expected utility maximization, which allows for subjective risk considerations, in addition to profit maximiation, a decision framework is needed that will facilitate farmers' decisions based on expected utility maximization. One method would be to employ the method used be Lin, Dean and Moore [1974] and elicit each individual's utility function; however, this would be impractical given the large number of producers represented in this study. An alternative would be to assume a general form of a utility function and use it for all producers. Again, this would not be sufficient because of the diversity of utility functions among individual producers [Young et al., 1979]. The subsequent discussion presents a framework which is neither too restricting nor too general in its application.

Expected Value - Variance Markowitz [1952] and Anderson, Dillon and Hardaker [1977] suggest using an expected value and variance (EV) of returns framework for choosing amoung different alternatives characterized by risk. They suggest using "each possible combination of production, marketing and investment alternatives attainable by the firm be depicted as a point in Figure 2, e.g., point A representing a specific combination of expected returns and risk" [Klinefelter, 1979, pg. 16]. Here, variance is used as the measure of risk. The efficient EV frontier would lie on arc xy. Arc xy is efficient, in terms of a

risk averse decision maker, as a risk averter would choose a given expected income which minimizes variance and/or would choose a given variance which maximizes expected income [McCarl, 1980].

Known Preferences Arc xy in Figure 2 is an efficient locus of points of alternative production, marketing and/or investment alternatives. Figure 2 by itself, however, provides no mechanism for choosing among alternatives.

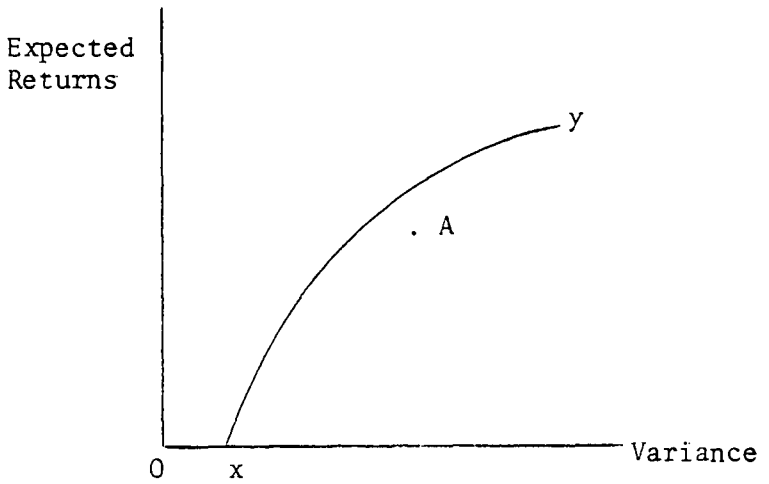

Figure 2. The efficient expected returns and variance (EV) frontier.

Such a mechanism is presented in Figure 3. The decision maker's preference between risk and expected returns can be viewed conceptually as a utility map of indifference curves. Arc xy in Figure 3 is the efficient EV frontier as presented in Figure 2. The same assumptions also apply. The isoutility curves (indifference curves) represent different levels of utility. I_2 represents a higher level of utility than I_1 and I_3 higher than I_2. A decision maker would choose a production, marketing and/or investment alternative from the efficient EV frontier that maximizes expected utility, e.g., point B. On Figure 3, an alternative on I_3 would be unattainable and a point on I_1 would not maximize the decision maker's utility [Klinefelter, 1979].

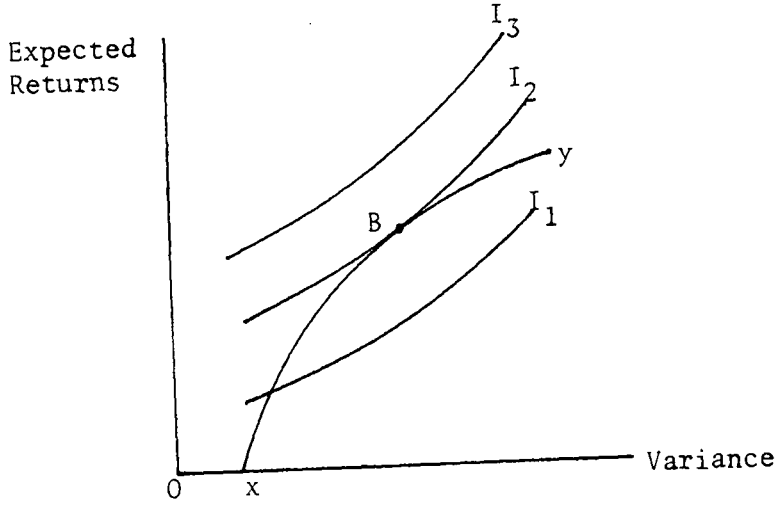

Figure 3. Conceptual utility decision framework.

Practical application of the utility-decision framework hinges on accurately deriving the decision maker's utility function, but this is a difficult empirical task. First, eliciting an individual's utility function depends on the decision maker correctly assessing his subjective probability distributions of the expected outcome related to the decision. These subjective probability distributions are subject to biases which leave their reliability in question [Anderson, Dillon, and Hardaker, 1977]. Secondly, as noted previously, there is wide spectrum of risk preferences among decision makers; therefore, it may not be appropriate to elicit a "representative" utility function and use it for all decision makers.

Revealed Preference An alternative to deriving utility functions is the revealed preference approach. The idea of revealed preference can be seen conceptually by viewing Figure 4. Three loci of points representing EV efficient frontiers for (1) risk averters (arc ab), (2) risk takers (arc bc), and (3) those decision makers who are indifferent toward risk (line ef) are presented. Risk averse, risk taking, and risk neutral, decision makers have indifference curves convex to the origin, concave to the origin, and parallel to the abscissa in Figure 4 respectively. A risk averter would choose from a point on arc ab, a risk taker would choose from a point on arc cd, and a risk neutral decision maker would choose from a point on line ef.[6/] The specific point chosen on arc ab, arc cd, or line ef would depend on the direction of the decision maker's preference map and the slope and degree of

6/ A risk neutral decision maker would be indifferent as to which point along line ef he would choose. This is due to his attitude towards risk -- neutral.

curvature of the map's composite indifference curves. Also, the point chosen would be the tangency point between the appropriate indifference curve and the EV efficient frontier. When a decision maker chooses a point, he maximizes expected utility and he implicitly reveals his preference towards risk even though there has been no explicit elicitation of his utility function. Before this method can be effectively used, the decision maker must be familiarized with variance as the measure of risk.

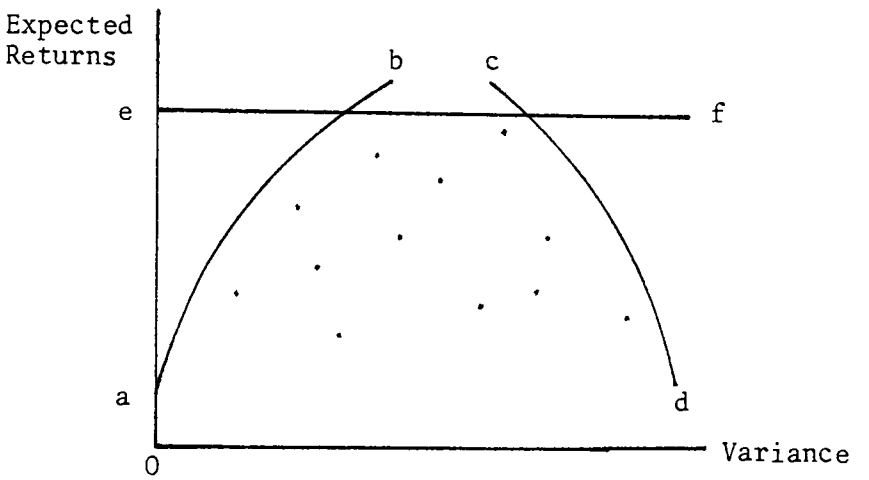

Figure 4. Revealed preference.

Quadratic Programming A third alternative for utilizing a efficient EV decision framework is quadratic-risk programming which generates portfolios of production, marketing, and/or investment alternatives. Quadratic-risk programming is a mathematical programming formulation that takes explicit account of risk. The expected values of a portfolio of alternatives are discounted by some weighted value (risk-aversion co-

efficient) of the variance of expected returns. As the risk-discount factor is parameterized, a risk-averse EV frontier is generated by the quadratic-risk programming algorithm. The choice among alternatives is made according to the revealed preference decision criteria.

One important difference exists between the portfolios generated by the quadratic programming algorithm and the individual alternatives presented in Figure 4. Each portfolio generated by the quadratic programming algorithm maximizes expected utility. That is, each portfolio lies on a risk-averse EV efficient frontier. In contrast on Figure 4, only those alternatives which lie on the risk-averse EV efficient frontier, arc ab, would maximize expected utility. The revealed preference decision framework can, nevertheless, be used in each situation as expected utility will be maximized when either a portfolio or single alternative is selected.

Assumptions In all of the expected value-variance decision frameworks, the returns of production, marketing, and/or investment alternatives are assumed to follow a normal distribution. By appealing to the central limit theorem of mathematical statistics, the assumption of normality for returns may be a reasonable approximation even though it is unlikely to be strictly true. Also, the decision maker's utility function is assumed to be quadratic, i.e., expected value and variance are the only arguments in his utility function. Theoretically, this latter assumption need not be strictly true. When returns are normally distributed, the third and higher odd moments are equal to zero, and the fourth and higher odd moments can be expressed in terms of mean and variance. Thus, if he wishes, the decision maker can consider higher moments by using the mean and variance to calculate them [Anderson,

Dillon, and Hardaker, 1977].

Several other assumptions are implied by using the previously mentioned decision frameworks. First, if the decision maker seeks to maximize expected utility, it is assumed that he behaves rationally if his choices between risky alternatives do not violate the axioms of ordering and transitivity, continuity, and independence [Anderson, Dillon, and Hardaker, 1977]. The decision maker's utility function is concave downward, the first derivative of his utility function is positive, and the second derivative of his utility function is negative [Klinefelter, 1979].

Summary

This chapter has illuminated the recent increased variability of PNW white wheat prices and many of the factors associated with this price instability. It was also pointed out that these factors are somewhat external to the PNW white wheat producer. Thus, it was posited that the timing of sales and the marketing alternatives used are methods the farmer can use to effect alternative and possibly better marketing outcomes. Finally, the rationale was presented for using a risk-efficient expected value-variance decision framework when choosing among these alternative marketing strategies. The following chapter will delineate the EV model and marketing strategies to be used in the empirical analysis of Chapter IV.

CHAPTER III

METHODOLOGY - DESIGN

Introduction

In this chapter, various types of marketing strategies are developed to simulate PNW white wheat selling strategies over the eight marketing years 1972-73 through 1979-80. The sales decisions are executed based on predetermined decision rules and on a quadratic programming (QP) algorithm. First, however, the risk-efficient decision framework used in evaluating the strategies' performance is made explicit, and the mathematical model used in the QP algorithm is specified.

Expected Value - Standard Deviation Decision Framework

In the ensuing empirical analysis of Chapter IV, the alternative marketing strategies' performances are evaluated using an expected value - standard deviation, ES, decision framework. The parameter expected value is measured as the arithmetic average of the price received for each marketing strategy. Although the choise of an expectations model can significantly alter the optimal marketing patterns generated, no formal attempt is made herein to evaluate alternative expectation models for PNW white wheat prices.[1/] Standard deviation, rather than

1/ Klinefelter [1979] chose an average returns expectations model over a distributed lag (limited memory) because the possibility exists for an aberration in observed prices to bias the latter. Brink [1976] also chose an average returns expectations model over an ARIMA (autoregressive integrated moving average) model based on minimum mean square error (MSE). Each of these studies used expected value - variance analysis.

variance, will be used as the parameter to measure risk. In contrast to variance, standard deviation should be better understood by the decision maker as the units of standard deviation are the same as the average of returns. The assumptions regarding the individual decision maker's utility function are the same as those discussed in Chapter II.

Figure 5 illustrates the use of the ES decision framework. The mean and standard deviation of the alternative marketing strategies are plotted in ES space, e.g., points A and B. In choosing among the alternative marketing strategies, the decision maker is assumed to be risk averse, i.e., he would choose from among the marketing strategies that lie on the risk-averse efficient frontier, arc ab.[2/]

Quadratic Programming Model

Some of the strategies to be evaluated are portfolios of several different marketing strategies generated by a quadratic mathematical programming algorithm. The general mathematical framework for the QP

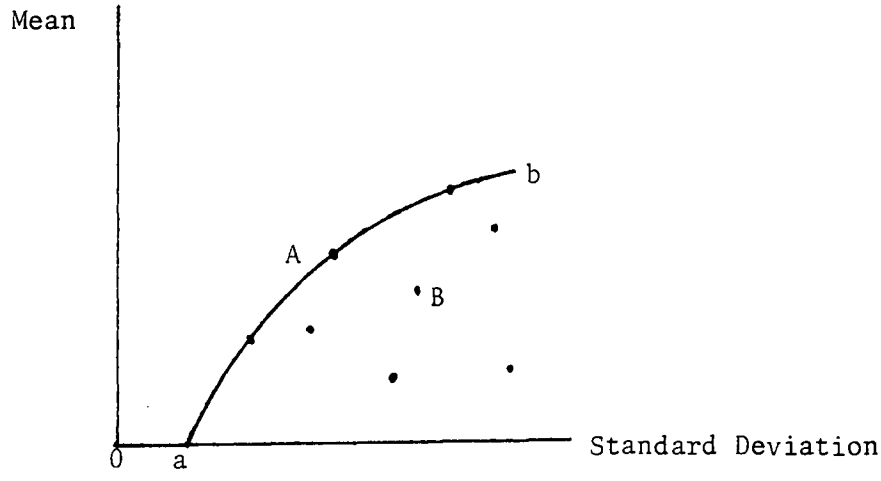

Figure 5. Expected value(mean) - standard deviation decision framework.

2/ Young, et al[1979] reviewed literature that empirically measured the risk preferences of individual farmers. Their summary reveals that while there are farmers in all three risk classifications(averse, neutral, and preferring) the majority of farmers are risk averse.

model is as follows:

$$\text{Maximize } C'X - \theta(X'QX)$$

$$\text{Subject to } AX \leq b$$
$$X \geq 0$$

where

C is a nxl vector of expected values per marketing strategy,

X is a nxl vector of activity levels(amount sold in each marketing strategy),

Q is a nxn estimated variance-covariance matrix of the marketing strategies' expected values,

θ is the risk aversion coefficient,

A is a mxn matrix of technical coefficients,

b is a mxl vector of constraints,

n is the number of marketing strategies, and

m is the number of constraints.

Thus, the expected value of the chosen portfolio of marketing strategies is C'X. The variance of the portfolio is X'QX. The measure of expected value used in the QP model is the same as that used for the expected value - standard deviation, ES, decision framework. And, although the QP model generates the expected value(mean) and variance of marketing strategy portfolios, the variance will be converted to standard deviation so the results can be mapped into ES space.

Several portfolios of marketing strategies will be generated by parameterizing the risk aversion coefficent, θ.[3/] Brink and McCarl

3/ If utility is expressed in the negative exponential form, $U = K - \phi \exp[-\lambda M]$ where K, ϕ, and $\lambda > 0$ and M = money income (or C'X in the QP problem) it can be shown that the Pratt risk aversion coefficient, R(M), equals $-U''(M)/U'(M) = \lambda$ [Buccola and French, 1978]. Also, if $U = K - \phi \exp[-\lambda M]$ and if $M \sim N(\mu, \sigma^2)$, $Z = \mu - (\frac{\lambda}{2})\sigma^2$; therefore, λ equals 2θ from the QP maximization problem [Fruend, 1956].

1978, estimated the risk aversion coefficients for 38 generally large (305 to 3,600 acres) Cornbelt cash grain farmers. They found, "The majority, twenty-five farmers, had coefficients that were zero or less than 0.25. On the other hand, the estimated coefficients ranged as high as above 1.25 ... "[Brink and McCarl, 1978, pg. 262]. Thus, to the extent that PNW white wheat farmers exhibit a similar range of risk aversion, θ will be parameterized from 0.00 to 1.50. The approximate size of the increments will be 0.25.

Parameterizing the risk aversion coefficient, θ, in the above QP model poses an inconvenient empirical problem. As the model is presented, every element of the mxm variance-covariance matrix, (X'QX). must be changed to reflect changes in the risk aversion coefficient. To avoid this time consuming task an alternative formulation of the QP model is developed below.

1) Divide the original objective function, $C'X - (X'QX)$, through by θ resulting in $\frac{1}{\theta} C'X - (X'QX)$.

2) To avoid changing each of the n elements of the expectations vector, C, each time θ is parameterized, an accounting equation, $C'X - Y = 0$, is added to the constraints. The resulting QP model is as follows:

$$\text{Maximize } \frac{1}{\theta} Y - X'QX$$

$$\text{Subject to } AX \leq b$$
$$C'X - Y = 0$$
$$X \geq 0$$

where C,X,Q,A,b, and θ are as previously described. And, where

Y is a scalar equal to C'X.

Marketing Strategies Evaluated

Five basic types of marketing strategies, which are evaluated in the subsequent empirical analysis, are discussed in this section. They are cash or spot market sales, forward contracting using either cash contracts or the futures market, various combinations of marketing strategies dictated by the QP model, mixed strategies that utilize certain market variables, and benchmark strategies that are used for comparison purposes. At the end of this section, simulation of the marketing strategies and the data sources used in evaluating the strategies are discussed.

In the following strategies, all monthly sales, whether the entire crop or only part of the crop is sold, are made on the second Thursday of the appropriate month. This is done to accomodate hedging on the futures market since trading generally stops after the second week in a delivery month. Thursday prices are used for the strategies which specify sales in any given week. None of the strategies specify sales on a daily basis.

Cash or Spot Market Sales The cash market sales analyzed include strategies which sell the entire crop at one time, sell at various times throughout the marketing year, and which sell according to moving average signals. Those strategies which sell the entire production at one time sell during various months throughout the marketing year. A priori, if there is any seasonality to prices, on average, prices would advance throughout the marketing year until the new crop exerted downward pressure on prices in the spring, e.g., December prices should be higher than August and May prices (see figure 6).

Several strategies which sell at various times throughout the marketing year are also specified. They include strategies which sell one-half of production in August and January and strategies which sell one-third of production in various months. The strategy which sells production in halves (August and January) may account for income-tax considerations.[4/] Those strategies which sell thirds at various months throughout the marketing year are an attempt to capture any systematic seasonal variation in prices and to simulate the marketing patterns of producers who customarily sell a portion of their crop at harvest.

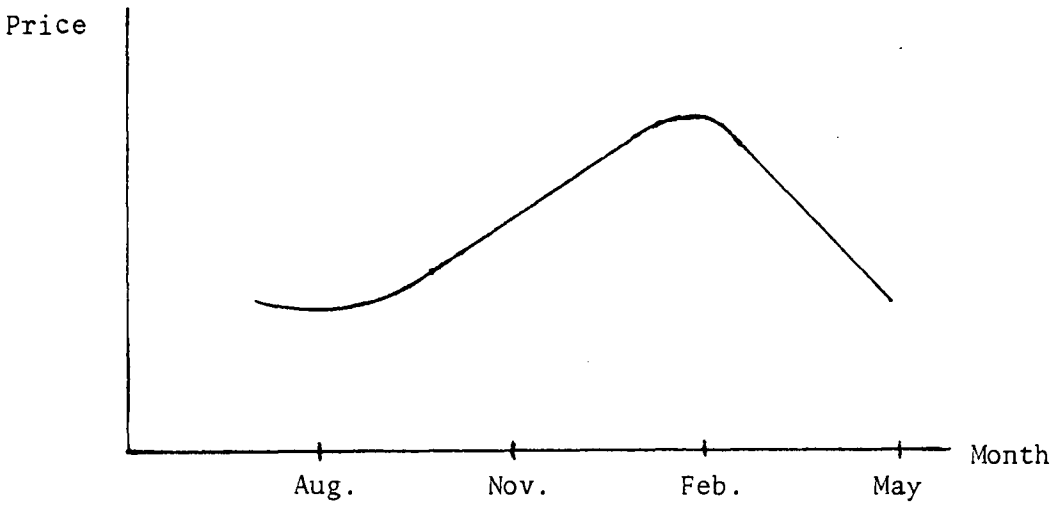

Figure 6. A seasonal pattern of cash prices.

Several strategies employ cash price moving averages to determine when to sell the entire production. All possible combinations of 3,5,10, and 15 week moving averages are used. The decision rule implied by the

4/ This research did not consider the income-tax consequences of marketing strategies in depth; however, strategies which spread sales over subsequent years affect income taxes for a producer on a cash basis accounting system.

moving average is that the shorter-period moving average responds more quickly to price changes than the longer-period moving average. Thus, when the shorter-period moving average crosses the longer-period moving average from above a sell signal is indicated, i.e., current prices would be declining relative to the longer run price trends. When a sell signal occurs, the entire production is sold. These moving average marketing strategies are based on the assumption that current prices and price trends incorporate relevant information regarding current and future market conditions.

Forward Contracting Basically, there are two types of marketing alternatives which utilize forward contracting. These involve cash-forward delivery contracts and hedging using the futures market. These marketing alternatives are used by farmers as a means of price risk management. Forward contracts are available, for the new crop, nearly a year in advance of delivery. Generally, farmers will cash-forward contract or hedge only a part of their crop as the actual production may fall short of that expected. For the same reason, most producers who forward contract before harvest will do so in early summer when the condition of the crop can be better analyzed [Goetze, 1971].

Marketing strategies involving cash-forward contracts will not be analyzed as the appropriate data were not available. Some organizations have recently begun to compile this information, but time series data on forward contracts are not compiled by the U.S.D.A. or commercial grain firms [Lauderback, 1981].

The second type of forward contracting is hedging on one of the commodity futures markets. Hammonds [1974, p. 16] defines hedging as "The process of forward pricing a product through the commodity

futures market." Thus, hedging is similar to cash-forward contracting; however, the reliability of a futures market hedge depends upon the predictability of the basis.[5/]

Historically, as the contract matures, there is a tendency for the wheat basis to "narrow" over time (cash price moves toward and/or above futures). This narrowing of the basis generally provides a positive return to storage; however, the narrowing of the basis varies considerably from year to year. In fact, the return to storage has been negative in some years, i.e., the producer would have received a better price by selling on the cash market when the hedge was placed. Nevertheless, over time, the variability of the basis has been less than cash price variability. Thus, hedging strategies will be used as a risk reducing marketing strategy that generally provides a positive return to storage [Cornelius, 1980].

Each of the five months for which futures contracts are available, September, December, March, May and July, will be used in the hedging strategies. Some of the strategies hedge the entire production in each of the five contract months. Others hedge a third of the production in each of three contract months. Also, strategies which sell a portion of the production at harvest on the spot market, and then hedge the remaining production in later contract months, will be evaluated. Finally, hedges in each of the five contract months will be implemented according to the same cash price moving average signals used for the cash market sales. When the shorter-period moving average crosses the

5/ "Basis can be defined as the difference between current cash market price and a futures market price for a given futures contract" [Cornelius, 1980, p.2].

longer-period moving average from above, the hedge is placed by selling a contract(s) in the futures market. The hedge is offset, by buying a futures contract, when the shorter-period moving average crosses the longer-period moving average from below or when the specific futures contract matures. Any number of sell and buy transactions may occur depending on the number of times the moving-averages cross. The actual production is not sold on the cash market until the futures contract matures; consequently, any gains or losses which occur prior to the expiration date are purely speculative. Also, if the shorter-period moving average never crosses the longer-period moving average from above, no hedge is placed, and the wheat is sold when the futures contract matures.

Diversification Using the QP Model The QP model is used to analyze the effects of diversifying among the previously discussed cash and forward contracting marketing strategies. The composition of the generated portfolios is based solely on statistical considerations, i. e., mean, variance, covariance, and the risk-aversion coefficient. At larger values of the risk aversion coefficient, the algorithm usually generates a portfolio consisting of an unrealistically large number of marketing strategies. This was judged to be managerially impractical, so the portfolios are limited to five strategies. Also, the marketing strategies involving hedging are constrained to be greater than or equal to 5,000 bushels as this is the size of the contracts traded on the commodity exchange used. If the amount hedged is greater than 5,000 bushels, no attempt is made to guarantee that the number of bushels hedged is a multiple of 5,000. Also, the total amount of pro-

duction available for sale is limited to 30,000 bushels of PNW white wheat.[6/]

Mixed Strategies For each of the strategies discussed up to this point, when a method of sale is specified, the wheat is sold in the same manner during each of the eight marketing years; the strategies are inflexible. It is unlikely, however, that any one of these inflexible strategies will perform well in each of the marketing years analyzed. Thus, several flexible marketing strategies are presented below which are based on key market variables. These strategies are termed mixed, because, depending on the relative value of the market variables, several different marketing alternatives may be utilized over the eight marketing years.

Standaert [1981] found that U.S. wheat stocks is an important variable in the explanation of the Portland price of white wheat. Also, Standaert, Dewbre [1977], and Heid et al. [1974] discuss the importance of previous export demand, expected export demand, and supply as determinants of future price levels. Thus, the following combinations of market variables are used to determine what type of marketing alternatives to use in any given year:

- $\frac{\text{Stocks (carryover)}}{\text{Disappearance during the previous period}}$
- $\frac{\text{Stocks (carryover)}}{\text{Expected amount available for export or carryover}}$
- $\frac{\text{Expected amount available for export or carryover}}{\text{Expected supply}}$

6/ 30,000 bushels of wheat is an average total production figure for a typical 1,000 care dryland summer-fallow Oregon Columbia plateau White Wheat farm [Cook et al., 1972-1980].

Also, a single valued variable, stocks (carryover), is used.

The stocks (carryover) variable is the amount of wheat in storage at the beginning of the marketing year. Disappearance during the previous period is the amount of wheat which was used domestically and for exports during the previous marketing year. Expected supply is the sum of beginning stocks and expected production. Expected amount available for export or carryover is the expected supply minus the expected domestic use of wheat.

Each of the four market variables (the three ratios and the stocks variable) are being evaluated because it is felt they may reflect the price effects of changes in expected wheat supply relative to historical and expected demand. If the relative value of a market variable is high, prices would be expected to be depressed at harvest. If the variables' relative value is low, prices would be expected to be relatively high at harvest. And, if the variables' relative value is in the middle of its range the expected direction and magnitude of price changes would be uncertain. Thus, the relative values of the four market variables, over the eight marketing years 1972-73 through 1979-80, are used as decision rules to select marketing alternatives that hopefully as consistent with expected white wheat prices.

The method used to select a marketing alternative for each of the variables is a two-stage process. First, the performance of the cash sale and forward contracting strategies is evaluated. The strategies which, on average over the eight marketing years, provided a positive return to storage, provided high expected values early in the crop year, and which provided protection against uncertain price movements are identified. Secondly, the identified strategies are then used to

sell the wheat when the values of market variables are relatively high, relatively low, and are in the middle of their range, respectively.

The relative highs and lows are determined by calculating the ranges (highest value minus lowest value), over the eight marketing years, for each of the four market variables. The ranges are then divided into equal thirds. The top third being a relatively high value of a market variable which dictates selection of a strategy which provided a positive return to storage. The bottom third is a relatively low value of a market variable which dictates selection of a strategy which provided high expected values early in the crop year. And finally, a market variable falling in the middle third of its range dictated selection of a strategy which provided relatively stable returns over the eight marketing years.

Benchmark Strategies Assuming perfect hindsight, the highest Thursday cash prices that could have been realized each marketing year are tabulated. The results are then plotted in ES space and compared with the results of the previously described strategies. This is an attempt to calculate the value of perfect information.[7/] Also, two strategies which sell one-twelfth of the production in every month and one-fifty-second in every week are evaluated. These two strategies should provide

7/ If market information is provided such that the highest price was realized each year, the difference between the performance of the best strategy, resulting from perfect hindsight, and the performance of the other strategies is a measure of the value of that information. In reality, however, participants in government storage programs and producers with fixed financial commitments may not be able to realize this potential gain.

relatively low-risk average returns, especially if there is little predictability to prices.

Simulation of the Marketing Strategies For each marketing year, 1972-73 through 1979-80, the gross return for each marketing strategy is computed on a per bushel basis. For those strategies involving only cash market sales, the gross return is discounted for storage costs and opportunity costs if the wheat is not sold at harvest.[8/] The gross returns to the hedging strategies are discounted for storage costs, opportunity costs, brokerage fees, interest on the initial margin, and interest on any maintenance margin that may be required. If there is any windfall gain over the life of the hedge, the total margin account (initial plus maintenance) is reduced by the amount of the gain. Finally, for each marketing strategy, the mean and standard deviation of the net returns, using the eight observations from the marketing years 1972-73 through 1979-80, are calculated to be used in the ES analysis.

Data Sources[9/] The gross cash price received by producers will be the Portland track price of No. 1 soft white wheat. This data was taken from compiled statistics in the Extension Economic Information Office, Department of Agricultural and Resource Economics, Oregon State University. Futures price data, used in the hedging strategies, was com-

8/ By storing his wheat for sale at a later date, the wheat farmer foregoes the opportunity to use the harvest value of his wheat in some other way. In this case, the farmer could repay some debt upon which he is paying interest, or he could invest the money in the financial market.

9/ All of the price and cost data are in nominal dollars.

piled from a Chicago Board of Trade commodity futures magnetic data tape. The tape provided observations through December 31, 1978. The remainder of the data was taken from various issues of the *Wall Street Journal*. The Chicago exchange trades soft red winter wheat contracts. The soft red winter wheat contracts were chosen arbitrarily. The Portland white wheat - Chicago soft red winter wheat basis and the Portland white wheat - Kansas City hard red winter wheat basis have been similar during 1972-73 through 1979-80 [Wirak, 1979].

Storage costs include the actual cost of storage and insurance. These data were compiled from various issues of *Estimated Wheat Production and Marketing Costs on a 2,000-Acre Dryland Farm, Oregon Columbia Plateau* published by the Oregon State University Extension Service. Interest rates used in the calculation of opportunity costs are the costs of capital used in the above production and marketing studies. The brokerage fees, size of the initial margin account, and the maintenance margin required were estimated from various conversations with Dr. Carl O'Connor, Associate Professor of Agricultural and Resource Economics, Oregon State University, and from conversations with brokers at the commodity trading firm Maduff and Sons, Incorporated, Portland, Oregon. U.S. wheat and PNW white wheat stocks, disappearance, expected supply, and expected amount available for carryover data were taken from various issues of the U.S.D.A. publication *Wheat Situation* and from *Wheat: Supply and Disappearance, United States, 1935 - *, Extension Economic Information Office, Oregon State University.

Summary

This chapter has specified the risk-efficient decision framework,

expected value-standard deviation, to be used in the subsequent empirical analysis. Several different categories of marketing strategies were described, as well as the method of simulating the strategies over time and the sources of the data used in evaluating the marketing strategies. In the following chapter, 73 separate marketing strategies are ultimately specified. These include 19 cash sale strategies of which six utilize moving average signals, 33 forward contracting strategies of which 24 utilize moving average signals, eight portfolios of strategies generated by the QP algorithm, 10 mixed strategies, and three benchmark strategies.

CHAPTER IV

ANALYSIS - RESULTS

Introduction

The purpose of this Chapter is to evaluate the performance of the 73 marketing strategies specified in terms of the thesis objective which is to determine to what extent, if any, market performance by producers can be improved. The 19 cash sale strategies and 33 forward contracting strategies will be evaluated separately. Subsequently, the dominant cash sale and forward contracting strategies will be evaluated relative to each other and relative to the portfolio strategies, mixed strategies, and benchmark strategies. Finally, the results will be interpreted according to differences in performance within and between categories of strategies.

Results

"Evaluation of the various strategies consists of comparing their relative performance in meeting the producer's assumed preference for both higher and more stable profits" [McLemore et al., 1981 p. 9]. However, as the producers discussed herein are assumed to be risk averse, these two goals are in many cases inconsistent. Thus, the strategies will be discussed in terms of their expected value (mean) and standard deviation dominance. For a risk-averse

decision maker, a strategy is dominated if the expected value (mean) can be increased without increasing standard deviation by adopting another strategy. Conversely, a strategy is dominated if standard deviation can be reduced without decreasing expected value (mean) when another strategy is adopted.

Cash Sale Strategies. The mean and standard deviation of the cash sale marketing strategies are presented in Table 5. The first six marketing strategies involve selling the entire production on the second Thursday of the month listed. Strategies 7 through 13 sell either one-half or one-third of production in the months listed. Three, five, ten, and fifteen week moving averages are used to trigger sales decisions in strategies 14 through 19. As the moving averages are computed using Thursday prices, the sales are enacted on the Thursday when the shorter-period moving average crosses the longer-period moving average from above. This process begins during the first week of August.[1/] If, during the first week of harvest, the shorter-period moving average is initially below the longer-period moving average, the next week's moving averages are computed to see if the gap (longer-period moving average minus shorter-period moving average) has narrowed. If so, the wheat is sold; if not,

1/ In Chapters I, II, and III, the term "crop year" or "marketing year" implied the months June through May. This was based on the U.S.D.A.'s definition of the crop year for the entire nation. For the PNW, however, white wheat harvest begins in August. Thus, although national and regional statistics are based on a June through May crop year, the actual use of the marketing strategies discussed herein is based on an August through July crop year.

Table 5 . Per Bushel Mean and Standard Deviation of Returns for Cash Sale Alternative White Wheat Marketing Strategies, PNW, 1972-1973 through 1979-1980.

No.	Marketing Strategy	Mean	Standard Deviation
		----------dollars----------	
1	August	3.72	1.01
2	October	3.72	1.02
3	December	3.61	0.93
4	March	3.39	0.72
5	May	3.07	0.35
6	July	3.36	0.57
7	1/2 @ August & January	3.65	0.91
8	1/3 @ August, October & December	3.68	0.95
9	1/3 @ August, December & March	3.57	0.84
10	1/3 @ August, March & May	3.39	0.63
11	1/3 @ August, May & July	3.39	0.53
12	1/3 @ December, March & May	3.35	0.62
13	1/3 @ March, May & July	3.28	0.49
14	3-5 week moving average	3.81	0.92
15	3-10 week moving average	3.76	0.80
16	3-15 week moving average	3.71	0.86
17	5-10 week moving average	3.77	0.92
18	5-15 week moving average	3.71	0.87
19	10-15 week moving average	3.69	0.84

the evaluation continues. The wheat is not sold until the last Thursday in July if the shorter-period moving average never crosses the longer-period moving average from above. Similarly, if the amount by which the shorter-period moving average is initially below the longer-period moving average never decreases, the wheat is not sold until the last week in July.[2/]

Figure 7 is an expected value (mean) and standard deviation of returns graph for the cash sale marketing strategies. As a group, the moving average strategies 14 through 19 generated the highest expected values relative to the other types of cash sale strategies. For example, the means of strategies 14 and 19 are 3.81 and 3.61, respectively. Strategies 1, 2, 3, 7, 8, and 9, which sell during the early part of the marketing year, also generate relatively high expected values. Strategies 1, 2, 3, 7, 8, 9, and 14 through 19 also exhibit higher levels of standard deviation. The standard deviations of strategies 2 and 15 are 1.02 and 0.80 respectively. Finally, strategies 4, 5, 6, 10, 11, 12 and 13 exhibit relatively lower expected values and standard deviations. For example, the mean and standard deviation of strategies 10 and 5 are 3.39 and 0.63, and 3.07 and 0.35, respectively.

Strategies 1, 2, 3, 4, 7, 8, 9, 12, and 19 are dominated. For each of these strategies, mean returns are increased, and the

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2/ Any amount of production which may be in storage at the end of July is not carried into the subsequent crop year, i.e., the wheat would be sold in July.

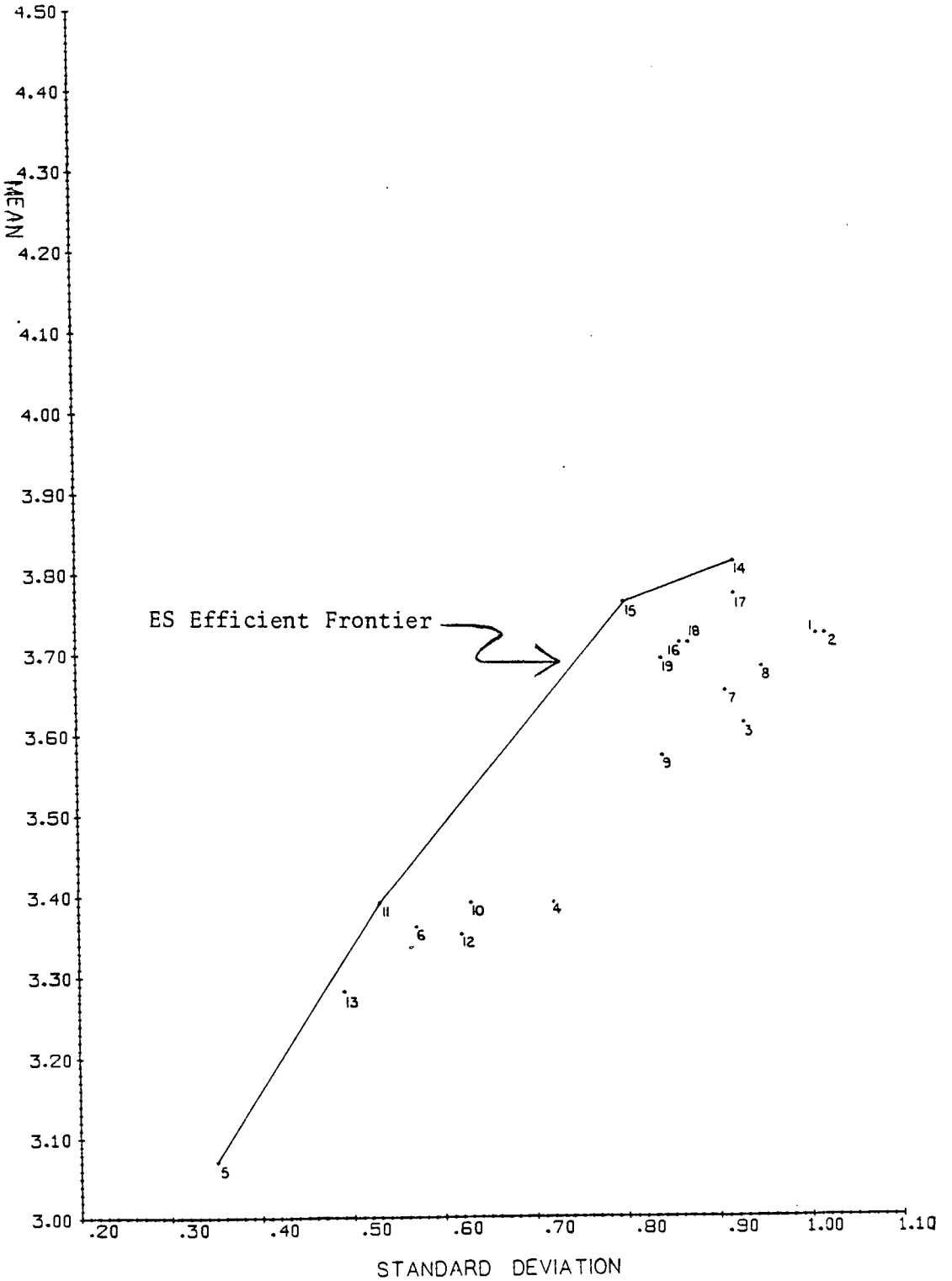

Figure 7. Cash sale marketing strategies.

standard deviation of returns decreased by selecting another strategy. For example, strategy 15 dominates strategy 3 as the mean of the former, 3.76, is larger than the latter, 3.61; the standard deviation of strategy 15, 0.80, is less than that of strategy 3, 0.93. Strategies 6, 16, 17, and 18 are also dominated; however, because of covariance considerations, they are included in some of the portfolio strategies to be discussed later. They are, therefore, included in the final analysis. The ES efficient frontier is made up of line segments connecting strategies 14, 15, 11, and 5.

Forward Contracting Strategies The forward contracting marketing strategies are tabulated in Table 6. Strategies 20 through 24 hedge the entire production during the first week in August. The hedge is offset, and the cash market equivalent is sold on the second Thursday of the respective contract month. One-third of the production is hedged in each of the three contract months listed in strategies 25 and 26. Production is sold on the cash market when the hedge is liquidated in the contract months specified. Strategies 27 and 28 sell one-third of the production in August on the cash market and then hedge the remaining two-thirds of production in the months listed. The hedges are offset as in strategies 25 and 26. Strategies 29 through 52 hedge on each of the five contract months according to moving average signals. The way in which the moving averages trigger the hedges is the same as for the cash sales moving average strategies; however, the hedges may be set and offset as many times as the moving averages dictate. All hedges in effect during the second Thursday of the contracts's delivery month are offset and the wheat is sold on the cash market. If a hedge was never placed or was offset prior to the

Table 6. Per Bushel Mean and Standard Deviation of Returns for Forward Contracting Alternative White Wheat Marketing Strategies, PNW, 1972-1973 through 1979-1980.

No.	Marketing Strategy	Mean	Standard Deviation
		----------dollars----------	
20	Hedge September	3.49	0.95
21	Hedge December	3.37	0.92
22	Hedge March	3.33	0.89
23	Hedge May	3.19	0.85
24	Hedge July	3.18	0.87
25	Hedge 1/3 @ December, March & May	3.26	0.91
26	Hedge 1/3 @ March, May & July	3.19	0.80
27	Sell cash 1/3 in August; Hedge 1/3 @ December & March	3.47	0.90
28	Sell cash 1/3 in August; Hedge 1/3 @ March & May	3.41	0.86
29	Hedge December; 3-5 week moving average	3.56	0.96
30	Hedge December; 3-10 week moving average	3.57	0.76
31	Hedge December; 3-15 week moving average	3.58	0.73
32	Hedge December; 5-10 week moving average	3.63	0.78
33	Hedge December; 5-15 week moving average	3.65	0.73
34	Hedge December; 10-15 week moving average	3.64	0.71
35	Hedge March; 3-5 week moving average	3.39	0.87
36	Hedge March; 3-15 week moving average	3.39	0.72

Table 6. Per Bushel Mean and Standard Deviation of Returns for Forward Contracting Alternative White Wheat Marketing Strategies, PNW, 1972-1973 through 1979-1980 (continued).

No.	Marketing Strategy	Mean	Standard Deviation
		----------dollars----------	
37	Hedge March; 3-15 week moving average	3.39	0.72
38	Hedge March; 5-10 week moving average	3.56	.088
39	Hedge March; 5-15 week moving average	3.47	0.68
40	Hedge March; 10-15 week moving average	3.45	0.63
41	Hedge May; 3-5 week moving average	3.17	0.67
42	Hedge May; 3-10 week moving average	3.45	0.71
43	Hedge May; 3-15 week moving average	3.18	0.54
44	Hedge May; 5-10 week moving average	3.28	0.71
45	Hedge May; 5-15 week moving average	3.18	0.49
46	Hedge May; 10-15 week moving average	3.08	0.39
47	Hedge July; 3-5 week moving average	3.31	0.89
48	Hedge July; 3-10 week moving average	3.56	0.58
49	Hedge July; 3-15 week moving average	3.26	0.45
50	Hedge July; 5-10 week moving average	3.40	0.57

Table 6. Per Bushel Mean and Standard Deviation of Returns for Forward Contracting Alternative White Wheat Marketing Strategies, PNW, 1972-1973 through 1979-1980 (continued).

No.	Marketing Strategy	Mean	Standard Deviation
		----------dollars----------	
51	Hedge July; 5-15 week moving average	3.26	0.46
52	Hedge July; 10-15 week moving average	3.21	0.36

contract's delivery date, the wheat is held in storage and sold on the second Thursday of the appropriate contract's delivery month.

Figure 8 presents the ES graph for the forward contracting marketing strategies. As a group, the December moving-average hedges, strategies 29 through 34, have the highest expected values, e.g., the expected values of strategies 33 and 34 are 3.65 and 3.64, respectively. Strategies 20 through 28, which hedge without any moving average signals, have lower expected values and higher standard deviations than the December moving-average hedges. For example, the mean and standard deviation of strategies 20 and 26 are 3.49 and 0.95, and 3.19 and 0.80, respectively. Generally, the March moving-average hedges, strategies 35 through 40, have lower means and have standard deviations that are equal to or greater than the December moving-average hedges. And, the May and July moving-average hedges tend to have lower means and lower standard deviations than the December moving-average hedges. Examples are strategies 35, 40 and 52. Their means and standard deviations are 3.39 and 0.87, 3.45 and 0.63, and 3.21 and 0.36, respectively.

The dominant strategies in Figure 8 are 33, 34, 48, 49, 50, and 52. For example, strategy 48 dominates strategy 24. Relative to strategy 24, with a mean of 3.18 and standard deviation of 0.87, performance can be improved by selecting strategy 48 with a mean of 3.56 and standard deviation of 0.58. Strategy 40 is dominated by strategy 48, and strategy 51 is dominated by strategy 49. Strategy 40 and 51 are, however, included in a subsequent portfolio strategy, and thus, they will not be eliminated from further discussion. The forward contracting ES efficient frontier consists of line segments connecting strategies 33, 34, 48, and 52.

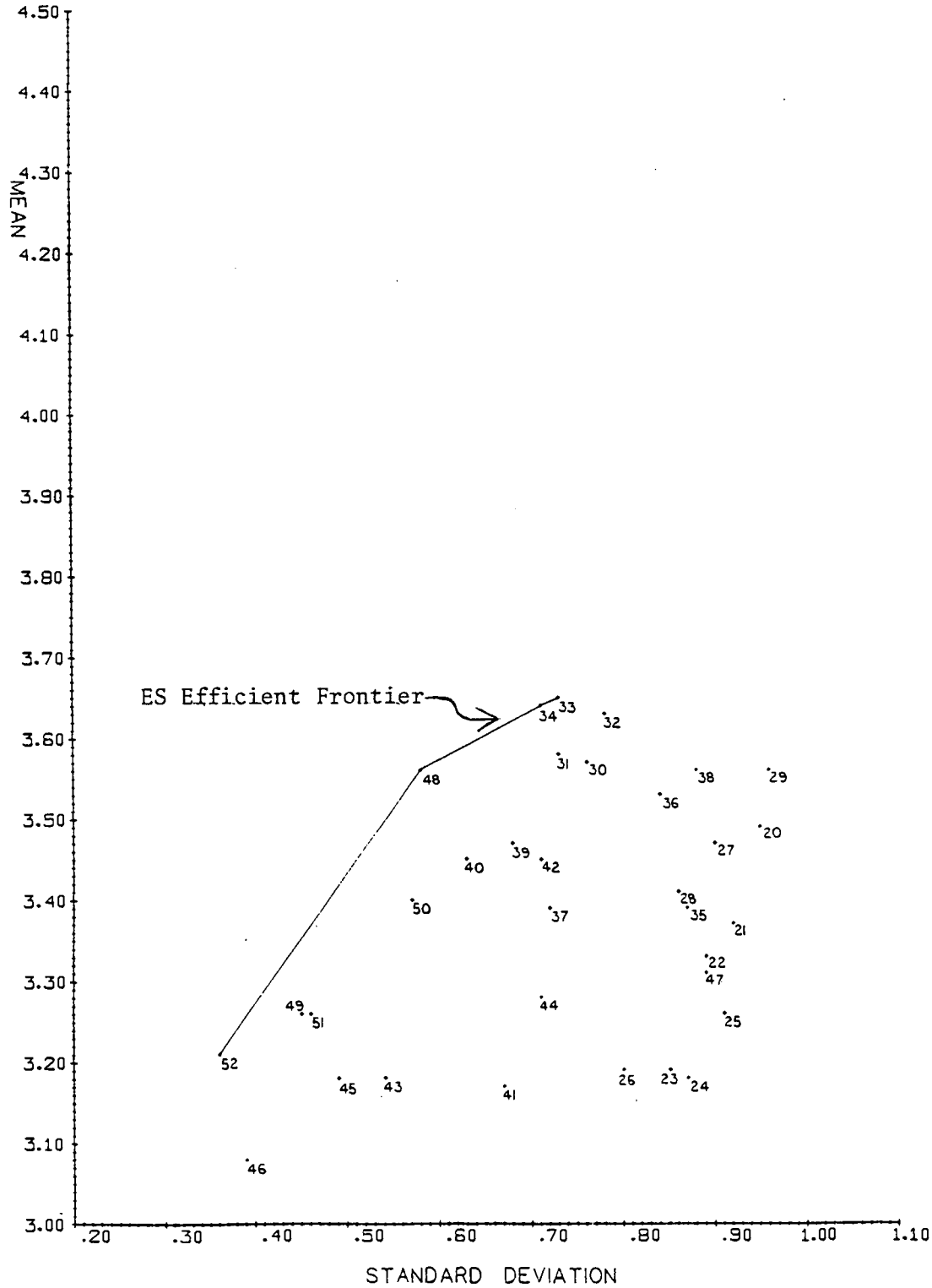

Figure 8. Forward contracting marketing strategies.

Portfolio, Mixed, and Benchmark Strategies Table 7 presents the diversified or portfolio marketing strategies, 53 through 60. As the risk aversion coefficient, θ, is parametized from approximately 0.00 to 1.50, the portfolios consist of from one to five strategies. The possibility set from which the portfolios are drawn consists of the 52 cash sale and forward contracting marketing strategies. Except for portfolio number 53, each of the strategies within a portfolio sell a portion of 30,000 bushels total production as indicated in Table 7. A total of 30,000 bushels are sold in each portfolio.

Mixed marketing strategies 61 through 70 are presented in Table 8. As stated in Chapter III, the design of the mixed marketing strategies is a two-stage process. First, strategies 1 through 52 are specified and their results evaluated as to whether they provide a positive return to storage, provide high expected values early in the crop year, and whether they provide protection against uncertain price movements. Subsequently, the values of the four market variables are computed, and the range, over the eight marketing years, is divided into thirds for each market variable. If the value of the market variable is in the top third of its range, a strategy is adopted which provided a positive return to storage. A strategy is adopted which provided high returns early in the corp year if the market variable is in the bottom third of its range. And, if the value of the market variable is in the middle third of its range, a strategy which provided relatively stable returns, over the eight marketing years is adopted. In summary, each market variable is analyzed for each of the eight marketing years. Depending on where the variable falls within its range, as computed over the eight marketing years, an appropriate selling strategy is utilized.

Table 7. Per Bushel Mean and Standard Deviation of Returns for Diversified (QP) White Wheat Marketing Strategies, PNW, 1972-1973 through 1979-1980.

Marketing Strategy					
No.	θ	Portfolio (Strategy No(s))	No. of Bushels	Mean	Standard Deviation
				-------dollars-------	
53	0.09	14	30,000	3.81	0.92
54	0.22	14	14,892	3.79	0.73
		15	9,976		
		17	5,132		
55	0.42	14	10.765	3.78	0.70
		15	11,992		
		16	827		
		17	5,915		
		18	501		
56	0.69	14	5,863	3.71	0.57
		15	8,459		
		17	3,423		
		34	5,000		
		48	7,255		
57	0.97	6	4,045	3.63	0.49
		14	4,086		
		15	7,081		
		34	5,000		
		48	9,788		
58	1.14	6	4,520	3.62	0.38
		15	5,924		
		34	5,000		
		48	8,676		
		52	5,880		

Table 7. Per Bushel Mean andStandard Deviation of Returns for Diversified (QP) White Wheat Marketing Strategies, PNW, 1972-1973 through 1979-1980 (continued).

		Marketing Strategy			
No.	Θ	Portfolio (Strategy No(s))	No. of Bushels	Mean	Standard Deviation
				--------dollars--------	
59	1.38	6	4,468	3.47	0.35
		15	4,331		
		33	5,000		
		48	7,318		
		52	8,883		
60	1.74	6	4,349	3.36	0.29
		40	5,389		
		48	6,841		
		51	5,000		
		52	8,421		

Thus, after an ex post evaluation of the cash and forward contracting strategies 1 through 52, two different marketing scenarios were adopted. One scenario, which includes strategies 61, 63, 65, 67, and 69, sells the wheat using strategy 13 if the market variable is in the top third of its range, sells the wheat using strategy 14 if the market variable is in the bottom third of its range, and sells one-third of production in each of the strategies 1, 14, and 39. The second scenario, which includes strategies 62, 64, 66, 68, and 70, is different from the first in only one respect. When the market variable is in the top third of its range, the wheat is sold using strategy 33 rather than 13.

The benchmark strategies are listed in Table 9. Assuming perfect hindsight, strategy 71 sells on the highest Thursday price for each year. Strategy 72 sells one-twelfth of the production on the second Thursday of each month. And, strategy 73 sells one-fiftysecond of production on each Thursday throughout the marketing year. Strategies 71, 72, and 73 sell on the cash market.

Figure 9 is an ES graph of the portfolio strategies, mixed strategies, benchmark strategies, and the dominant cash sale and forward contracting strategies. Except for strategy 69, the mixed marketing strategies all tended to fall in the same ES space as the cash sale moving average strategies, i.e., their means and standard deviations are relatively close in value. For example, the range of means and standard deviations for the mixed strategies, except for strategy 69, is 3.87 to 3.72 and 1.02 to 0.71, respectively. For the cash sale moving average strategies, the range of means and standard deviations is 3.81 to 3.71 and 0.92 to 0.80, respectively. Of all the strategies analyzed

Table 8. Per Bushel Mean and Standard Deviation for Mixed Alternative White Wheat Marketing Strategies, PNW, 1972-73 through 1979-1980.

No.	Market Variable and Marketing Strategy(s) Used 1/ 2/	Mean	Standard Deviation
		--------dollars----------	
61	Stocks (Carryover); PNW white wheat; T:13, B:14, M: 1/3 @ (1, 14, 39)	3.77	0.84
62	Stocks (Carryover); PNW white wheat; T:33, B:14, M: 1/3 @ (1, 14, 39)	3.75	0.96
63	Stocks/Disappearance; U.S. wheat; T:13, B:14, M: 1/3 @ (1, 14, 39)	3.84	0.71
64	Stocks/Disappearance; U.S. wheat; T:33, B:14, M: 1/3 @ (1, 14, 39)	3.75	0.84
65	Stocks/Disappearance; PNW white wheat; T:13, B:14, M: 1/3 @ (1, 14, 39)	3.87	0.84
66	Stocks/Disappearance; PNW white wheat; T:33, B:14, M: 1/3 @ (1, 14, 39)	3.74	0.90
67	Stocks/Expected amount available for export or carryover; PNW white wheat; T:13, B:14, M: 1/3 @ (1, 14, 39)	3.74	0.90
68	Stocks/Expected amount available for export or carryover; PNW white wheat; T:33, B:14, M: 1/3 @ (1, 14, 39)	3.72	1.02
69	Expected amount available for export or carryover/Expected supply; PNW white wheat; T:13, B:14, M: 1/3 @ (1, 14, 39)	3.52	0.88
70	Expected amount available for export or carryover/Expected supply; PNW white wheat; T:33, B:14, M: 13 @ (1, 14, 39)	3.72	0.93

1/ PNW white wheat and U.S. wheat indicate which region the market variable is computed for, e.g., the stocks variable used for strategies 61 and 62 are PNW white wheat stocks only.

2/ T, B, M indicate which strategy(s) the wheat is sold in if the market variable is in the top, bottom, or middle third of its range.

Table 9. Per Bushel Mean and Standard Deviation of Returns for Benchmark White Wheat Marketing Strategies, PNW, 1972-1973 through 1979-1980.

No.	Marketing Strategy	Mean	Standard Deviation
		----------dollars----------	
71	Best cash sale	4.43	0.90
72	Cash sale 1/12 each month	3.49	0.70
73	Cash sale 1/52 each week	3.49	0.72

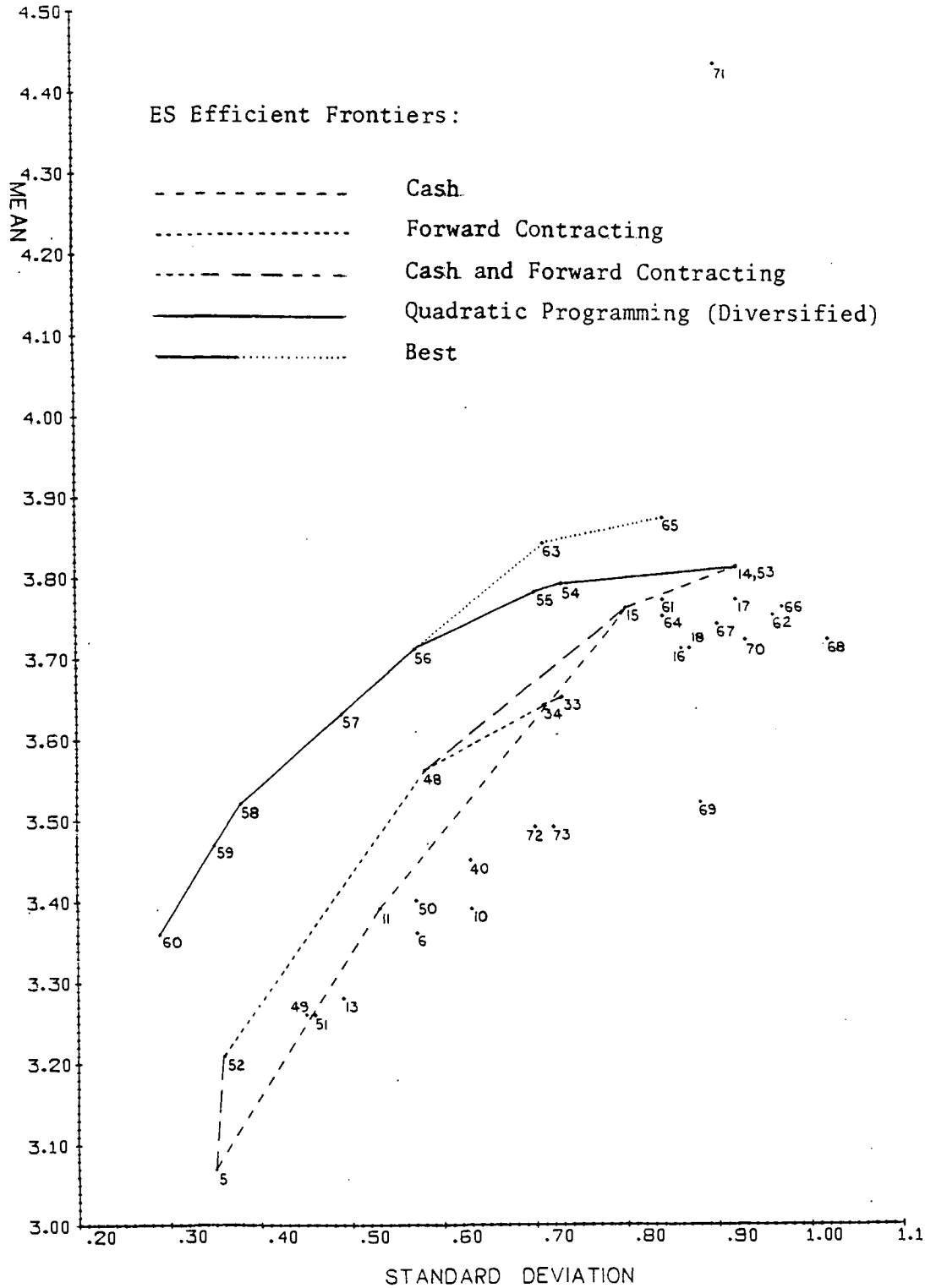

Figure 9. Portfolio, mixed, benchmark, and dominant cash sale and forward contracting marketing strategies.

except benchmark strategy 71, mixed strategies 63 and 65 generated the highest expected values, 3.84 and 3.87, respectively.

By diversifying, portfolio strategies 53 through 60 substantially reduced the standard deviation of returns without reducing expected values relative to the cash sale and forward contracting strategies. For example, the means of strategies 11 and 60 are 3.39 and 3.36, respectively. Their respective standard deviations are 0.53 and 0.29.

As can be seen by their relative position, strategies 72 and 73 generate average returns and risk. For example, strategies 14 and 5 have means and standard deviations of 3.81 and 0.92, and 3.07 and 0.35, respectively. The same statistics for strategies 72 and 73 are 3.49 and 0.70, and 3.49 and 0.72, respectively.

Relative to strategy 71, market performance can be improved beyond the strategies described herein at least in terms of mean returns. The standard deviation of strategy 71, 0.90, is very close to that of strategies 65 and 14, 0.84 and 0.92, respectively; however, the differences between the means are much larger. The mean of strategy 71 is 4.43, while the mean of strategy 65 is 3.87. Thus, an approximate value of perfect information, in terms of mean returns, is 0.56 (4.43 minus 3.87).

Several ES efficient frontiers and dominant cash sale and forward contracting marketing strategies are presented in Figure 9 for comparison. If a risk-averse producer preferred to use only cash sale marketing alternatives, he might choose from the dominant cash sale strategies 5, 10, 11, 13, 14, 15, 72, and 73, depending on his degree of risk aversion. Although 72 and 73 are used as benchmarks; they are essentially cash sale strategies. As such, they are included in the

list of dominant cash sale marketing strategies. As in Figure 7, the cash sale ES efficient frontier is composed of line segments connecting strategies 5, 11, 15, and 14.

If a producer chose to use only forward contracting strategies, he might choose from among the dominant strategies 33, 34, 48, 49, 50, and 52. The ES efficient frontier would include strategies 52, 48, 34, and 33. Combining the cash sale and forward contracting strategies would result in strategies 5, 52, 49, 13, 11, 50, 48, 34, 33, 15, and 14 being dominant. The resultant ES efficient frontier would consist of line segments connecting strategies 5, 52, 48, 15, and 14. By using the QP portfolio strategies 53 through 60, however, the ES efficient frontier can be moved further upward and to the left relative to the cash sale and forward contracting ES efficient frontier. And finally, by including the mixed strategies 63 and 65, the "best" ES efficient frontier would include strategies 65, 63, 56, 57, 58, 59, and 60.

Statistical Significance The analysis to this point has been based on point estimates of the means and standard deviations of the strategies discussed. A somewhat more exact determination of whether or not improvements in market performance are possible can be realized by testing for statistically significant differences between the means and standard deviations of the alternative strategies.

Table 10 presents the sample value of t and F test statistics for selected strategies. The t and F test statistics are used to test for significant differences between the means and standard deviations, respectively, of the various strategies. If the absolute value of the sample t statistic is less than or equal to the critical $t_{.10,7}$, the null hypothesis that the means are equal is not rejected. If [t] >

$t_{.10,7}$, the null hypothesis is rejected which implies that the means are not equal. Considering the null hypothesis that the standard deviations of the strategies are equal, if the sample F statistic is less than or equal to the critical $F_{.10,7,7}$, the null hypothesis is not rejected. If, however, $F > F_{.10,7,7}$, the null hypothesis is rejected which implies the standard deviations are not equal [Peterson, 1975].

Initially, several cash sale and forward contracting strategies were termed dominated. In fact, however, some of the strategies which were said to be dominated did not have significant differences with the dominant strategies in terms of mean and standard deviation. For example, strategy 19 was said to be dominated by strategy 15, and strategy 32 dominated by strategy 33. The sample t and F statistics in Table 10 indicate otherwise. In both cases, the differences between the means and standard deviations are not significantly different. Thus, some of the strategies which were said to be dominated were not dominated statistically; nevertheless, the dominated strategies were not included in the final analysis of those strategies included in Figure 9. Otherwise, an unwieldy number of strategies would have been included.

The dominated cash sale and forward contracting strategies do, however, suggest that market performance can be improved. The standard deviations of strategies 14 and 3 are not significantly different; however, their means are significantly different which indicates a risk efficient performance improvement. Considering the forward contracting marketing strategies, the performance of strategy 52 is significantly better than strategy 24 in terms of standard deviation but not in terms

Table 10. Sample t and F Statistics for Various Strategies.

	Critical $t_{.10,7}$ = 1.415	Critical $F_{.10,7,7}$ = 3.79	
	Strategies	Sample t	Sample F
Cash Sale			
	3,14	1.489	1.03
	5,11	3.137	2.29
	5,14	2.638	6.97
	5,15	2.859	5.16
	11,14	2.260	3.04
	11,15	2.365	2.25
	15,14	0.591	1.35
	19,15	1.101	1.11
Forward Contracting			
	33,32	0.380	1.15
	33,34	0.056	1.05
	33,48	0.435	1.56
	33,52	1.544	4.06
	34,48	0.405	1.48
	34,52	1.640	3.85
	48,52	1.549	2.60
	48,24	1.348	2.22
	52,24	0.080	5.76
Cash Sale and Forward Contracting			
	5,52	0.926	1.07
	5,48	2.291	2.79
	5,15	2.859	5.16
	5,14	2.638	6.97
	52,48	1.549	2.60
	52,15	1.919	4.81
	52,14	1.754	6.50
	48,15	0.922	1.85
	48,14	1.024	2.50
	15,14	0.591	1.35
Portfolio			
	53,55	0.803	1.14
	53,57	1.354	2.35
	53,60	1.775	7.47
	55,57	1.288	2.05
	55,60	1.810	6.53
	57,60	2.095	3.18
Mixed			
	63,65	0.391	1.39
	65,3	1.858	1.24
	65,24	2.058	1.07
Mixed and Portfolio			
	65,53	0.863	1.20
	65,55	1.259	1.05
	65,57	2.015	1.95
	65,60	2.218	6.21
	63,53	0.323	1.67
	63,55	0.888	1.46
	63,57	2.518	1.40
	63,60	2.542	4.46
Highest			
	65, (14,53)	0.863	1.20
	65,33	1.610	1.53
	(14,53), 33	1.410	1.60
	33,55	1.418	1.40
	33,63	1.894	1.05
Middle and Lowest			
	57,48	0.539	1.07
	57,11	2.299	1.30
	57,33	0.146	1.46
	48,11	0.970	1.22
	60,52	1.434	1.14
	60,11	0.219	2.45
	60,5	2.685	1.07
	52,5	0.926	1.07
Benchmark			
	65,72	4.276	21.44
	57,72	1.743	1.56
	60,72	0.753	4.32
	14,72	2.805	1.73
	11,72	1.050	1.76
	5,72	2.224	4.05
	33,52	1.076	1.08
	48,72	0.411	1.45
	52,72	1.070	3.70

of mean. The performance of strategy 65, which has the highest mean, is also significantly better than several of the dominated cash and forward contracting strategies, e.g., strategies 3 and 24.

An indication of whether or not significant differences in the tradeoff between risk and returns are possible is given by comparing the strategies on a given ES efficient frontier. For example, strategies 5 and 14 lie on the cash sale ES efficient frontier. The sample t and F statistics in Table 10 suggest that there are significant differences in both dimensions of mean and standard deviation.[3/] When comparing strategies 52 and 33, 60 and 53, and 60 and 65, similar results are obtained. Thus, if a producer is willing to move far enough along a given ES efficient frontier, he can effect significant changes in market performance. Whether this would be an improvement in performance would depend on the producer's degree of risk aversion.

When considering the portfolio, mixed, benchmark, and dominant cash sale and forward contracting strategies, as presented in Figure 9, risk efficient improvements in performance are not always possible. For example, test statistics in Table 10 indicate that neither the means or standard deviations of strategies (14, 53) and 65 and 48 and 57 are significantly different. There are examples, however, when risk-efficient improvements are possible. By moving from strategy 33

3/ When comparisons of means are picked out by inspection, especially when comparing the highest and lowest values, the probability of finding an erroneous significant result [Type I erros] is greater than the specified significance level. Scheff'e's test and the studentized range test are two methods of keeping the probability of a Type I error within the specified significance level. In the context of this research, these tests were judged, however, to provide too much protection against Type I errors; consequently, the students t test is used herein [Snedecor and Cochrane, 1980].

to 55 and from strategy 62 to 60, mean returns are significantly increased without significantly increasing standard deviation. Thus, it appears market performance can be improved between classes of strategies as there are significant differences between the means and standard deviations; however, as the differences become relatively smaller, their statistical significance decreases.

Skewness In the analyses of the various strategies, a normal distribution of returns was assumed. Actually, however, this assumption was not strictly true as the strategies' distribution of returns exhibit varying degrees of skewness.[4/] For example, cash sale strategies 1, 3, and 4 were initially eliminated from further consideration, as they were dominated by strategy 14. Strategy 14 has a skewness of -0.1002, which is approximately normal. The skewness of strategy 1 is -0.8203. As decision makers tend to prefer positive skewness to negative skewness, strategy 14 dominates strategy 1 in all three dimensions of mean, standard deviation, and skewness [Anderson, Dillon, and Hardaker, 1977]. However, strategies 3 and 4 both have positive skewness of 0.4999 and 0.5093, respectively. If skewness were being considered as an additional argument in the decision maker's utility function, strategies 3 and 4 may have not been considered as dominated. Thus, although skewness is not considered herein, it is recognized that it may be important to decision makers Also,the statistical difference tests may not be strictly valid as they assume normally distributed re-

4/ "Skewness is the degree of asymmetry, or departure from symmetry, of a distribution. If the frequency curve of a distribution has a longer "tail" to the right of the central maximum than to the left, the distribution is said to be skewed to the right or have positive skewness. If the reverse is true, it is said to be skewed to the left or have a negative skewness" [Spiegel, 1961, p. 90].

turns. Table A-1 in Appendix A lists the skewness of each of the strategies evaluated.

Summary

In Chapter I, the objective of this research was stated as ... to determine to what extent, if any, market performance by producers can be improved .... From the analyses of the various categories of marketing strategies, it would appear that market performance can be improved.

Considering the dominant cash sale and forward contracting strategies, the cash sale moving average strategies 14 and 15 generated the highest ES combinations, while the moving average hedges and the later crop year cash strategies generated lower ES combinations. Using the fixed portfolios generated by the QP algorithm substantially reduced the risk associated with the marketing strategies. And, the mixed marketing strategies 65 and 63 perform the best in terms of expected value. These results are, however, based on point estimates of the means and standard deviations of the various strategies.

Considering each strategy's distribution of returns and the limited number (eight) of observations, t and F tests were conducted to test for statistically significant differences between the means and standard deviations, respectively. Based on these tests, if a producer is willing to move far enough along a given ES risk-efficient frontier, he can effect significant changes in market performance. Whether this would be an improvement in performance would depend on the producer's degree of risk aversion. Most obvious is that performance relative to the dominated cash sale and forward contracting

marketing strategies can be improved. However, when considering only the portfolio, mixed, benchmark, and dominant cash sale and forward contracting marketing strategies, the possible improvements in mean and standard deviation are not always statistically significant. Thus, market performance by producers selling white wheat in the PNW can be improved; however, as the differences between the means and standard deviations of alternative strategies becomes relatively smaller, their statistical significance decreases.

CHAPTER V

SUMMARY - CONCLUSIONS

Background

A risk-efficient decision model was developed to evaluate white wheat marketing strategies for Pacific Northwest white wheat producers. The strategies were evaluated in terms of whether or not market performance could be improved.

Summary

The U.S. and PNW wheat market situation prior to and after the 72-73 marketing year are significantly different. In both markets, there was generally a predictable return to storage prior to and after 72-73; however, this situation changed after the 72-73 marketing year. Internationally, increased energy costs and a change from fixed to floating exchange rates have added to the uncertainty involved in the production and distribution of agricultural products. Also, flucuations in world production have created significant changes in U.S. export demand. Domestically, government price support programs related to the production and distribution of wheat have been reduced. And, especially important in the PNW white wheat export dependent market, export subsidies have been eliminated and P.L. 480 authorizations greatly reduced. Prior to 72-73, these latter two programs helped create a PNW white wheat market that was somewhat independent of the U.S. wheat market. Thus, not only is the post 72-73 pattern of U.S. wheat prices unstable, but the PNW white wheat market also reflects this instability.

The financial risk associated with fluctuating PNW white wheat prices has created uncertainty about future cash flows which disrupts long-run management plans for PNW white wheat producers. It was proposed, therefore, to determine to what extent, if any, market performance by producers can be improved given the range of marketing alternatives and strategies currently available for marketing years 72-73 through 79-80. This objective was to be realized by testing the hypothesis that there is no significant difference between the performance of the alternative PNW white wheat strategies.

Seventy-three different marketing strategies were ultimately specified. These strategies were divided into five classifications including: (1) cash sale strategies, (2) forward contracting strategies, (3) quadratic programming-portfolio strategies, (4) mixed strategies, and (5) benchmark strategies. The cash sale strategies utilized different types of sales on the spot market. The forward contracting strategies were hedging strategies using the futures market. A quadratic programming, QP, algorithm was used to generate portfolios of the cash sale and forward contracting strategies. For the mixed strategies, U.S. and PNW and wheat market variables were used to determine, in each of the eight marketing years evaluated, which one of the cash sale or forward contracting strategies to use. Finally, the benchmark strategies were used to give an indication of the value of perfect information and the value of average returns.

The strategies were evaluated according to a utility maximization performance criterion. This was accomplished by assuming the producer possessed an expected value (mean) - standard deviation, ES, utility function. The mean and standard deviation of returns for each marketing

strategy were computed and mapped into ES space. The strategies were then evaluated in terms of their dominance and the statistical significance of the differences between the means and standard deviations.

Conclusions

In terms of the thesis objective, it appears that PNW white wheat producers' market performance can be improved. The mixed marketing strategies generated the highest ES combinations followed by the cash sale moving-average strategies. The moving-average hedges and the later crop year cash sale strategies generated the lowest ES combinations. Relative to the cash sale and forward contracting strategies, the portfolios generated by the QP algorithm substantially reduced the risk associated with the marketing strategies. These results are, however, based on point estimates of the means and standard deviations of the various strategies.

Using sample t and F statistics to test for significant differences between the means and standard deviations of the various strategies, it was found that a producer can effect significant changes in market performance if he is willing to move far enough along a given ES efficient frontier. Whether this would be an improvement in performance would depend on the producer's degree of risk aversion. Absolute improvements in performance were possible but not in all cases. In other words, market performance by producers selling their wheat in the PNW can be improved; however, as the differences between the means and standard deviations of alternative strategies becomes relatively smaller, their statistical significance decreases.

What do these results mean to the PNW white wheat producer?

Essentially, the results indicate that, during the 1972-73 through 1979-80 marketing years, it does make a difference how wheat production is marketed at least in terms of the mean and standard deviation of the evaluated strategies. From a management point of view, however, other performance criterion are also important; criterion that may be evaluated in terms of the following and other questions: Does the strategy cover his costs of production? Does the strategy provide stable returns? Does the strategy provide timely returns? How much technical expertise and managerial input does the marketing strategy require? How does the strategy compare with his past methods of marketing?

In terms of the risk-return tradeoff the results are consistent with theoretical expectations. A priori, it was expected that higher levels of returns would be accompanied by higher levels of risk, and that lower returns would exhibit lower risk. Except for the mixed strategies, this was true for each class of strategies. Even the benchmark strategy, which selected the highest weekly price in each marketing year, exhibited relatively high standard deviation. Thus, it would appear that if a producer desires relatively high average returns he may have to accept attendant high risks.

Hedging by itself does not appear to be a good marketing tool. Most of the strategies which hedged a portion or all of the crop in a specific futures contract(s), were dominated by nearly all of the other strategies. By using, however, moving-average signals, the performance was markedly improved, e.g., the December moving-average hedges. Similar results were obtained by using moving-average signals together with cash sale strategies; however, the differences in performance were not quite as pronounced.

In the discussion of the U.S. and PNW wheat market situation, it was posited that a predictable positive return to storage was no longer available since the 72-73 marketing year. The results would tend to support this hypothesis. As marketings are made successively later in the year, average expected returns decrease. Thus, the results suggest that prices received tend to decrease during the course of the marketing year.

When evaluating the thesis results and the above conclusions, it is important to recognize the nature of the data used. The criteria used to evaluate the strategies' performance, mean and standard deviation, are sample estimates of unknown population parameters. In controlled experiments, the experiments may be run a sufficient number of times to obtain unbiased estimates of the population parameters; however, the "experiment" conducted in this research can not be repeated. The relative performance of the marketings might be substantially different due to changes in supply and demand conditions and structural changes in the wheat market if this research were conducted again. This is evidenced by the different market structure the U.S. and PNW wheat market exhibits prior to and after 72-73. Thus, the results should be evaluated relative to current and expected market conditions.

Suggestions for Further Research

This research has identified and evaluated 73 different marketing strategies. No attempt was made to see to what extent these strategies concur with the actual marketing strategies employed by PNW white wheat

producers. Further research could illuminate the extent of this disparity with a survey of actual marketing strategies utilized by producers. Other considerations weighed when the wheat is sold could also be addressed; considerations in terms of the timing of sales(cash flow and tax consequences), anchoring(how much do past marketing practices influence present marketing practices), how are future price expectations formed, how aware are producers of PNW, U.S., and world wheat market conditions, and what are the producers' perceived marketing problems. Hopefully this survey would enlighten the extent to which further research needs to be conducted in PNW white wheat farmer marketing strategies.

Given the relative "good" performance of the moving-average cash sale and forward contracting strategies and the mixed strategies, further studies could possibly develop better technical price signals and fundumental market variables. For example, daily and monthly moving-average signals could be compared with the performance of the weekly moving averages used herein. Also, using moving averages computed with futures price time series data may perform different than moving averages computed with cash time series data. Also, world wheat stocks and production data could be incorporated into mixed marketing strategies given the dependence of the U.S. wheat market on the international grain trade.

Marketing strategies where a decision is made at weekly intervals whether to sell wheat or keep the grain in storage could be developed. The model would be based on econometric and/or ARIMA forecasts of Portland white wheat prices and basis. If the expected returns to storage for some time interval into the future were greater than the costs of

storage, the wheat would be held and the evaluation conducted again the next week. Otherwise, the wheat would be sold using one of several different types of marketing strategies.

Finally, this thesis and the research suggested above could be evaluated using real rather than nominal price and cost data. The latter crop year marketing strategies would be heavily discounted(see table 1); however, this would affect each marketing strategy. Thus, a priori, it is uncertain whether this would have any effect on the relative performance of the various strategies.

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APPENDIX A

Table A-1. Yearly Returns.

Crop Year	Strategies: Returns: $ per bushel																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
72-73	1.8075	2.3497	2.7020	2.4004	2.5526	3.1749	2.7478	2.7864	2.3033	2.2335	2.5117	2.5517	3.7093	2.4959	2.5342	2.3442	2.5442	2.7642	2.5704
73-74	4.7275	4.8853	5.0833	4.7650	3.3128	4.1307	5.0674	4.8986	4.8585	4.2684	4.0570	4.3870	4.0695	5.1325	4.3325	4.6540	4.7025	4.7049	4.7549
74-75	4.5873	5.1258	4.8142	3.6117	3.0300	3.1383	4.4093	4.8423	4.3378	5.7431	3.5970	3.8186	3.2867	4.5373	4.8175	4.5749	4.4275	4.3049	4.6249
75-76	4.3275	4.1238	3.5401	3.5595	2.0956	3.0420	3.9504	3.9971	3.8090	3.0609	3.4884	3.3984	3.2324	4.2849	4.1323	4.0833	4.2123	4.1323	3.9507
76-77	3.3450	2.9746	2.6042	2.6436	2.3532	2.4428	3.0095	2.9580	2.8643	2.8473	2.7804	3.0004	2.5406	3.1889	3.3250	3.3350	3.3350	3.3250	3.3230
77-78	2.8730	2.6816	2.8183	3.1283	3.2449	3.3416	2.9233	2.7849	2.9405	3.0827	3.1538	3.0638	3.2383	3.8230	2.8430	2.7289	2.7289	2.7689	2.7289
78-79	3.7150	3.6497	3.4943	3.3416	3.4763	4.1710	3.5809	3.6157	3.3170	3.3110	3.7874	3.4375	3.6630	3.6350	3.7150	3.6725	3.6800	3.6325	3.5031
79-80	4.4135	3.9970	3.8316	3.6535	3.3280	3.4475	4.0408	4.0770	3.9655	3.7979	3.7276	3.6010	3.4746	4.4125	4.4035	4.4135	4.4125	4.4035	4.3687
Mean	3.7247	3.7159	3.6098	3.3880	3.0742	3.3630	3.6537	3.6825	3.5741	3.3958	3.3873	3.3573	3.2751	3.8140	3.7643	3.7132	3.7716	3.7144	3.6860
Standard Deviation	1.0091	1.0168	0.9370	0.7216	0.3501	0.5702	0.9054	0.9534	0.8420	0.6359	0.5300	0.6151	0.4892	0.0245	0.7053	0.7472	0.9193	0.8778	0.8391
Variance	1.0183	1.0339	0.8780	0.5207	0.1226	0.5252	0.8107	0.0090	0.7089	0.4044	0.2809	0.3784	0.2395	0.8543	0.6325	0.8844	0.8452	0.7705	0.7041
Skewness	-0.8203	0.0483	0.4999	0.5093	-0.8529	0.1761	-0.0105	-0.0658	-0.0074	-0.5305	-0.5069	0.1481	-0.0000	-0.1002	-0.4076	-0.4098	0.3235	-0.4743	-0.0376

Crop Year	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
72-73	1.6393	1.7991	1.8398	1.7641	2.0161	1.8010	1.8723	1.8155	1.8028	2.7447	2.7820	2.7820	2.7820	2.7820	2.7820	2.5140	2.5723	2.3218	2.3218
73-74	3.8187	3.4271	2.4482	2.9860	2.5970	3.2871	3.0104	3.8676	3.7205	4.9786	4.2750	4.2440	4.4889	4.3763	4.5776	4.6288	4.4838	4.3538	4.0251
74-75	4.6990	4.7015	4.6313	4.4699	4.0750	4.6010	4.2921	4.6402	4.5830	4.5464	4.4282	4.2076	4.2982	4.2840	4.4380	4.2452	4.4949	3.8954	4.3848
75-76	4.1448	4.2977	4.1729	3.8839	4.4977	4.1189	3.8323	4.2661	4.1388	4.4480	4.4095	4.1776	4.1592	4.2082	3.7339	3.9587	4.4176	3.8866	4.4948
76-77	3.4424	3.4703	3.5836	3.7735	3.8862	3.6098	3.7484	3.4670	3.3680	3.1105	3.5663	3.3605	3.3665	3.3665	3.1413	3.4341	3.4341	3.4350	3.4230
77-78	2.7444	3.5762	2.7331	2.5681	2.8487	2.3631	2.6573	2.7334	2.7327	2.4033	2.4229	3.3423	2.3434	2.4238	2.6349	2.7549	2.7044	2.6137	2.6137
78-79	3.4295	3.0324	2.6189	3.7734	2.0613	2.8083	2.6848	3.1221	3.0560	2.8058	2.1772	3.4023	3.4282	3.0321	3.4751	2.4254	2.7073	3.0612	3.0097
79-80	3.0170	3.6356	3.5760	3.2954	3.0523	3.3038	3.3079	3.8781	3.7613	3.4119	3.7027	4.1339	3.0314	4.1339	4.0930	3.2498	3.4330	2.8809	3.6614
Mean	3.4016	3.3680	3.3285	3.1895	2.1793	3.2616	3.1008	3.4738	3.4143	3.5645	3.8705	3.5873	3.6260	3.6451	3.6404	3.3898	3.5335	3.3036	3.5625
Standard Deviation	0.9458	0.9205	0.8045	0.8543	0.8700	0.9146	0.8051	0.0045	0.8676	0.9584	0.7665	0.7316	0.7840	0.7303	0.7110	0.8707	0.8383	0.7158	0.8820
Variance	0.8945	0.8473	0.8001	0.7300	0.7569	0.8365	0.6449	0.8177	0.7527	0.9185	0.5841	0.5353	0.6147	0.3333	0.5036	0.7580	0.7027	0.5124	0.7780
Skewness	-0.8227	-0.3350	-0.2139	-0.1420	0.3020	-0.1688	-0.1109	-0.5773	-0.6063	0.3549	-0.1702	-0.5923	-0.4379	-0.6321	-0.0808	0.4509	n 1078	-0.3961	-0.7987

Crop Year	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54 1/	55	56	57
72-73	2.5821	2.5204	2.1991	2.3737	2.0904	2.1397	2.2311	2.4139	2.4843	2.0481	2.5029	2.6523	2.7458	2.9065	2.4959	-	2.4732	-	2.7911
73-74	4.3331	4.3434	4.1800	4.2272	2.5636	3.8546	3.1701	2.9661	4.0443	4.2435	3.3412	3.5850	3.0671	3.1210	5.1325	-	4.8428	-	4.4731
74-75	3.9358	3.8122	3.9404	4.3697	3.7308	4.2794	3.8103	3.6125	4.1044	4.1218	3.4826	3.9901	3.5838	3.4139	4.5375	-	4.5601	-	4.3187
75-76	3.0074	3.4470	3.4918	4.0209	3.4996	3.9912	3.4303	3.7508	3.3039	3.9426	3.0210	3.7117	3.2201	2.3786	4.2849	-	4.2006	-	3.8782
76-77	3.4569	3.3989	3.1373	3.5303	3.3528	3.4816	3.5648	3.2304	3.0536	3.5464	3.3589	3.4179	2.3409	3.3327	3.1880	-	3.2762	-	3.2667
77-78	2.7133	2.9367	2.7104	2.7318	2.6810	2.6810	2.7838	3.0042	2.6030	2.8671	2.8065	2.8062	2.9107	3.1570	2.8250	-	2.8103	-	2.8848
78-79	3.1562	2.9742	2.8873	3.1596	3.3150	3.4783	3.3503	3.1051	3.6230	3.9534	4.0815	4.1934	4.1958	3.7930	3.6350	-	3.6733	-	3.8041
79-80	3.0000	4.1793	2.7749	3.1504	3.1923	3.1578	3.0836	3.3127	2.3781	2.8899	3.1195	2.8732	2.0824	3.3381	4.4123	-	4.4121	-	2.7316
Mean	3.4755	3.4513	3.1672	3.4480	3.1792	3.3827	3.1752	3.0827	3.3118	3.5041	3.2595	3.4037	3.2554	3.2071	3.8140	5.7900	3.7813	3.7100	3.6310
Standard Deviation	0.6781	0.6341	0.6662	0.7174	0.8407	0.7075	0.4004	0.3916	0.8872	0.5845	0.4489	0.8227	0.4618	0.3628	0.9243	0.7300	0.8642	0.3700	0.6035
Variance	0.4557	0.4020	0.4430	0.5146	0.2924	0.5005	0.2405	0.1533	0.7880	0.3416	0.2015	0.3279	0.2130	0.1315	0.8543	0.5320	0.7468	0.3749	0.3643
Skewness	-0.4337	0.0510	0.2304	-0.0755	-1.1025	-0.5780	-0.7510	-0.2682	0.6822	-0.2142	0.2995	-0.0452	1.0334	-0.1947	-0.1002	-	0.3056	-	-0.1635

Crop Year	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73
72-73	-	-	2.8580	2.4950	2.4959	2.7095	2.7820	2.4959	2.4959	2.2285	2.2285	3.4959	2.4939	3.7700	2.4953	2.4815
73-74	-	-	5.7338	5.1325	8.1325	4.7310	4.7310	5.1323	5.1325	5.1325	5.1335	5.1333	5.1325	6.0500	4.6333	4.6340
74-75	-	-	3.6380	4.5375	4.5375	4.5375	4.5375	4.5375	4.5375	4.5375	4.3575	4.3336	4.3558	5.2200	4.0771	4.0849
76-76	-	-	3.2197	4.2849	4.2849	4.2949	4.2849	4.2840	4.2849	4.2849	4.2849	3.2324	4.3082	4.5600	3.6225	3.6114
76-77	-	-	3.7657	3.3303	3.3303	3.3303	3.3303	3.3303	3.3303	3.3303	3.3303	2.5466	3.3665	3.2800	3.7455	3.7312
77-78	-	-	3.0358	3.2383	2.4238	3.2383	3.4338	3.2383	3.2383	3.2383	3.2383	3.2383	2.4238	3.5700	3.0150	3.0008
78-79	-	-	3.8050	3.6630	5.6521	3.6650	3.6521	3.6630	3.6521	3.6630	3.6630	3.6521	5.8650	3.6521	4.3000	3.6083	3.5834
79-80	-	-	3.3484	3.4746	3.1339	4.2419	4.2419	4.2419	4.2419	3.4746	4.1339	3.4746	4.1339	4.4700	3.7618	3.8110
Mean	5.5200	3.5700	3.3830	3.7607	3.2489	3.8420	3.7479	3.8655	3.7624	3.7302	3.7154	3.5171	3.7208	4.4338	3.4871	3.4901
Standard Deviation	0.3800	0.3500	0.3383	0.8374	0.9623	0.7142	0.8448	0.8427	0.9692	0.8986	1.0132	0.8845	0.0346	0.8975	0.7030	0.7168
Variance	0.1444	0.1338	0.1144	0.7012	0.9260	0.5102	0.7131	0.7101	0.9394	0.8075	1.0207	0.7823	0.8735	0.8054	0.4942	0.5138
Skewness	-	-	-0.0383	0.3062	-0.1743	-0.2612	-0.4004	-0.3110	-0.3048	-0.0402	-0.2687	0.6136	-0.1538	-.5250	0.0841	0.0600

1/ Yearly returns were computed for only a representative sample of the portfolio strategies.