ESTIMATED EFFECTS OF VARIATIONS IN WHEAT PRODUCTION UPON COST LEVELS OF COUNTRY ELEVATORS IN NORTHWESTERN OKLAHOMA

By

EDWARD McCRORY CORLEY

Bachelor of Science
Colorado State University
Fort Collins, Colorado
1957

Master of Science
University of Illinois
Urbana, Illinois
1958

Submitted to the Faculty of the Graduate School of
the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
DOCTOR OF PHILOSOPHY
May, 1964

ESTIMATED EFFECTS OF VARIATIONS IN WHEAT PRODUCTION

UPON COST LEVELS OF COUNTRY ELEVATORS IN

NORTHWESTERN OKLAHOMA

Thesis Approved:

Thesis Adviser

Dean of the Graduate School

ACKNOWLEDGMENT

A sincere debt of gratitude is expressed to Dr. Nellis A. Briscoe for his guidance, encouragement, and unselfish donation of time throughout various phases of this dissertation. Dr. Briscoe's assistance extended far beyond his official responsibility as the chairman of my graduate committee.

Appreciation is expressed to Dr. Leo V. Blakley and Dr. Kenneth B. Boggs for their constructive comments on several parts of the manuscript. Thanks are given to Dr. Julian H. Bradsher of the Department of Economics and Dr. Carl E. Marshall of the Department of Mathematics and Statistics.

I am indebted to the Department of Agricultural Economics for the opportunity to pursue graduate training toward the Doctor of Philosophy Degree. A one-year fellowship from the Chicago Board of Trade is also gratefully acknowledged.

The information supplied by elevator managers, the Oklahoma State University Extension Service, and grain-trade personnel was invaluable--to each my sincere thanks.

I wish to recognize Mrs. Juanita Marshall for typing the final copy. The numerous last-minute typing jobs cheerfully done by Mrs. Judy Tilton were very much appreciated. A note of thanks is given to other members of the secretarial staff for earlier copies and to Miss Pat Cundiff and the clerks in the statistical section for computational assistance.

Above all, a deep and heartfelt appreciation of gratitude is expressed to my aunt, Miss Esther McCrory, for her quiet manner of encouragement throughout my entire scholastic program.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Problem Statement

Widespread expansion in storage facilities of country grain elevators has occurred in recent decades in the United States. This trend has existed in conjunction with improved technology in the grain farming regions. Technological advancements have been made in planting and harvesting grain. The development of improved plant varieties, the rotation of crops, and the general adoption of fertilizers in grain production have increased per acre yields. A direct result of these advancements has been an increase in total production of grain.

Specifically, this study was concerned with only a limited segment of the vast rise in grain production and grain storage capacity. The geographical region under analysis was restricted to the major grain producing area in Oklahoma. The type of storage facility considered was elevator storage located at country points throughout the wheat producing area of Oklahoma.

Oklahoma country elevators were characterized by: (1) a situation of overcapacity relative to grain supplies and (2) a situation in which the elevators had several years of useful life remaining. Consequently, scale modifications were not expected in the near future. Wheat supply variations of a permanent or semi-permanent nature can alter the level of permanent labor costs in addition to altering many of the other costs of handling wheat by these elevators. The impact of these variations upon total handling costs leads to the objective of this study.

Objective

The previous background information suggests the possibility of varying supplies of grain handled by country elevators. Accordingly, the primary objective was to determine the handling costs incurred by all-grain elevators of different capacities at alternative levels of grain handled. Capacity was defined to be the rated storage capacity or maximum capacity with no turning space. Each elevator model in the study was considered to be a single-unit model. The elevators were located in the wheat producing area of northwestern Oklahoma.

Specifically, the varying levels of grain handled were both above and below 1962 levels. Consideration of these variations in the volume of grain handled included only those of a permanent or semi-permanent nature, i.e., primarily those due to government programs. Therefore, temporary unpredictable changes in crop production and elevator grain handling volume were not under consideration. The main reason for this approach was to permit full-time labor costs to vary. Unpredictable and temporary variations in the volume of grain handled do not result in a high degree of full-time labor variation. The importance of labor as an expense will become more evident in a later discussion concerning the size of the cost components in country grain elevator operations.

Variations in handling volume are primarily from the short-run viewpoint in the analysis. "The short run is a time period so short that the firm is unable to vary the quantities of some resources used."[1] In this study, management and elevator storage capacity were considered to be fixed resources.

A fundamental reason for considering capacity as fixed was an attempt to depict reality. The useful life of an elevator can encompass several decades. Therefore, capacity alterations, especially in a downward direction, would not be expected for several years. Notation should also be made at this point that most of the concrete elevators have been erected within the past three decades. These elevators have many years of usefulness remaining.

Achievement of the primary objective necessitates variations in grain handling volume. The current situation of a production surplus of wheat could result in more stringent controls upon wheat production. A consequence of this action would be a reduction in the quantity of grain handled by country elevators. However, the possibility of expanded wheat production should not be neglected. In the event that governmental controls were removed, the possibility of increased production could easily occur. In fact, the increase could greatly exceed the increases that have occurred in recent years when governmental controls on production have been in effect. An increase in wheat production would result in an increased handling volume.

Emphasis has been made that government programs are the initiating source of the production variations to be considered here. This stress

[1] Richard H. Leftwich, The Price System and Resource Allocation (rev. ed., New York, 1960), p. 139.

is made only to convey the impression that the change in the production level is a sudden one that will be prolonged for several years. Such an approach is in contrast to: (1) technological alterations which will have gradual effects upon total production levels in an area, or (2) unpredictable fluctuations in production explained by seasonal, climatic, and disease variations.

Sources of Data

Several publications and individuals were consulted during the course of the study. The primary reason for using both previous research plus personal interviews and correspondence was to depict input components for the grain handling function more accurately than if only one method were chosen.

Published Information

Two groups of published information were consulted. Each group was used for a particular purpose.

One group was a series of research studies on cost-volume relationships for country elevators in various geographical regions of the United States. The purpose of examining these studies was to gain an insight into the makeup of the total costs for handling grain. Since each study assumed either a specific level of sideline sales volume or constant short-run total costs, many of the cost figures were not directly applicable to the costs that would be incurred in an all-grain handling operation. Consequently, the actual amounts of the cost components were not obtained from these studies. Only a classification and discussion of the costs involved in handling grain was achieved through an inspection of these geographical research analyses.

The other group of published information examined was a selection of elevator audits. Files in the Department of Agricultural Economics at Oklahoma State University include annual audits for the majority of the cooperative grain elevators in the state. Many of these audits have been received for several years.

Due to the heterogeneity of these firms with respect to the various sources of their revenues, the amounts of the costs shown in the audits were not used. Instead the audits were examined to gain a rough approximation of the relative importance of the cost components in country grain elevator operations without regard to the level of handling, storage, or sideline activities.

Personal Interview with Elevator Personnel

Oklahoma cooperative elevators were divided into ten capacity groups. These groups ranged in size from rated capacities near 100,000 bushels through rated capacities in excess of 1,000,000 bushels. Interim groups were in multiples of 100,000 bushels.

Subsequently, a manager was interviewed from one firm in each group. These managers were chosen with the assistance of staff members from the Department of Agricultural Economics and the Extension Service. There was no attempt to select managers on a random basis. Criteria for selection were number of years of service as an elevator manager and the extent to which the manager would be expected to cooperate with an interviewer. Permanent and seasonal labor costs were the costs of concern in these interviews.

Consultation with Agricultural Specialists

A final source of data included agricultural engineers, elevator construction contractors, businessmen engaged in the sale or use of resource inputs common to elevator handling operations, and other individuals with a knowledge of the country elevator economy. These individuals were consulted to gain current and accurate estimates of the cost components for each model. At the time of the study some of the cost components were not fully or efficiently utilized. Also, elevator operators did not have a complete knowledge of optimum cost levels for many of the costs.

Description of the Area

The ten elevators whose managers were interviewed are located in the northwest section of Oklahoma. To avoid identification of the individual firms interviewed only their county location is described. Eight counties are represented. Blaine and Grant counties each had two of the elevators while one elevator was located in each of the following counties: Alfalfa, Custer, Garfield, Kay, Kingfisher, and Noble. Figure 1 shows the location of the firms interviewed.

A recent study notes that the northwest and north-central areas of Oklahoma include the specialized wheat-producing counties.[2] The eight counties listed above and shown in Figure 1, with the possible exception of Custer County, are encompassed within these two areas.

---

[2]John J. Klein, et al., The Oklahoma Economy, Economic Research Series No. 1 (Stillwater, 1963), p. 50.

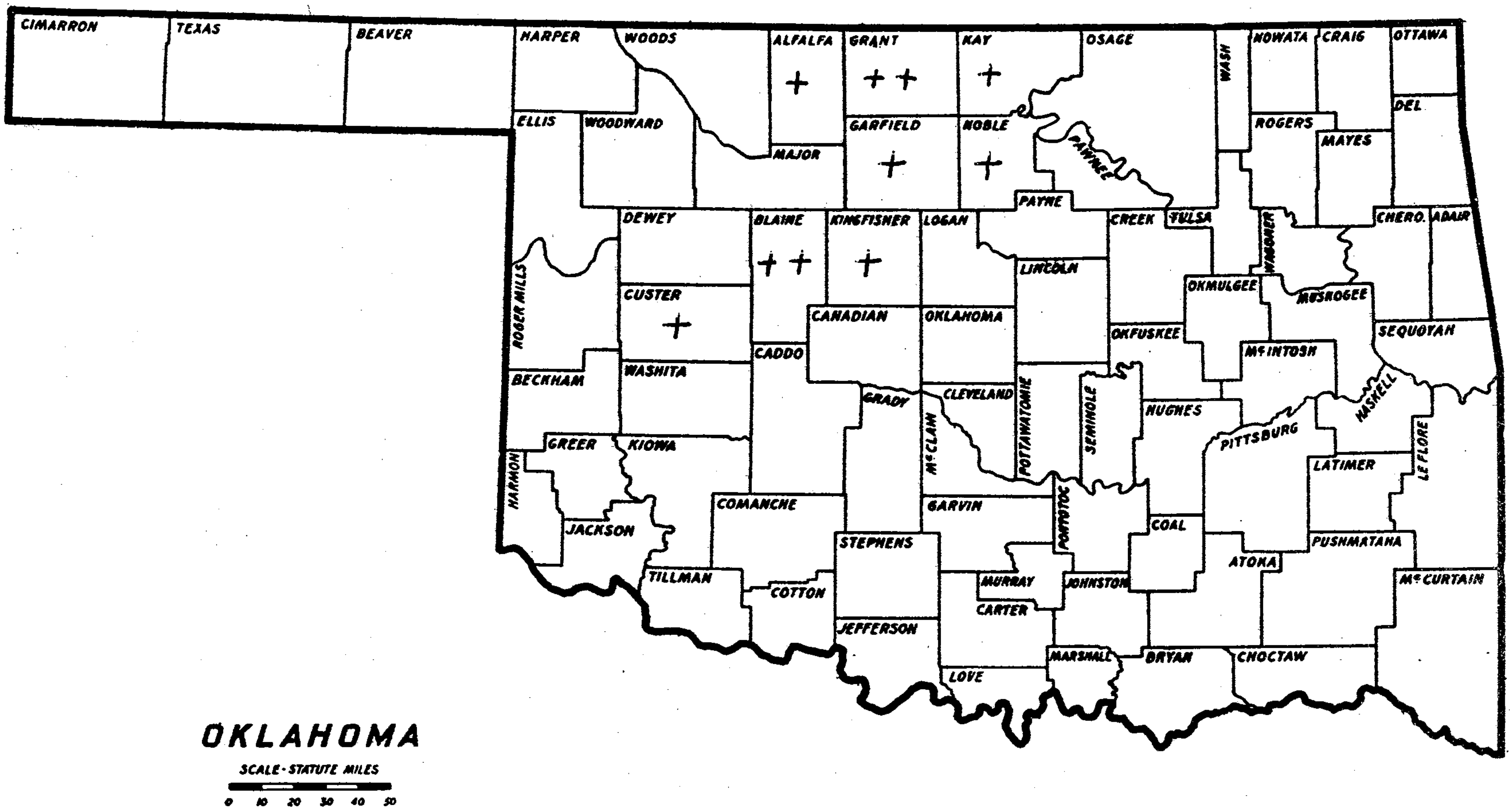

Figure 1. County Location of the Firms in the Study.

The relative importance of these eight counties in the Oklahoma wheat economy can be seen by a ranking of these counties upon the basis of wheat production. Table I shows this ranking during a recent seven-year period. Out of the 77 counties in the state, the lowest ranking county in the eight-county grouping was never below the rank of nineteenth from 1955 through 1961. There was only one year, 1955, when less than four of the selected eight counties failed to rank in the top six wheat-producing counties in Oklahoma.

TABLE I

STATE RANKING OF EIGHT SELECTED COUNTIES IN WHEAT PRODUCTION, OKLAHOMA, 1955-1961

County	Year and Rank						
	1955	1956	1957	1958	1959	1960	1961
Alfalfa	9	4	3	4	3	5	4
Blaine	14	11	10	15	10	14	11
Custer	18	10	6	13	12	15	16
Garfield	4	1	2	3	2	1	3
Grant	3	2	1	2	1	2	2
Kay	2	3	4	5	5	4	6
Kingfisher	12	5	9	8	6	7	7
Noble	15	13	14	19	15	16	18

Source: Oklahoma Agriculture, State Board of Agriculture and Statistical Reporting Service, United States Department of Agriculture, Annual Issues.

Wheat production accounts for a large proportion of the aggregate production of wheat, corn, oats, barley, and grain sorghum in these eight counties. In the 1957-1961 period, wheat represented 73 percent of the average annual amount of this aggregate production in these counties.[3] The quantities of these five grains moving to country elevators constituted the major amount of grain handled by elevators. The latter four grains are feed grains and, consequently, were expected to be consumed in large quantities at the point of production. Therefore, the amount of wheat handled by elevators relative to these four feed grains in the counties should have exceeded 73 percent. This tendency is indicated from the results of interviews with ten elevator managers in these counties. These ten inverviews indicated that the average amount of wheat relative to the total bushels of all grains handled by the elevators ranged from a high of 100 percent to a low of 66 percent. Only two of these firms estimated the ratio to be under 80 percent. The above percentages indicate the importance of wheat in country elevator operations in the wheat production areas of Oklahoma.

The supply of commercial storage space in the eight counties accounted for a large proportion of the state total. In 1961 a total of 45 percent of off-farm storage capacity was located in these eight counties (Table II). Terminal storage in Garfield County resulted in this high percentage. However, the fact that the seven counties, excluding Garfield, had 15 percent of Oklahoma off-farm grain storage space shows the import of country elevator storage capacity in these counties upon the grain storage economy. With the exception of Noble

[3]Computed from annual crop reports issued by Oklahoma Crop and Livestock Reporting Service, Office of the Agricultural Statistician, Oklahoma City, Oklahoma.

TABLE II

RELATIVE IMPORTANCE OF OFF-FARM GRAIN STORAGE CAPACITY IN EIGHT SELECTED COUNTIES: OKLAHOMA, 1961

County	Off-Farm Storage Capacity (Percent of State Total)
Alfalfa	2
Blaine	3
Custer	2
Garfield	30
Grant	2
Kay	3
Kingfisher	2
Noble	1
Total of Eight Counties	45

Source: Commercial Grain Warehouses in Oklahoma, Extension Service, Oklahoma State University (Stillwater, January 1, 1961).

County, all of the eight counties in Table II had at least two percent of the total amount of commercial Oklahoma storage space.

Based upon the above production and capacity data, the eight counties appear to be representative of the wheat producing area in Oklahoma. Consequently, as discussed in detail later, ten elevator managers in these counties were interviewed for estimates of labor costs attributable to the grain handling function.

CHAPTER II

CHARACTERISTICS OF THE OKLAHOMA GRAIN ECONOMY

The importance of wheat production in Oklahoma will be discussed in this chapter. Subsequently, the relationship between wheat supplies and the amount of storage space in Oklahoma will be presented. The possibility of more rigid production and marketing controls will be emphasized. Finally, several observations will be made regarding the relevance of the objective of the study to firm and governmental decision-making.

Relative Importance of Wheat Production In Oklahoma Agriculture

Wheat production in Oklahoma has demonstrated an upward trend. Figure 2 shows this movement in production over a 27-year period. While annual production has been somewhat erratic, the peaks in production have progressively climbed to new heights. The lowest production in 1955 occurred simultaneously with the highest number of acres abandoned in the 1952-1961 period. Adverse weather conditions were the major determinant of this apex in abondoned acreage.

Recently, wheat yields have been nearly twice as great as the yields in the 1935-1957 period. The fluctuations in yields on a harvested acreage basis are depicted in Figure 3. Basically, the variations are due to changing weather conditions and insect damage.

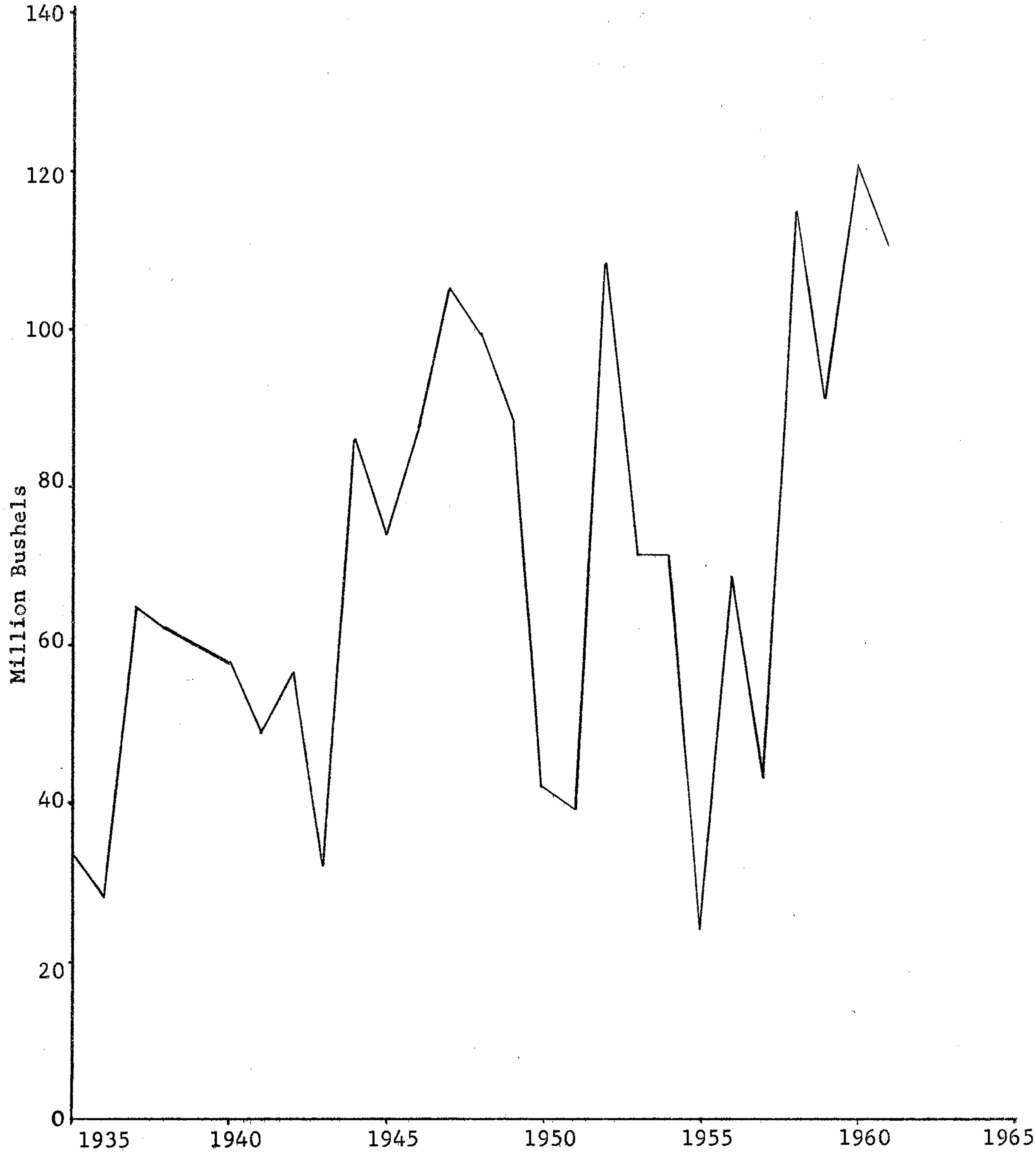

Figure 2. Oklahoma Wheat Production, 1935-1961.

Source: 1935-1958 production from Agricultural Statistics, U. S. Department of Agriculture (Annual issues); 1959-1961 production from Oklahoma Agriculture, 1962, State Board of Agriculture and Statistical Reporting Service, U. S. Department of Agriculture.

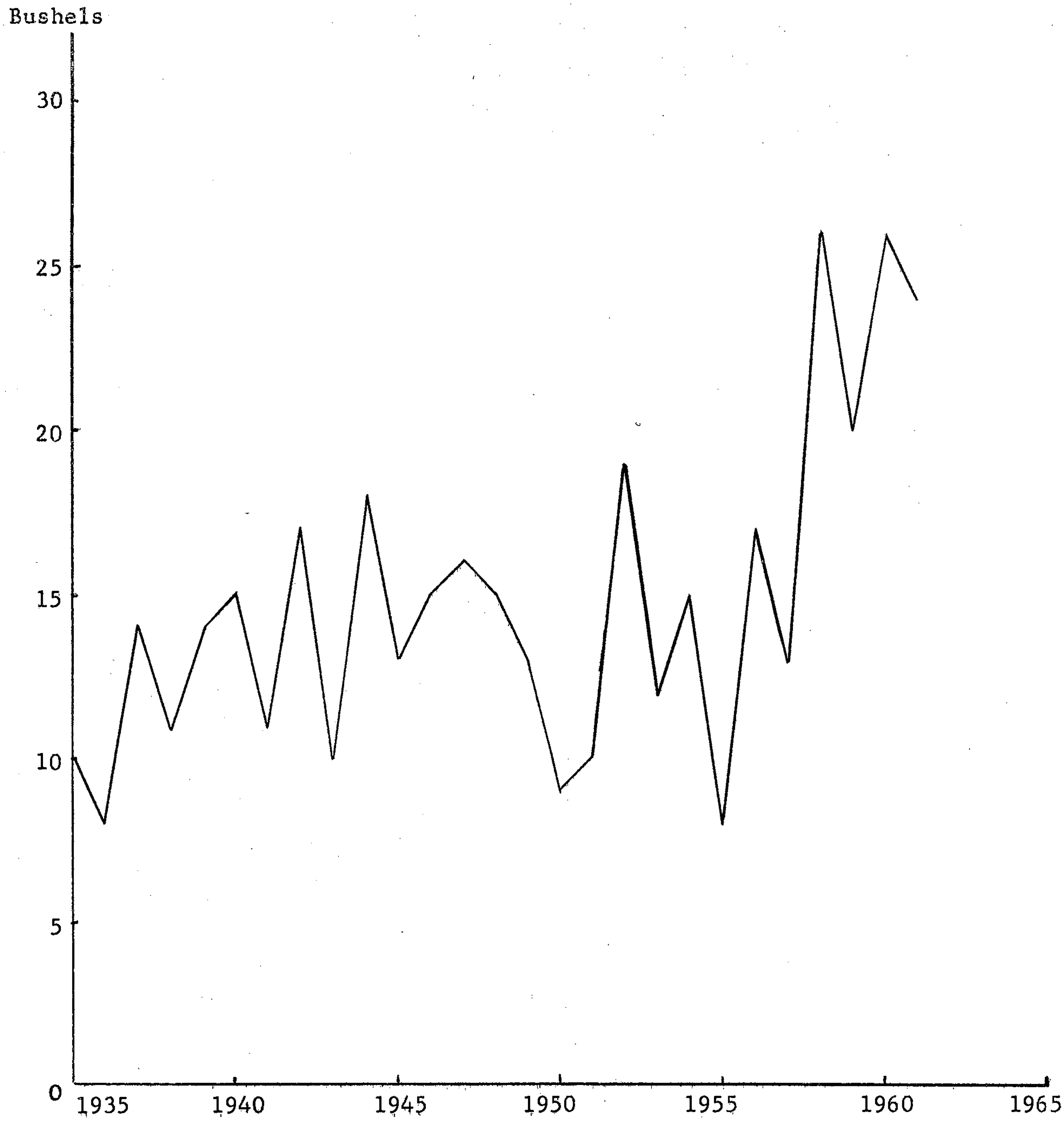

Figure 3. Oklahoma Wheat Yields Per Harvested Acre, 1935-1961.

Source: 1935-1958 yields from Agricultural Statistics, U. S. Department of Agriculture (Annual issues); 1959-1961 yields from Oklahoma Agriculture, 1962, State Board of Agriculture and Statistical Reporting Service, U. S. Department of Agriculture.

Applied technological improvements have occupied a major role in increasing the per acre wheat yields. Higher yielding varieties have been developed as have varieties which are resistant to various pests.[1]

A simultaneous movement with the increase in wheat yields has been a decline in harvested acreage since the late 1940's. This acreage decline has occurred during a period of time when wheat yields were rising. Wheat acreage harvested is shown in Figure 4. Seeded wheat acreage in Oklahoma decreased during the 1950's when contrasted with the higher seeded acreage in the 1940's.[2] Wheat acreage allotments and marketing quotas were two factors responsible for this decline in seeded and harvested acreage. In the 26-year period beginning in 1938 and ending in 1963, acreage allotments for wheat were in effect 16 years while marketing quotas were in effect 12 years.[3]

Several crops are grown in Oklahoma in addition to wheat. The component of these crops which can be handled in grain elevators includes: grain sorghum, barley, oats, soybeans, and corn. In 1961, the value of wheat production in Oklahoma was second only to cattle and calves. During the same year, of the six crops mentioned above, wheat production was valued at approximately twelve times its nearest rival, sorghum for

---

[1]The Wheat Situation, AMS, U. S. Department of Agriculture, Feb., 1959, p. 30.

[2]Agricultural Statistics, U. S. Department of Agriculture (Selected Issues).

[3]Status of acreage allotments and marketing quotas, 1938 through 1959, Adlowe L. Larson and Nellis A. Briscoe, Some Effects of Wheat Policy on the Oklahoma Wheat Marketing Industry, Oklahoma Agricultural Experiment Station Bul. B-521 (Stillwater, 1959), p. 24. Status of acreage allotments, 1960, The Wheat Situation, ERS, U. S. Department of Agriculture, June, 1962, p. 27. Status of acreage allotments, 1961 through 1963, and marketing quotas, 1960 through 1963, The Wheat Situation, ERS, U. S. Department of Agriculture, Aug., 1962, pp. 22 and 19, respectively.

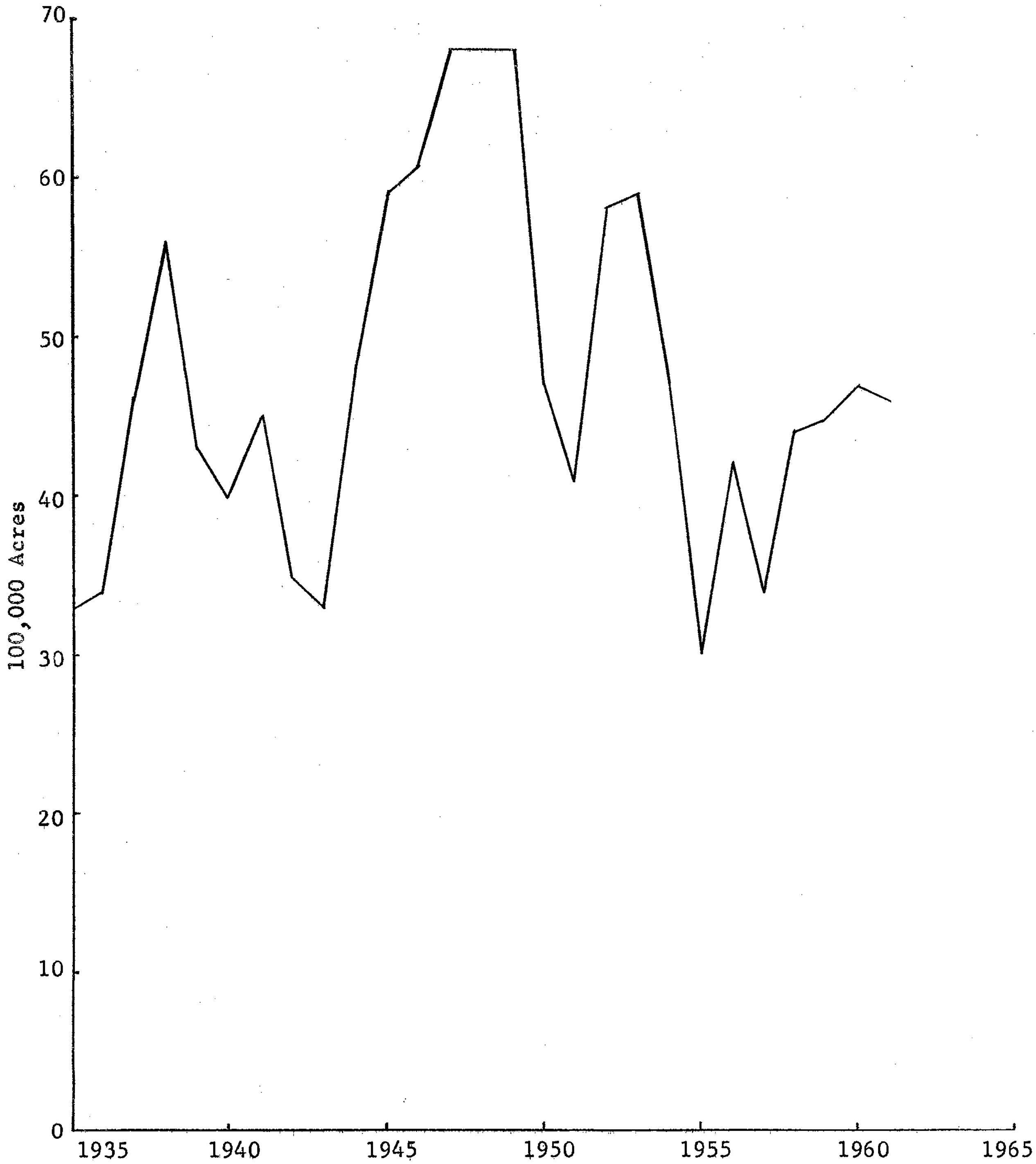

Figure 4. Oklahoma Wheat Acreage Harvested, 1935-1961.

Source: 1935-1958 acreage from Agricultural Statistics, U. S. Department of Agriculture (Annual issues); 1959-1961 acreage from Oklahoma Agriculture, 1962, State Board of Agriculture and Statistical Reporting Service, U. S. Department of Agriculture.

grain. In 1961, wheat production on a total bushel basis exceeded its closest rival, barley, by almost sixfold.[4]

Fifteen year averages of the value of production and of the total production of the primary grains handled in Oklahoma grain elevators are shown in Table III. Wheat occupied the dominant position in both physical and monetary units.

TABLE III

PRINCIPAL CROPS HANDLED IN GRAIN ELEVATORS, TOTAL PRODUCTION, AND VALUE OF PRODUCTION: OKLAHOMA, 1947-1961 AVERAGE

Crop	Total Production[a]	Value of Production[a]
	-1,000 Bushels-	-1,000 Dollars-
Wheat	79,412 (69)	154,966 (77)
Grain Sorghum	12,822 (11)	13,418 (7)
Barley	6,014 (5)	5,024 (2)
Oats	13,697 (12)	10,370 (5)
Soybeans	849 (1)	1,771 (1)
Corn	1,768 (2)	16,823 (8)
Total	114,562	202,372

[a]Numbers in parentheses are percentages of the totals.

Source: Oklahoma Agriculture, State Board of Agriculture and Statistical Reporting Service, U. S. Department of Agriculture, Annual Issues.

---

[4]Oklahoma Agriculture, 1962, State Board of Agriculture and Statistical Reporting Service, U. S. Department of Agriculture, pp. 98 and 104-107.

The above background information on wheat production and the relative importance of wheat production to that of other grains grown in Oklahoma constitute the basic reasons for concentrating the analysis upon wheat. While several grains other than wheat are grown throughout Oklahoma, the fact that wheat accounts for the highest percentage of total production and total value of production demonstrates the importance of wheat in Oklahoma country elevator operations.

A further point merits attention at this stage of the discussion. Notwithstanding the importance of production estimates in approximating the relative significance of various grains moving into country elevators, farmer grain sales data portray this relative significance to a more exacting degree. Sales disposition of grain indicates the relative importance of the major grains in their movement to country elevators. In Table IV, wheat is noted to account for 78 percent of the total farm sales of six principal crops handled by elevators. Grain sorghum, accounting for nine percent, is a distant second. The fact that wheat is primarily used for food purposes accounts for the high percentage of off-farm wheat sales relative to other grains. A study by Meinken indicated that 85 to 90 percent of the wheat crop is sold from farms and becomes part of the commercial supply. Food uses account for nearly 50 percent of commercial utilization while the remaining percent is composed of usage in feed, seed, industrial purposes, and exports.[5]

---

[5]Kenneth W. Meinken, The Demand and Price Structure for Wheat, U. S. Department of Agriculture Technical Bul. No. 1136 (Washington, 1955), p. 5.

TABLE IV

FARM SALES OF PRINCIPAL CROPS HANDLED IN OKLAHOMA GRAIN ELEVATORS, 1955-1961 AVERAGE

Crop	Farm Sales	Percent of Total
	-1,000 Bushels-	
Wheat	547,767	78
Grain Sorghum	64,648	9
Barley	41,540	6
Oats	28,752	4
Soybeans	9,163	1
Corn (for grain)	12,301	2
Total	704,171	100

Source: Oklahoma Agriculture, 1962, State Board of Agriculture and Statistical Reporting Service, U. S. Department of Agriculture, pp. 111-112.

Elements of Storage Capacity

Off-farm Storage

In an effort to facilitate the handling and storage of increased wheat supplies, the amount of storage space has expanded. For example, during the first half of 1954 there were 47 firms that erected over 14 million bushels of new storage space.[6] Several flat warehouse facilities were built in early 1959.[7] Elevator managers interviewed in the summer of 1963 indicated that wheat accounted for 75 to 100 percent of their total grain stored.

Recent trends concerning the structure of the Oklahoma grain storage industry are shown in Table V.[8] While the number of firms increased by only 11 percent, total capacity of these firms rose by 80

[6]Oklahoma Agriculture, 1954, State Board of Agriculture and AMS, U. S. Department of Agriculture, p. 11.

[7]Oklahoma Agriculture, 1959, State Board of Agriculture and AMS, U. S. Department of Agriculture, p. 73.

[8]Jim E. Smith, Secretary-Treasurer of the Oklahoma Grain and Feed Dealers Association in a letter written April 23, 1963, stated that the firms listed in the Directory of the Association comprised 95 percent of the total number of cooperative and independent grain elevators in Oklahoma. Emphasis should be made that the percentage is only an estimate.

percent from 1957 to 1963. Consequently, growth in storage space appears to be explained more by expansion of existing facilities than by formation of new firms. Some consolidation of existing firms could have taken place. In Table V, the decline in the total number of firms from 1957 to 1958, and the concurrent increase in total capacity demonstrate the possibility of consolidation.

TABLE V

OKLAHOMA OFF-FARM STORAGE: NUMBER OF FIRMS AND CAPACITY, 1957-1963

	1957	1958	1959	1960	1961	1962	1963
Total Number of Firms	429	426	439	508	484	485	474
Total Capacity (1,000 Bushels)	143,349	146,100	164,385	232,907	228,542	259,481	257,703

Source: Oklahoma Grain and Feed Dealers Association Official Directory, Annual Issues.

The estimated capacity of off-farm commercial grain storage facilities in Oklahoma has risen from 96,157,000 bushels in 1951 to 255,000,000 bushels on January 1, 1963.[9] This is a 165 percent increase. These amounts do not include storage owned by Commodity Credit Corporation. Oklahoma grain storage space in 1942 was only 42,000,000 bushels.[10] At the time of the study, the Commodity Credit Corporation did not own any storage space in Oklahoma. The Commodity Credit Corporation owned storage in Oklahoma was never very large. In recent years this storage space has been sold to private firms or transferred out of Oklahoma.[11]

---

[9] The Wheat Situation, AMS, U. S. Department of Agriculture, August, 1958, p. 33; The Wheat Situation, ERS, U. S. Department of Agriculture, April, 1963, p. 32.

[10] Adlowe L. Larson, "Adjustments Facing Grain Storage Operators," Oklahoma Current Farm Economics, 35 (1962), p. 39.

[11] Conversation with Marvin Munger, Chief, Price Support Section, ASCS, U. S. Department of Agriculture, Stillwater, Oklahoma.

On-farm Storage

On-farm storage space in Oklahoma, in contrast to the above comments pertaining to off-farm storage facilities, has followed a different pattern.[12] Utilization of on-farm storage in Oklahoma has decreased since the 1950's. At the time of the study, less than ten percent of Oklahoma wheat was stored on farms. A basic reason for this low percent is related to the amount of risk involved. Oklahoma wheat is harvested during a warm period of the year. If excess moisture exists during the harvest, then the possibility of wheat spoilage will be high. Insect damage under moist conditions can result in additional grain damage. Producers desire to shift these risks by transferring their grain directly from the field to the country elevator points.

The fact that most of the wheat crop is sold from farms for food, feed, seed, industrial purposes, and exports also results in the storage of only small amounts of wheat on farms. Since wheat production in Oklahoma accounted for nearly 70 percent of the total production of the six primary grains raised in the state that were handled by elevators, the incentive for off-farm storage is emphasized further.

Another incentive to farmers to store their grain in off-farm positions was the patronage payment which they received when their grain was stored in cooperative elevators. The high proportion of cooperative elevators in Oklahoma rendered this especially important.

Additionally, the advent of the self-propelled combine has created a desire by farmers to move their grain directly to the local elevator.

---

[12]The following discussion concerning the amount and use of on-farm storage space in Oklahoma is adapted from a conversation with James R. Enix, Oklahoma State University Extension Wheat Marketing Specialist.

The purchase of this type of combine and the employment of "custom harvesters" have resulted in a shorter harvest span. The consequent need for hired trucking would result in little or no cost reduction if producers were to hire their grain moved to on-farm storage facilities as opposed to truck hauls by the producers to a country elevator point.

While the utilization of on-farm storage has declined, the amount of potential storage located on farms is undetermined. In 1954, on-farm storage facilities were estimated to be 40,000,000 bushels. The present capacity of this type of storage is difficult to ascertain. However, the following point appears clear: Much of the on-farm storage in Oklahoma has alternative uses. For example, the storage facility possibly can be used as a machine shed. Consequently, the abundance of storage facilities with alternative uses located on Oklahoma farms results in less pressure upon grain producers to use their storage space for storing grain only.

Assuming that the 40,000,000 bushel capacity figure for Oklahoma on-farm storage space did exist on January 1, 1963, then on-farm facilities would account for only 14 percent of total off-farm plus on-farm storage in the state. The decline in the use of on-farm storage discussed above accentuates the small role of this form of storage in the Oklahoma grain economy.

Previous research indicates that actions by farmers to decrease their usage of on-farm storage space have been economically correct. A study of the comparative costs of storing Oklahoma grain in on-farm versus off-farm positions was made in 1950. The results of the analysis indicated that off-farm storage costs were lower than the costs of storing on the farm. This conclusion was true for both new on-farm storage facilities and previously constructed farm storage space.[13]

Effects of Incentives for Elevator Construction

Government incentive programs for elevator construction have occupied a major role in the increase of off-farm storage capacity. These programs were designed to encourage the construction of additional facilities for storing grain. Specific features of the programs included: (1) occupancy contracts, (2) accelerated amortization, and (3) storage and handling agreements.[14]

Occupancy contracts were initiated formally in August, 1953. The acceptance of new contracts was terminated on August 20, 1954. A termination followed by a reopening occurred during the period between these two dates.[15]

Three plans existed under the occupancy contract program. They included:

Plan 1 - Occupancy of 75 percent of the total bin capacity of the facility for the first three years and 40 percent of such total bin capacity for an additional two years for a total of five years.

Plan 2 - Occupancy of 60 percent of the total bin capacity of the facilities for five years.

---

[13]Adlowe L. Larson et al., Comparative Costs of Grain Storage On Farms and In Elevators, Oklahoma Agricultural Experiment Station, Bul. B-349 (Stillwater, 1950).

[14]Geoffrey S. Shepherd, Allen B. Richards, and John T. Wilkin, Some Effects of Federal Grain Storage Programs on Grain Storage Capacity, Grain Stocks and Country Elevator Operations, North Central Regional Pub. No. 114 (Lafayette, Indiana, 1960), pp. 4-6.

[15]Ibid., p. 5.

Plan 3 - Occupancy of 50 percent of the total bin capacity of the facilities for six years.[16]

For any one of the trio of alternative plans, Commodity Credit Corporation would utilize the facilities of elevators constructed under occupancy contracts.

The second incentive, accelerated amortization, "allowed warehousemen to construct grain storage facilities and depreciate these facilities for income tax purposes over a five-year (60 month) period."[17] However, this incentive was only in effect for a limited time span. Only construction completed during the period 1953 through 1956 was eligible for rapid amortization.[18]

The final government incentive focused upon the rates for storage and handling of Commodity Credit Corporation grain by individual warehousemen. Examination of elevator audits revealed that storage rates for wheat were .047 cents per bushel per day for annual audits with fiscal years ending in the year prior to June 30, 1960. This is an annual rate of $ .17155 per bushel.

A decrease in this incentive has occurred with the downward revision of storage rates on grain stored for Commodity Credit Corporation. Effective June 30, 1960, these storage rates for wheat on a commingled basis were lowered to 0.37 cents per bushel per day or $ .13505 per bushel per year.[19] These lower rates are currently in effect.

---

[16]Ibid.

[17]Ibid.

[18]Ibid.

[19]Schedule of Rates, 1960 Supplement to Uniform Grain Storage Agreement, Commodity Stabilization Service, CCC, U. S. Department of Agriculture, May 17, 1960.

Consultation with elevator managers and government wheat specialists disclosed that an annual storage rate decline of over 3.5 cents per bushel has reduced the incentive for new elevator construction to a large degree.

A further incentive which was not directly initiated through governmental action was loans to cooperatives by cooperative banks for storage construction to be leased from the Commodity Credit Corporation. Such loans were made only if Commodity Credit Corporation guaranteed to lease or utilize at least 75 percent of the storage space for a minimum of two or three years depending upon whether the new construction was or was not, respectively, an addition to the present facility.[20] Since a 75 percent commitment for a specified time period constituted an occupancy contract, the loan incentive was eliminated upon the termination of occupancy contracts in 1954.

The government incentives described above, in conjunction with increased grain production, have created a storage problem in the Oklahoma warehouse and elevator economy. Basically, this problem was one of over-expansion of storage facilities.

First, owners of off-farm storage space have increased their facilities in an effort to derive the benefits from the government construction incentive programs. These programs were designed to provide ample storage space for grain. Commodity Credit Corporation grain was included in the storage use made of these new facilities.

Second, usage of storage space has not increased as rapidly as storage construction. Off-farm stocks of major grains serve to reflect

[20]Shepherd, Richards, and Wilkin, p. 6.

grain production, particularly with respect to wheat, to a high degree since on-farm storage usage is small. The percent utilization of off-farm storage facilities reflects the differential rates of increase of storage space and off-farm grain stocks.

Table VI illustrates the results of these varying rates of increase. During the 1957-1961 period the quarterly utilization of off-farm storage capacity indicates a decrease as the storage season progresses from the high October utilization to the low July utilization. This trend is logical since the aggregate amount of grain consumed increases as the summer harvest period is reached in any given year.

However, inter-year comparisons fail to yield such logical consistency. In fact, the percent utilization estimates shown in Table VI demonstrate a declining rate of storage usage between years. This is primarily evident in the quarter beginning on October 1. In this quarter, as would be expected, the use of storage normally reached a peak each year. Excluding the low production of wheat in 1957, the percent utilization of off-farm storage in the October 1 to December 31 quarter declined from the 1958 high to the 1960 and 1961 lows. This decline in storage utilization occurred simultaneously with an increase in the combined production of wheat, corn, oats, barley, and sorghum grain from 1959 to 1960 of 37,829,000 bushels.[21] Consequently, while off-farm capacity increased from 1959 to 1960, storage utilization, as reflected by production, did not rise enough to maintain the percent

---

[21] Oklahoma Agriculture, 1962, State Board of Agriculture and Statistical Reporting Service, U. S. Department of Agriculture, p. 111.

TABLE VI

QUARTERLY OFF-FARM STOCKS[a] OF WHEAT, CORN, OATS, BARLEY, AND SORGHUM GRAIN AND OFF-FARM STORAGE CAPACITY:[b] OKLAHOMA, 1957-1961

	January 1			April 1			July 1			October 1		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Year	Off-Farm Stocks	Off-Farm Capacity	Percent (1÷2x100)	Off-Farm Stocks	Off-Farm Capacity	Percent (4÷5x100)	Off-Farm Stocks	Off-Farm Capacity	Percent (7÷8x100)	Off-Farm Stocks	Off-Farm Capacity	Percent (10÷11x100)
	-1,000 Bushels-			-1,000 Bushels-			1,000 Bushels-			-1,000 Bushels-		
1957	105,301	143,349	73	84,286	143,349	59	75,534	143,349	53	104,557	143,349	73
1958	114,045	146,100	78	92,559	146,100	63	65,727	146,100	45	140,403	146,100	96
1959	139,540	164,385	85	124,325	164,385	76	107,696	164,385	66	152,473	164,385	93
1960	139,786	232,907	60	113,985	232,907	49	101,235	232,907	43	194,534	232,907	84
1961	185,759	228,542	81	136,204	228,542	60	110,124	228,542	48	192,412	228,542	84

[a]Oklahoma Agriculture, 1962, State Board of Agriculture and Statistical Reporting Service, U. S. Department of Agriculture, p. 99.

[b]Oklahoma Grain and Feed Dealers Association Official Directory, Annual Issues.

utilization of 1959. This situation is evidenced in Table VI by the drop in utilization from 93 percent in 1959 to 84 percent in 1960. Over-expansion of storage space was a basic cause for this downturn in the proportion of storage space utilized.

Off-farm capacity must be adequate to accomodate off-farm stocks. In the high production year of 1958, storage utilization in the quarter commencing on October 1 was 96 percent. A percentage of this size is expected during years of high production. However, the fact that the percentage utilization of storage space has declined from 1958 to 1961 concurrently with a rise in storage capacity of over 56 percent reveals the imbalance between grain supplies and capacity available for storing these supplies.

Governmental Production and Marketing Controls

A final factor which may further widen the gap between supplies of grain and available storage space is one that could reduce the supply of grain. Reference here is to government programs designed to lower production surpluses of grains. Wheat is the primary grain in Oklahoma that is in a major surplus position on a national scale.

Evidence of attempts to reduce Oklahoma wheat production has been noted earlier in the form of decreases in seeded wheat acreage. Higher wheat yields per acre have more than offset this seeded acreage reduction. Consequently, wheat production has increased. However, the possibility of effective supply reduction programs should not be overlooked. If such programs were to assume a realistic role, then grain storage space would represent a greater amount of overcapacity than existed at the time of the study. The fact that wheat acreage allotments and marketing quotas have been a part of agricultural policy, especially in the last decade, reflects a desire to restrict wheat production. Any additional policy measures which are aimed at reducing wheat supplies also could result in serious adjustment problems in the grain elevator industry. In the following section a discussion is presented regarding the relevance of the objective of the study to these adjustment problems and to governmental wheat supply policies.

Policy Implications

Once the costs have been computed for several levels of grain handled, a question arises as to the usefulness or purpose of such computations. Elevators, as will be noted later, are characterized by high fixed costs of construction. The popular concrete models designed to store and handle wheat have no alternative uses. A prevalent situation of overcapacity in most elevators exists today. This condition appears likely to continue into the future.

What will be the value of these cost determinations of elevator firms? The answer to this question is found in the relationship between costs and revenues of the basic functions of country grain elevators. Determination of cost and revenue relationships aids the elevator operator in making decisions regarding the optimum combination and magnitude of these functions. Consequently, the operator will be able to use his alternative income enhancement policies more accurately. These alternative policies may be formulated under two different assumptions.

First, production control of wheat can be assumed to "freeze" at a reduced level the quantity of wheat the local elevator will receive. In this event, the elevator might expand its sideline sales volume in an effort to more fully utilize its resources, notably labor. Also, the elevator might increase its handling volume of other grains.

Second, the assumption of reduced wheat supplies resulting in decreased wheat receipts at a "frozen" or fixed level can be relaxed. Consequently, elevator operators might compete among each other for reduced wheat production from farmers.

The second situation conforms more with reality. Elevator managers do compete for wheat receipts with others in their general geographical area. Competition might be in the form of reduced grain handling charges to farmers. Additionally, competition might be indirectly in the form of increased sideline offerings. Interviews with elevator managers indicated that a primary reason for the large increase in sideline activities in recent years has been to attract farmers to their respective elevators. The opportunity for farmers to purchase sideline merchandise at a specific elevator location has caused many farmers to bring their grain to this same elevator.

Achievement of the primary objective of the study has relevance to the pricing and output policies initiated by government. A knowledge of the costs of handling wheat enables governmental policy makers to foresee the effects of the presence or absence of effective supply control programs. The profit position of the firm can be affected by these programs. Consequently, determination of wheat handling costs at varying quantities handled in conjunction with information on handling charges permits governmental decision making to be effected with a knowledge of the relative price-cost positions for varying levels of supply control. Therefore, control of wheat supplies can achieve a predetermined position for profit margins.

Governmental regulation of elevator charges for handling services can be viewed in relation to the level of cost incurred by elevators for this service. Handling charges fixed by the government coupled with governmental supply control of wheat production offer a means of setting profit margins from handling a fixed volume of grain.

Governmental policies for Oklahoma wheat production and handling charges for wheat can be constructed with the objective of achieving a specified range of income to country elevators from the grain handling function. A knowledge of handling costs and revenues is essential if such an objective is to be fulfilled.

The above policy implications, both from the firm and governmental viewpoint, suggest some of the reasons underlying research on determination of grain handling costs for country elevators.

CHAPTER III

THEORETICAL FRAMEWORK

Since the subsequent empirical discussion will be primarily concerned with the short run, the present theoretical concepts will be examined with emphasis upon this time viewpoint. A brief description of the long-run cost concept will be given only to indicate some of the relationships between costs and revenues for various scales of plant. This description will not be presented to indicate comparative economies or diseconomies of scale associated with alternative plant capacities.

Cost Concepts

Time elements in cost analyses create different solutions for various adjustment alternatives faced by management. These adjustment alternatives, which are dependent upon the objective of the firm, are discussed in a later section. Suffice it to say at this point that situations involving varying lengths of run appear pertinent to management decisions of the firm. A discussion of cost elements necessitates the specification of the time period under consideration.

Numerous definitions exist for classifying the various time periods.[1] However, a determination of cost fixity becomes progressively complex in

---

[1]See for example, Leftwich, pp. 139-141; Kenneth E. Boulding, Economic Analysis (3rd ed., New York, 1955), pp. 568-569; and Alfred Marshall, Principles of Economics (8th ed., New York, 1959), pp. 314-315.

empirical studies as the number of time periods increases. Therefore, only two lengths of run were examined, namely, the short run and the long run. The short run has been defined earlier. The long run "is a period of time long enough for the firm to be able to vary the quantities per unit of time of all resources used."[2]

Short-run Cost Considerations

The cost components of country elevator operations that were considered to be fixed in the short run included management and elevator storage capacity. A theoretical set of short-run average and short-run marginal cost curves is illustrated in Figure 5. The symbols in the figures throughout this discussion denote the following costs:

ATC = average total cost

AVC = average variable cost

AFC = average fixed cost

MC = marginal cost

X/U.T. = output per unit of time

Since average total costs are composed of fixed and variable costs, the average total cost curve declines beyond the point of minimum average variable costs at point A because average fixed costs are monotonically decreasing.

The relationship between the production function and the short-run cost function helps to explain the shape of the theoretical cost curves (Figure 5).[3]

---

[2]Leftwich, p. 141.

[3]The following discussion of the relationship between productivity and costs is adapted from John Johnston, Statistical Cost Analysis (New York, 1960), pp. 10-11.

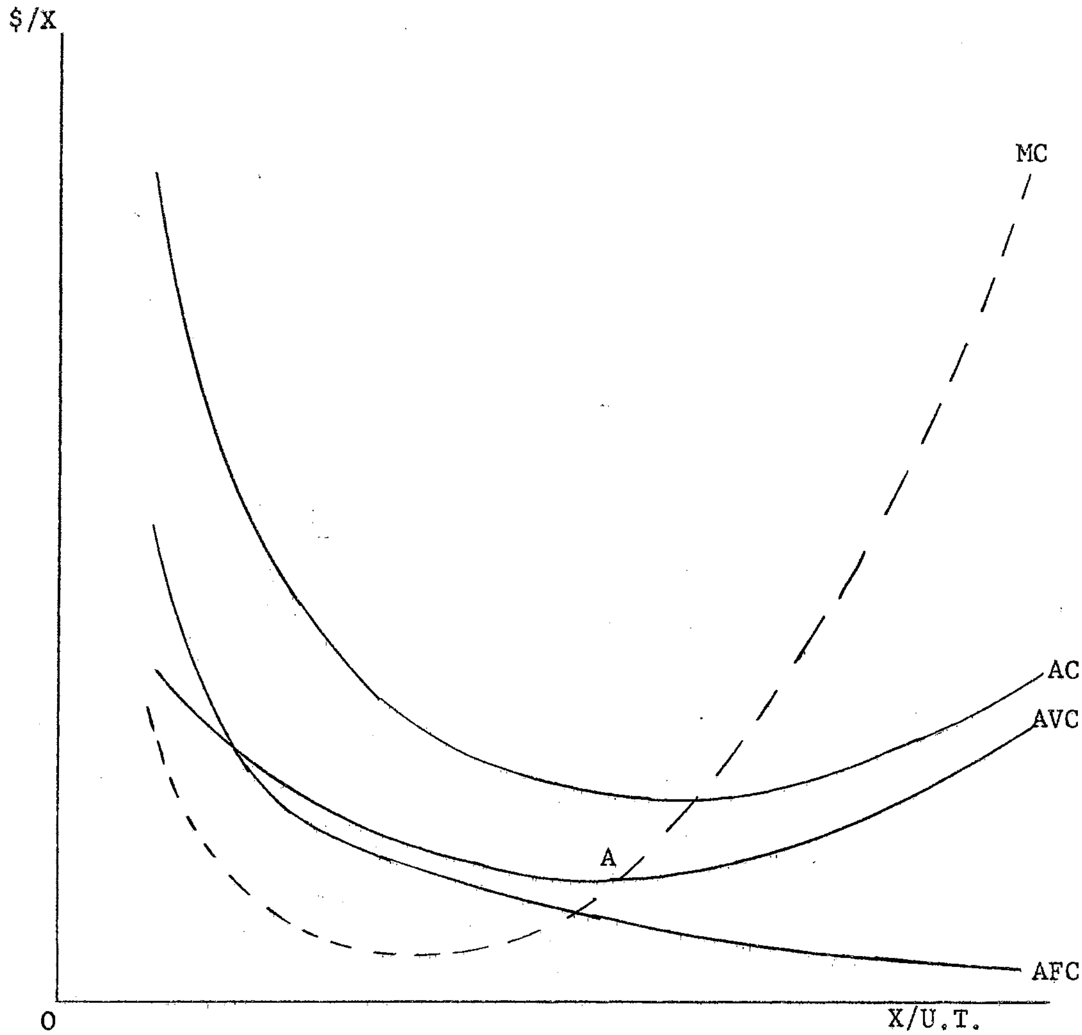

Figure 5. Theoretical Short-Run Cost Curves.

The following conditions were assumed:

1. The production function contains only one fixed and one variable input.

2. Marginal product and average product for the variable factor diminish after a certain point.

3. The price of the variable factor is constant.

Additional symbols and their definitions are:

A = number of units of the variable factor

p = price per unit of the variable factor

MP = marginal productivity of the variable factor

AP = average productivity of the variable factor

The relationship between AVC and AP can now be shown.

Since

$$AVC = \frac{p \cdot A}{X} = p \cdot \frac{1}{\frac{X}{A}}$$

and $AP = \frac{X}{A}$,

then $AVC = p \cdot \frac{1}{AP}$.

Therefore, in words, average variable costs are equal to the price of the variable factor multiplied by the reciprocal of average product. This inverse relationship demonstrates that the maximization of average product is equivalent to the minimization of average variable costs. Conversely, the maximization of average variable costs results in the minimization of average product.

A similar relationship exists between MC and MP.

Since $MC = \frac{d\ (p \cdot A)}{dX}$

and since p is constant by assumption, then

$$MC = p \cdot \frac{dA}{dX} .$$

Furthermore,

$$MP = \frac{dX}{dA} .$$

Therefore,

$$MC = p \cdot \frac{1}{\frac{dX}{dA}} = p \cdot \frac{1}{MP} .$$

The inverse relationship between marginal product and marginal cost shows that maximization of one results in minimization of the other. With these inverse relationships in mind between the production function and the short-run cost function, the basic reasons for the theoretical U-shaped cost curves become more evident.

Ryan attributes the U-shape of the average variable cost and average total cost curves to the behavior pattern of the total variable cost and total cost curves. This pattern is primarily a reflection of the law of non-proportional returns.[4] The law states:

> With a given method of production, the application of further units of any variable input . . . to a fixed combination of other factors . . . will, until a certain point is reached, yield more than proportional increases in output, and thereafter, less than proportional increases in output.[5]

Therefore, the influence of this law upon the product curves, coupled with the inverse relationship between the product curves and the cost curves described above, results in a characteristic U-shape for the average variable cost curve, the average total cost curve, and the marginal cost curve. Since marginal product eventually decreases, marginal costs eventually increase. Even though average variable costs may decrease initially, once marginal costs begin to increase they will eventually equal the declining average variable costs. Successive output increases beyond this point of equality will result in marginal costs in excess of average variable costs. Consequently, average variable costs will rise. Ultimately the increase in average variable costs will

---

[4] William J. L. Ryan, Price Theory (London, 1958), p. 74.

[5] Ibid., p. 60.

more than offset the decrease in average fixed costs. Therefore, average total costs will increase.

Emphasis is made at this point that the U-shaped curves are theoretical and do not necessarily describe cost curves found in empirical studies. In fact, according to Johnston, the hypothesis concerning cost-output variations which appears the most reasonable based upon empirical evidence does not hypothesize the familiar U-shaped average cost curves described above. Instead the evidence indicates curves like those shown in Figure 6.[6]

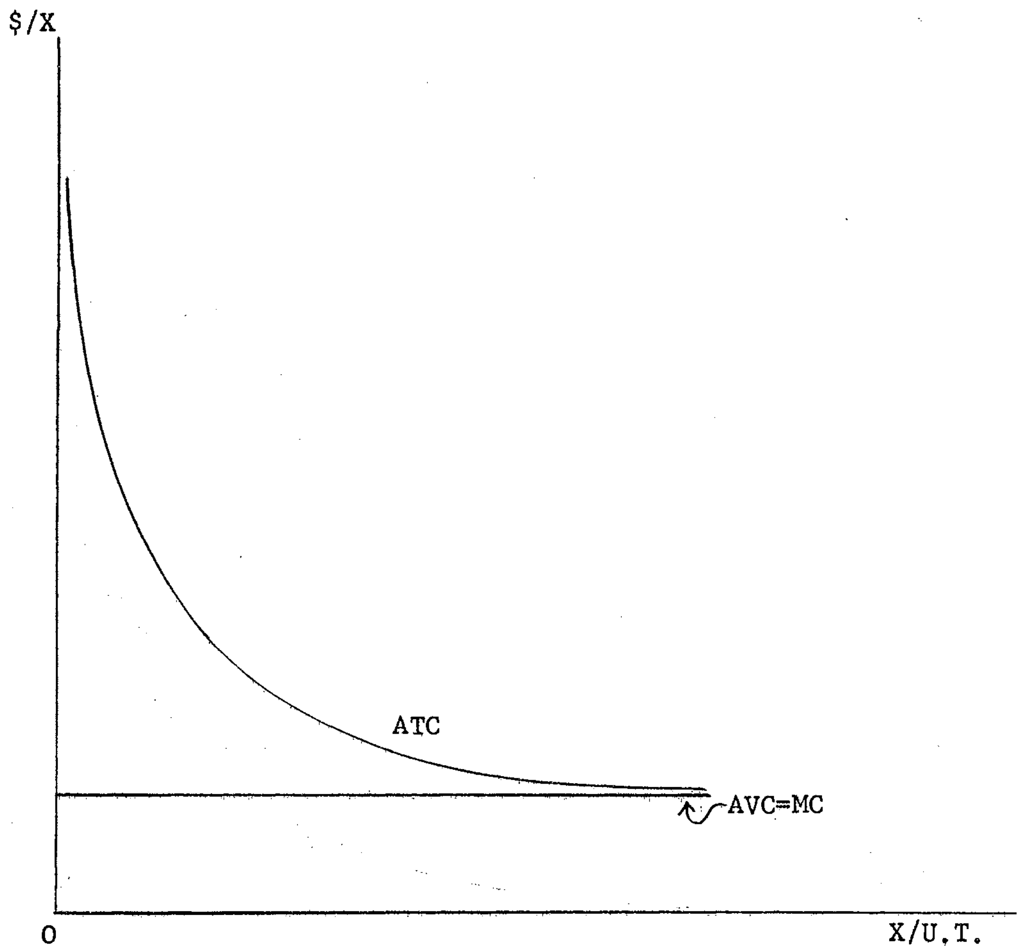

Figure 6. Alternative Theoretical Short-Run Cost Curves.

[6] Johnston, p. 13.

Constant average variable costs and marginal costs are hypothesized in Figure 6. Consequently, average total costs approach equality with average variable costs and marginal costs as output is increased. However, at extremely high levels of output the average variable cost curve could increase and cause the average total cost curve to turn up. Figure 6 is shown to demonstrate that over wide output ranges, average variable costs may remain constant.

A third possibility concerning the shape of the average variable cost curve is described by Bain.[7] In certain cases, as shown in Figure 7, the shape of this curve might reveal a decrease in costs, a relatively wide output range over which costs are constant, and finally a phase of increasing costs.

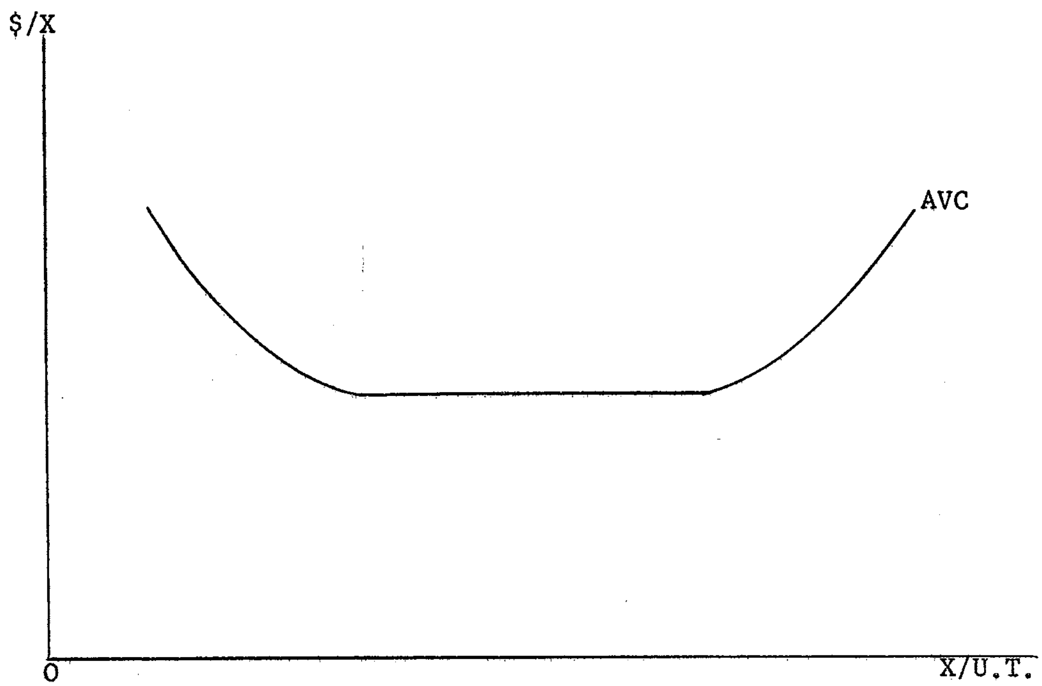

Figure 7. Theoretical Short-Run Average Variable Cost Curve.

---

[7]Joe S. Bain, Price Theory (New York, 1952), pp. 106-109.

One explanation for the shape of this curve is related to the technical character of the plant. Plants with designs and techniques that permit increasing amounts of flexibility in determining the ratio of variable to fixed factors will tend to have flater U-shaped variable cost curves than plants with less flexibility.

A second reason is the amount of divisibility possible within the plant. If the plant can be divided into several identical subdivisions, each subdivision capable of operating while some or all of the others are closed down, then the use of these additional subdivisions will result in the same proportion of variable to fixed factors while increasing the total amount of the variable factors that are employed.

Since average fixed costs always decline as output increases, the average total cost curve related to the average variable cost curve in Figure 7 will decrease over a wide range of volume increases. This range will be wider than would be the case if the average variable cost curve increased as soon as it reached its low point. Average fixed costs are assumed to be identical in both instances.

Examination of empirical cost curves in relation to the present study revealed average total cost curves similar to the one illustrated in Figure 6. Possibly, if the output range on these empirical curves were extended to include larger outputs, then the average total cost curve would rise somewhere beyond the point where average variable costs, as shown in Figure 7, increased from their plateau.

Alternative Scales of Plant

The scale of plant is a determinant of the level of costs at various outputs. Theoretically, as the scale is increased the minimum point on the average total cost curve for each successive scale is at a lower height up to a certain scale. In the usual textbook illustration one scale of plant has a minimum point lower than all others. Larger scales of plant have minimum points that lie at progressively higher average total cost levels. The above situations are shown in Figure 8 for three scales of plant. The long-run average cost curve, LAC, "shows the least possible cost per unit of producing various outputs when the firm has time to build any desired scale of plant."[8]

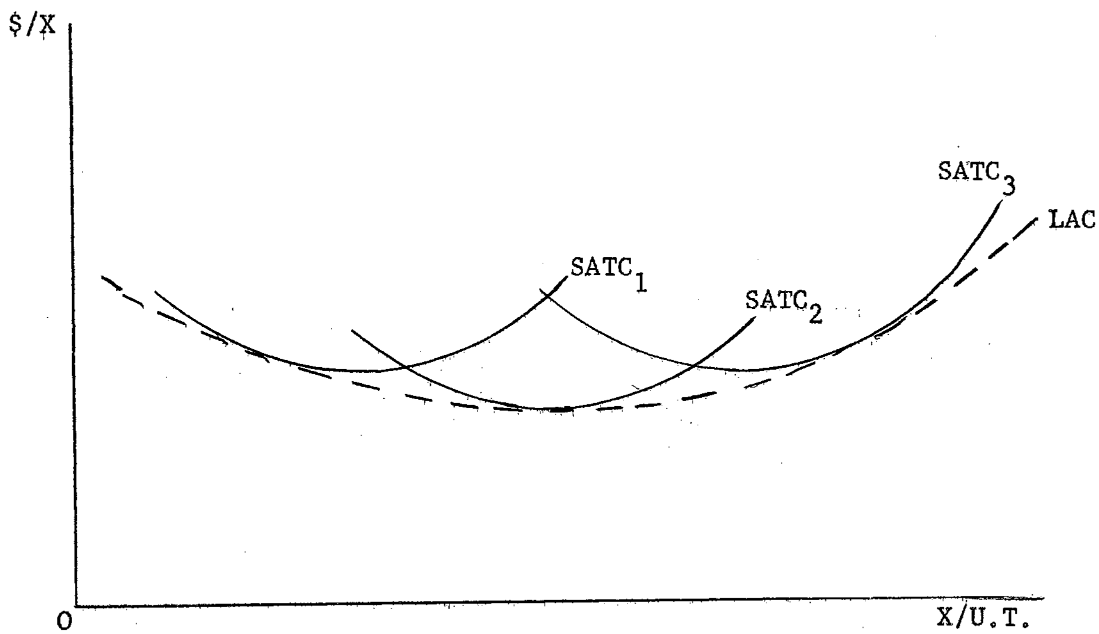

Figure 8. Theoretical Scales of Plant.

The shape of the long-run average cost curve is determined by internal economies and diseconomies of scale. The internal economies, which cause the long-run average cost curve to decline, include "(1) increasing

---

[8]Leftwich, p. 154.

possibilities of division and specialization of labor, and (2) increasing possibilities of using advanced technological developments and/or larger machines."[9] The internal diseconomies, which result in an increase in this curve as output and scale of plant are increased, "are generally based on a belief that eventually large bureaucratic organizations _must_ become inefficient."[10] The problem of coordination by management or "spreading itself too thin" can cause this inefficiency.

External economies and diseconomies of increasing production cause downward and upward shifts in the long-run average cost curve, respectively. Improvements in the quality of the resources furnished and greater efficiencies in the resource-furnishing industries result in external economies or decreasing costs. Increases in the demand for resources used in production result in external diseconomies or increasing costs.[11]

The shape of the long-run average cost curve in Figure 8 depicts the one usually illustrated initially in a theoretical cost discussion. However, recognition is given that the curve can have a horizontal segment before diseconomies of scale begin.[12] The implications of the exact shape of the long-run average cost curve and its related scales of plant to the objective of the firm are discussed shortly. First, a

---

[9] Ibid., p. 156.

[10] Herbert H. Liebhafsky, _The Nature of Price Theory_ (Homewood, Illinois, 1963), p. 175.

[11] Leftwich, pp. 186-193.

[12] See for example, Leftwich, p. 158; Joe S. Bain, _Industrial Organization_ (New York, 1959), pp. 152-155; and John F. Due and Robert W. Clower, _Intermediate Economic Analysis_ (4th ed., Homewood, Illinois, 1961), p. 171.

brief description of revenue functions, primarily in the realm of country grain elevator operations, is presented.

Revenue Concepts

Consultation with agricultural specialists indicated that individual country elevator managers charged a uniform grain handling rate for alternative volumes. However, uniformity may disappear when comparisons are made between managers. In either case the average revenue function from handling was assumed to be horizontal for any given elevator.

A constant average revenue function results in a three-way equality between average revenue, marginal revenue, and price. Under these conditions total revenue is linear. The above relationships between the revenue functions depict an atmosphere of pure competition for an individual firm. Revenue curves under this situation are illustrated in Figure 9.

Theoretical Output Positions Under Alternative Objectives

Firms comprising an industry have various objectives regarding their financial operation. These objectives could vary over time.

Specifically, the maximization of profits might not always be the paramount objective of the firm. Profits are defined here to be the difference between total revenue and total costs. Alternative objectives could include the minimization of costs or the maximization of gross revenues. In an oligopolistic situation, Baumol asserts that dollar sales maximization subject to a minimum profit constraint is the typical objective in both the long run and the short run.[13] If this assertion is extended to the more purely competitive setting surrounding cost and revenue operations in the short run, then possibly above a minimum profit level total revenue may be the basic factor of concern to the firm.

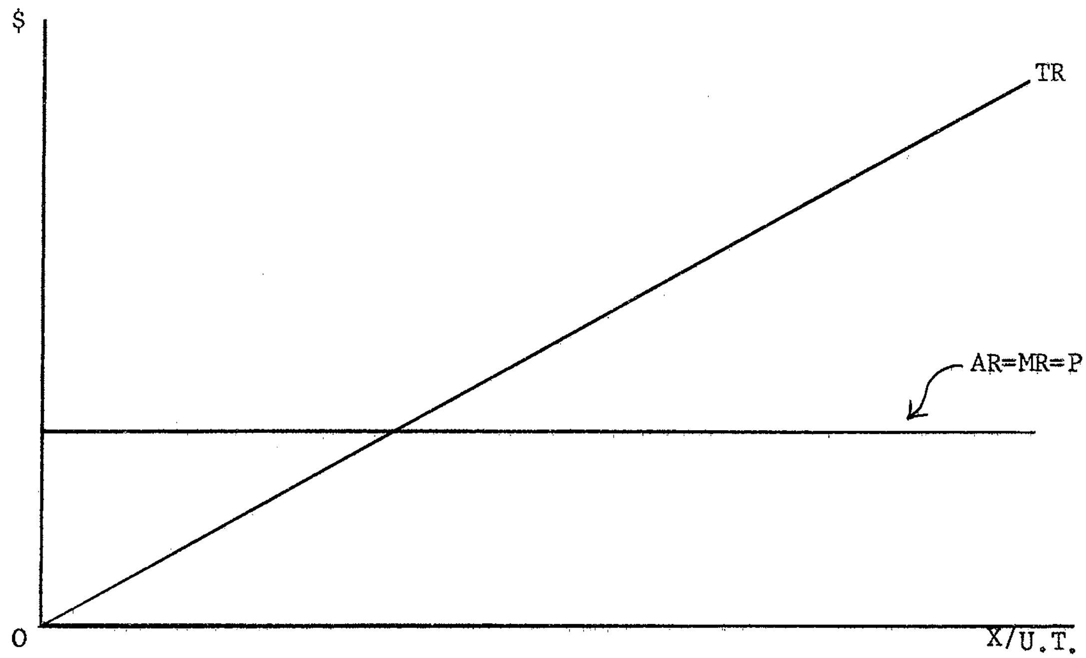

Figure 9. Theoretical Revenue Curves Under Pure Competition.

These considerations demonstrate a few of the potential objectives of the firm in its financial operation. The usual profit-maximizing motive of economic theory might not depict reality in many instances.

While a long-run time span was not under analysis here, each scale of plant considered will have a different relationship to the constant

---

[13]William J. Baumol, Business Behavior, Value and Growth (New York, 1959), pp. 45-53.

average revenue curve. For example, assume that a horizontal average revenue function exists. At any given level of output, the short-run average cost curve for each scale of plant will show a different relationship with average revenue in comparison to all other scales of plant. Consequently, the degree to which any of the above objectives are achieved will depend upon the specific scale of plant and the level of output under consideration.

CHAPTER IV

REVIEW OF LITERATURE

Several research studies related to the determination of intra-plant costs and scale in firm operations have been made. In some instances, the method of analysis varied between these studies.

Research restricted to Kansas depicted costs of country elevator operations.[1] Basic data were compiled in 1951 and 1952. Thirty-seven cost items were budgeted for six capacity models. Each of these models was analyzed under two levels of sideline sales. For every cost component an allocation was made to each of three basic functions.

Under the assumption that management was above average, the objective of the Kansas study was:

> . . . to develop more spcific and dependable guides that management of a country elevator in the hard winter Wheat Belt could use to make a choice of the size of new elevator to build for their particular volume specifications and grain marketing operating environment.[2]

The elevator rated storage capacity models included: old 20,000 bushel; new 20,000 bushel; new 100,000 bushel, plus old 20,000 bushel; new 200,000 bushel, plus old 20,000 bushel; new 300,000 bushel, plus old 20,000 bushel; and new 600,000 bushel, plus old 20,000 bushel. Both the

---

[1]Thomas E. Hall, Walter K. Davis, and Howard L. Hall, New Local Elevators, Farmer Cooperative Service, U. S. Department of Agriculture, Service Report 12 (Washington, 1955).

[2]Ibid., p. 76.

old and new 20,000 bushel elevators were of wood-cribbed iron-clad design. The remaining elevators were of slip-form concrete construction. At the time of the Kansas study, the old elevator was assumed to be 25 to 30 years old. However, new and faster legs, loading out scales, and a truck lift had been added to the old elevator.

Sideline sales were restricted to $30,000 and $145,000 annual sales volume in each model. Costs were apportioned to the merchandising or handling function, the grain storage function, and the sideline function. The first function was considered the primary function while the latter two were denoted as secondary.

The initial budgeting procedure required a determination of the amount of each cost component at one level of grain merchandised or handled and of grain stored for the six capacity models. The level selected for the merchandising or handling function was 150,000 bushels for both the old and new 20,000 bushel elevators and two times the rated capacity for the other larger new elevators. Levels of storage utilization were 15,000 bushels for the 20,000 bushel elevators and 90 percent of rated capacity in each of the models for the new concrete elevators.

Fixed costs were treated as one component of total costs. However, variable costs were separated into four categories. Separation was made upon the bases described below.

The four categories of variable expenses were: personnel expenses, slow or sticky expenses, other variable expenses, and nonoperating statement expenses. Personnel expenses were placed in a separate category mainly because they accounted for a relatively large proportion of total costs. Slow or sticky expenses were those having a minimum, such as electric power costs, or those set by the elevator manager, such as advertising expense. Other variable expenses included expenses that varied more directly with volume changes. Finally, nonoperating statement expenses included costs that were not listed as expenses in elevator audits.

Variation in grain volume permitted determination of costs at levels other than the initial levels. Costs were determined for both the storage function and for the grain handling function at the two previously stated levels of sideline sales volume.

A maximum level of volume for the merchandising or handling function was predetermined for each model elevator capacity. Maximum annual merchandising or handling capacity was: 250,000 bushels for the 20,000 bushel elevator; 400,000 bushels for the 100,000 bushel elevator; 600,000 bushels for the 200,000 bushel elevator; 900,000 bushels for the 300,000 bushel elevator; and 1,500,000 bushels for the 600,000 bushel elevator. Likewise, maximum storage capacity was predetermined for each model. The maximum storage capacity used at any given time was 90 percent of rated capacity in the new concrete elevators and 15,000 bushels in the 20,000 bushel elevator models.

Average total costs for the grain merchandising and handling function at maximum volumes in each model ranged from a high of 5.08 cents per bushel in the new 20,000 bushel model to a low of 2.63 cents per bushel in the model composed of the new 600,000 bushel and old 20,000 bushel elevators. The four categories of variable costs, when combined into an aggregate average variable cost figure, monotonically decreased in most instances as volume increased for any given elevator model. However, at identical merchandising or handling volumes a comparison of these combined expenses showed maximum differences in average variable costs between any two models of only 0.3 and 0.1 cents per bushel when volume merchandised or handled was under 400,000 bushels and 400,000 bushels or more, respectively. In contrast, at identical volumes the respective maximum differences in average total costs between models for volumes under 400,000 bushels and 400,000 bushels or more were 6.97 and 1.52 cents per bushel. Consequently, differences in average total costs between models at the same volume of grain merchandised or handled were accounted for almost wholly by fixed costs, i.e., size of plant and equipment. Annual sideline volume was $145,000 for the above comparisons.

For the storage function the inter-model differences between average variable costs for the four combined variable cost categories at identical storage volumes never exceeded 0.13 cents per bushel when maximum storage capacity used was greater than 15,000 bushels. At 15,000 bushels of utilized storage capacity the maximum inter-model cost difference was 1.53 cents per bushel. Average total storage costs at identical storage volumes differed between models by maximum amounts equal to 11.88 and 2.90 cents per bushel when maximum storage capacity used was greater than 15,000 bushels and 15,000 bushels only, respectively. Average total costs of the storage function when maximum storage capacity was used were highest, 11.44 cents per bushel, for the new 20,000 bushel elevator model and lowest, 5.14 cents per bushel, for the model composed of the new 600,000 bushel and old 20,000 bushel elevators. Sideline volume did not affect storage costs.

Since the combined variable cost categories changed negligibly between models at identical handling or storage volumes, the authors noted that the inter-model differences in fixed cost per bushel would nearly equal the difference in average total costs. This equality would be especially valid at volume levels greater than a single turn-over of the largest elevator under analysis. Therefore, if management was contemplating construction of an elevator, then per bushel cost differentials between elevators of various sizes could be determined with only a knowledge of fixed cost estimates.

A regional study similar in method to the one above was conducted to describe country elevator merchandising and storage costs for grains in the Corn Belt.[3] Costs were budgeted for facilities ranging in storage capacity from 30,000 bushels to 400,000 bushels. The old elevator model was similar in design and age to the old elevator model described in the Kansas study. Primary grains handled or stored by Corn Belt elevators were soybeans and corn. Sideline sales volume was $100,000 in all of the models.

Costs for Corn Belt elevators were budgeted over a volume range of 100,000 to 1,200,000 bushels for the grain merchandising and handling function. The highest average total costs, 17.76 cents per bushel, were incurred by the model composed of the old 30,000 bushel wood and new 100,000 bushel concrete elevators at a volume merchandised and handled equal to 100,000 bushels. The model composed of the old 30,000 bushel

---

[3]Stanley K. Thurston and R. J. Mutti, Cost-Volume Relationships for New Country Elevators in the Corn Belt, Farmer Cooperative Service, U. S. Department of Agriculture, Service Report 32 (Washington, 1957).

wood elevator and four 25,000 bushel concrete tanks had the lowest average total costs, 3.17 cents per bushel, when volume merchandised and handled was 1,200,000 bushels.

Average total storage costs when budgeted over a volume range of 15,000 to 360,000 bushels stored were highest at 15,000 bushels stored in the model composed of the old 30,000 bushel wood and new 60,000 bushel concrete elevators. These costs were lowest at 360,000 bushels stored in the model composed of the old 30,000 bushel wood and new 400,000 bushel concrete elevators. Total per bushel costs for the two models at the indicated volumes were 25.33 cents and 6.25 cents, respectively.

At identical volumes, for both the merchandising and handling function and the storage function the variable costs per bushel differed negligibly between the models. However, at identical volumes a large difference existed between the models with respect to average fixed cost comparisons. Consequently, inter-model differences in average total costs at identical volumes were primarily due to differences in average fixed costs.

Recently, a study of elevator merchandising and storage costs was made for firms located in the Spring Wheat Belt.[4] Individual units analyzed varied in capacity from a low of 40,000 bushels to a high of 110,000 bushels. As would be expected, the majority of the grain merchandised or stored was wheat. Inter-model differences in fixed and

---

[4]Francis P. Yager, Country Elevators--Cost-Volume Relations in the Spring Wheat Belt, Farmer Cooperative Service, U. S. Department of Agriculture, Service Report 63 (Washington, 1963).

variable costs at identical merchandising and storage volumes were not emphasized. Sideline sales volume was approximately $30,000 in all of the models.

The volume of grain merchandised ranged from 125,000 bushels to 1,191,000 bushels. The model with the highest average total merchandising costs was a 40,000 bushel wood main house and two 30,000 bushel wood units. Storage volume was 55,000 bushels. The volume merchandised and the corresponding merchandising costs were 145,000 bushels and 15.41 cents per bushel, respectively. Lowest merchandising costs were incurred by a model composed of the following facilities: 110,000 bushel concrete main house; 100,000 bushel wood elevator; 40,000 bushel wood elevator; 30,000 bushel wood elevator; and ten 10,000 bushel steel tanks. Storage volume was 285,000 bushels. The merchandising costs were 4.27 cents per bushel and the volume merchandised was 1,115,000 bushels.

Storage volumes analyzed ranged from 55,000 bushels to 285,000 bushels. Highest storage costs were incurred by a model composed of a 40,000 bushel wood main house and two 30,000 bushel wood units. The volume merchandised was 125,000 bushels while the volume stored and the storage costs were 75,000 bushels and 18.91 cents per bushel, respectively. Lowest storage costs were also achieved from this same model. These lowest costs occurred at a merchandising volume of 414,750 bushels and a storage volume of 85,250 bushels. Per bushel storage expenses were 9.21 cents.

A study designed to estimate cost functions for feed mills was conducted in the mid-1950's.[5] Emphasis was upon the production and overhead costs of the operation. The costs of feed ingredients and other raw materials were not considered. Consequently, only the actual costs of mixing feed were analyzed.

Short-run and long-run cost functions were estimated in the feed mill study. The inclusion of a capacity variable in the determination of the cost functions was employed for both time periods. Least squares regression analysis was applied to annual cost, volume, and capacity data from 29 feed mixing plants. The models included:

(1) $$Y = b_1X_1^{.5} + b_2X_2$$

(2) $$Y = b_1X_1^{.7} + b_2X_2$$

(3) $$Y = b_1X_1^{.8} + b_2X_2$$

(4) $$Y = b_1X_1^{.9} + b_2X_2$$

where:

Y = total annual feed mixing cost

X_1= annual volume of feed mixed

X_2= unused mixing capacity on an annual basis.

Equations (1) and (2) were eliminated after being fitted to the data due to a lower R^2 than in equations (3) and (4). When fitted to the data, equation (3) resulted in the regression equation $Y = 70.04X_1^{.8} + 0.301X_2$ and an R^2 of 0.979 while equation (4) resulted in the regression equation $Y = 22.702X_1^{.9} + 0.30X_2$ and an R^2 equal to 0.986.

---

[5]Richard Phillips, "Empirical Estimates of Cost Functions for Mixed Feed Mills in the Midwest," Agricultural Economics Research, VIII (1956), pp. 1-8.

The variables included in the equations demonstrate one approach in the determination of long-run and short-run average cost curves. The former curves can be obtained by letting X_2 equal zero in each equation, solving for a series of total costs at alternative volumes of feed mixed, and dividing the result for each volume by the mixing volume. Solution of the latter curves for several capacities is achieved by calculating the decrease in Y resulting from a given decrease in X_1 in conjunction with the corresponding increase in X_2 and dividing the result by the remaining value of X_1 in each case.

The basic reason for including a capacity variable was as follows:

> A simple regression of cost on output does not provide an appropriate estimate of the long-run total and average cost functions when the plants studied operate at various points on their short-run average cost functions. When actual plant capacity can be measured realistically, the introduction of a capacity variable into the model provides one means of adjusting for variations in short-run output.[6]

A cogent appraisal of the feed mill study sounds a note of caution in fitting cost functions from cross-section data.[7] The primary conclusion of this appraisal is that a priori reasoning should be utilized to a high degree in selecting the form of the equation. Furthermore, high correlation coefficients and significant regression coefficients resulting from several equation models obtained subsequently to the a priori selection of the equation forms emphasize the extreme care necessary if the researcher is to achieve results that realistically

---

[6]Ibid., p. 8.

[7]J. F. Stollsteimer, R. G. Bressler, and J. N. Boles, "Cost Functions from Cross-Section Data--Fact or Fantasy?" Agricultural Economics Research, XIII (1961), pp. 79-88.

describe the data. The authors suggest that plotting the observations is one technique that will give the researcher a "feeling" for his data.

Research conducted at Oklahoma State University in 1958 was designed to construct cost curves for grain merchandised at country elevator points.[8] Long-run and short-run cost functions were determined in this study.

A synthetic approach was used to calculate the amount of cost for 18 cost components. The sources of information for these costs included contractor estimates, audits, and previous research studies.

Elevator bin capacities budgeted were 20,000; 50,000; 100,000; 200,000; and 300,000 bushels. Farmers were assumed to harvest two-ninths of the wheat crop during the peak day of harvest. Transportation facilities for moving wheat from the country elevator to the terminal market were assumed to be available within one day of the time needed.

The two assumptions described above permitted establishment of the size of harvest which could be moved through the five elevator bin capacities. Consequently, the elevator merchandising capacities required to handle the harvests were 90,000; 225,000; 450,000; 900,000; and 1,350,000 bushels. These five merchandising capacities and their respective total synthesized costs were assumed to represent five points on a long-run total cost function.

Least squares regression analysis was used in fitting three forms of statistical functions to the five points in order to derive a

---

[8] T. P. Crigler, "A Method of Economic Analysis for Decision Making by Cooperative Elevator Associations" (unpub. Ph.D. dissertation, Oklahoma State University, 1958).

long-run total cost function. A linear, second degree polynomial, and logarithmic function were the statistical models examined. A low R^2 and lack of compatibility with theory caused rejection of the first and third forms, respectively. The second degree polynomial resulted in the following total cost regression equation:

$$TC = \$12{,}000. + .03722X - .0000000108X^2 \qquad R^2 = .990191$$

where:

X = bushels of wheat merchandised.

Therefore, the long-run average cost and long-run marginal cost functions were, respectively:

$$AC = \frac{\$12{,}000.}{X} + .03722 - .0000000108X$$

$$MC = .03722 - .0000000216X$$

In each instance, insertion of varying amounts of wheat merchandised into the above average cost equation gives the long-run average cost and minimum short-run average cost of merchandising that specific quantity of wheat. The minimum point is also the terminal point on the short-run average cost curve for the scale of plant which should be constructed to merchandise that amount of wheat.

Short-run average costs for each scale of plant were calculated for various quantities that were less than the quantity represented at the terminal point on each short-run average cost curve. Inspection of the cost budgets led to the conclusion that:

> . . . the variable costs made up such a small portion of the total cost that, for practical purposes, they were negligible. As a result, the short-run total cost function is constant over the relative range. The short-run average cost curves generated by constant total-cost functions are rectangular hyperbolas.[9]

---

[9] Ibid., p. 48.

Therefore, once a total cost had been computed for a specific quantity of wheat merchandised, the division of this total cost figure by various lesser quantities of wheat merchandised would give a series of points on a short-run average cost curve. Since the short-run total costs were assumed constant, the short-run marginal costs were zero.

CHAPTER V

METHOD OF ANALYSIS

The objective of the determination of wheat handling costs incurred by different capacities of all-grain country elevators at various grain volume levels can be achieved by several methods.

Alternative Approaches

One method of approach would have included the computation of wheat handling costs for various volumes for elevators of given capacities. Such a procedure would be applied to as many different capacity levels as desired. The result would be a schedule of handling costs for a series of elevators of varying capacities.

Costs incurred by an elevator operating at a given volume level with a specific scale of plant might or might not have been included in this schedule. Consequently, such a schedule would have been of only limited usefulness to country elevator operators throughout the wheat-producing region of Oklahoma.

A second method would be a freehand-smoothing approach. When this method is employed the cost data are plotted on graph paper and a continuous curve is drawn through the plotted points by visual inspection "in such a way as to pass approximately through the center of the observations all along its course."[1]

Use of the freehand curve might give a satisfactory description of the relation when the original observations closely indicated the nature of the relation between the variables. However, if the observations were widely scattered and the relationship was not so obvious, then the freehand curve could vary between different researchers. Prior to the drawing of a freehand curve, there should be certain logical limitations placed upon the shape of the curve. These limitations would be based upon the relationship under analysis.[2]

A third method to describe the relationship between variables would be through the use of a mathematical equation. Curves fitted to data by the equation method have an advantage over the freehand approach when a logical basis exists for expecting a specific relation to occur between the variables.[3] The use of mathematical equations was the approach employed in this study. In the following section the reasons for using this approach are presented.

Approach Used

In the data under analysis, a relationship typifying a theoretical short-run average total cost curve was expected. This expected relationship would be a decreasing function of the volume of wheat handled.

---

[1]Mordecai Ezekiel and Karl A. Fox, Methods of Correlation and Regression Analysis (3rd ed., New York, 1959), p. 104.

[2]Ibid., pp. 104 and 107.

[3]Ibid., p. 109.

Theoretically, the function would be expected to decrease at a decreasing rate, to reach a minimum, and then to increase with higher volume levels due to a decline in the efficiency of certain variable resources, notably labor.

However, the objective of this study was not to depict a maximum level of handling volume, where "maximum" could denote either maximum efficiency or a maximum level of total physical output in the sense of the total volume of wheat handled. Accordingly, the only necessary shape of the average total cost curve that was expected on an a priori basis was one that tended to decrease at a decreasing rate with increases in wheat volume levels. Whether the curve would or would not turn upward would depend upon the upward range on the volume variable. A visual inspection of the plotted data might serve to indicate whether the average total cost curve turned upward within the range of the observations.

Mathematical equations were fitted to the total cost data. These equations were based upon a visual inspection of the plotted data and upon the existence of a logical basis for expecting the shape of the resultant average total cost curve to appear similar to the one described above. The technique used and some of the qualifications that should be made when mathematical equations are fitted to data are presented in the following section.

Regression Technique Used

Least-squares regression analysis was the technique used in this study. The use of regression analyses in fitting a curve to a set of points has been utilized often in research studies in agricultural economics. What was the purpose of such analyses? An examination of this aspect of the regression approach indicated some of the ways the method could be used with validity.

Regression techniques between variables aid in estimating or predicting one of the variables.[4] The regression of the dependent variable upon the independent variable can be fitted to a linear or curvilinear relationship. Several independent variables can be studied to determine the degree of relationship between this group of variables and the dependent variable to be predicted.

As previously stated, a curvilinear relation was expected. Therefore, the form of the regression equation to be fitted to the total cost data was one that permitted curvilinearity in the resultant average cost curve. Total cost was regressed upon the bushels of wheat handled. These were the only two variables analyzed.

The paired observations on costs and wheat volume handled should satisfy certain requirements for testing short-run cost-output relationships. Johnston noted that in an ideal sense the paired observations should satisfy the following conditions:

> 1. The basic time period for each pair of observations should be one in which the observed output was achieved by a uniform rate of production <u>within</u> the period. It would not be desirable, for example, to have 4 weeks as the basic time period if there were substantial weekly variations in the rate of production for the 4-week figures would then be averages which might obscure the true underlying cost curve.

---

[4] Paul G. Hoel, Introduction to Mathematical Statistics (2nd ed., New York, 1954), p. 125.

2. The observations on cost and output should be properly paired in the sense that the cost figure is directly associated with the output figure. This condition would not be satisfied, for example, if we paired accounting data for weekly periods where the wages paid in any given week were, in fact, based on the number of hours worked in the previous week.

3. We should also like a wide spread of output observations so that cost behavior could be observed at widely differing rates of output. This result could be achieved by having a very large number of experimental firms, all of the same fixed capacity, and instructing each to produce at a certain rate, these arbitrary rates being chosen to give the desired range of output levels. Or we might have a small number of experimental firms, all of the same fixed capacity, and vary the rate of output over various periods of time. In both cases it would be necessary for the observations on any given rate of output to relate only to periods when the firm was fully adjusted to producing at that rate and doing so with maximum efficiency within the assumed capacity constraint.

4. It would also be necessary to keep the experimental data uncontaminated by the influence of factors extraneous to the cost-output relationship itself. For example, we should not wish to record cost observations which were influenced by variations in the prices paid by the firm(s) for factors of production such as labor, raw materials, etc. Secondly, we should not want different observations to relate to different environments of technical knowledge and expertise; instead, we should require that each firm in each period should have at its disposal the <u>same</u> stock of technical knowledge.[5]

It should be emphasized that these requirements were ideal and did not necessarily depict reality. In this cost analysis, as is shown later, these ideal requirements were not satisfied in their entirety.

Johnston recognized that data extracted from the real world fall short of fulfilling one or more of the four conditions listed above.[6] For example, if a cross-sectional study were made, very few firms would be found with a specific capacity limit. Consequently, if a series of

---

[5]Johnston, pp. 26-27.

[6]Ibid., pp. 28-29.

output observations for several fixed capacities were obtained, then given firms would need to be studied over successive time periods during which their capacities remained the same. However, the capacity of these firms could have changed over time.

Also, in the event that published cost information existed, the information could have been for time periods that were undesirably long for a uniform rate of production to have occurred. Even internal accounting data could have been too long to obtain a uniform rate.

Extrapolation of the data outside the observed range of paired observations on cost and volume would be desirable if the extrapolations described the new situation realistically. Since no actual observations existed within the extrapolated sections of the data, there would be no certainty that these observations would have depicted the expected reality.

Regarding extrapolation, Ezekiel and Fox stated:

> A rough rule-of-thumb has been given that estimates beyond the observed range should never be made, or, if they must be made, should be regarded as exceptionally hazardous.
> . . . .
> Extrapolation of the regression equation or curves beyond that range . . . represents an extension into unknown fields where sudden changes in the nature of the relations might conceivably occur. A priori knowledge of the relations, based on technical facts and theories, or on other evidence, may justify extrapolations of the curves.[7]

In this study an extrapolation of the data was not made. The primary reason for not extrapolating the data was the existence of uncertainty with respect to the amount of the labor cost component. Since labor costs were the largest item of expense, the effects of this component

---

[7]Ezekiel and Fox, pp. 322-323.

upon average total costs should not be underemphasized. Furthermore, certain other costs were derived from the labor bill. These costs included: workmen's compensation insurance and comprehensive general liability insurance, fidelity bond expense, and social security tax.

The expected levels of labor costs, both permanent and seasonal, and the costs derived from these labor expenses were not known. Therefore, an extrapolation of the costs beyond the range of the volume observations on wheat handled was not made. Such an extrapolation would not have added any reliable knowledge to the cost-volume relationships.

Classification of the Firms

Several alternative types of firm classifications could have been made. Each type could be used with a specific purpose in mind.

First, firms could have been classified upon the basis of the number of plants under one ownership. Single units versus multiple units would be one type of ownership classification. Multiple-unit firms, in contrast to single-unit firms, operate plants at several geographical locations. This method of classification was used in a 1954 cost study of cooperative elevators.[8]

A second method of firm classification could have been based upon the form of ownership. In the elevator industry a logical separation of this type would have been into private firms and cooperative firms.

---

[8]Adlowe L. Larson and Howard S. Whitney, Relative Efficiencies of Single-Unit and Multiple-Unit Cooperative Elevator Organizations, Oklahoma Agricultural Experiment Station Bul. B-426 (Stillwater, 1954).

A third method could have involved separating the firms into various levels of dollar sales volume. Sales in this case could have included revenue from merchandising or handling grain, from storing grain, and from sideline activities.

A fourth method of classification could have been based upon the rated storage capacity of the firms. This method was the one used in this study. Single-unit country grain elevators were selected and divided into rated storage capacity groupings. The handling function was the function under analysis. Therefore, the classification by storage capacity did not include sideline sales.

Several reasons existed for utilizing the above approach in this study. First, the objective of determining the handling costs for all-grain elevators of alternative capacities necessitated a classification of firms by capacity.

Second, since dollar sales volume of sideline activities fluctuated widely between firms in the real world, no specific level of sideline sales volume depicted the majority of the elevators. Consequently, sideline activities were discussed from the viewpoint of adding flexibility to an elevator that was initially handling grain only.

Third, the inclusion of multiple-unit firms in the analysis would have required a detailed study of several models. Each model would have included a different number of firms under a single ownership or management. An inspection was made of the audits for 59 cooperative elevator organizations that had handled a part of the 1962 Oklahoma wheat crop. Only 17 of these associations had a multiple-unit structure.

Consequently, a decision was made to exclude multiple-unit models. Cost studies for these models could be conducted in a separate report.

The elevator cost components in this study were based upon expenses incurred by cooperative firms. Access to previous research data on cooperatives and a willingness by cooperative managers to discuss the cost aspects of their operation were the basic reasons for using cost data from cooperative elevator operations. However, practically all of the cost components were applicable to firms operated under a private ownership structure.

Budgeting of the Data

Phillips recognized two techniques for determining cost-volume relationships. He stated:

> The problem of determining reliable cost functions may be approached either (1) by budgeting from relevant production and price data or (2) by observing cost and volume data from a representative sample of operating firms.[9]

One criticism of the former method would be the frequently large and expensive research cost involved in synthesizing the data. The latter approach often would have the advantage of using readily available cross-sectional data.[10]

Despite the above criticism of the budget approach, a budgeting of the majority of the cost components was carried out in the present analysis. The reasons for this procedure are described below.

---

[9] Phillips, p. 1.

[10] Stollsteimer, Bressler, and Boles, p. 79.

First, the fact that practically all country grain elevators in Oklahoma incurred expenses from a sideline function in addition to the grain functions would render a cross-sectional cost analysis of elevators nearly meaningless. Each firm would have to have been analyzed in detail through individual interviews with the managers and through observations of the workers in order to isolate the costs that were applicable only to the grain-handling function.

Second, many cost constituents, as discussed in detail later, could be budgeted without large research costs. Research costs of personal interviews were lower than research costs of lengthy time and motion studies. Interviews with elevator managers and agricultural specialists were used to obtain many of the cost components in this study.

Third, cross-sectional data from audits depicted elevators with many types of design. For example, some firms had flat storage facilities in addition to concrete tanks while other firms had only concrete tanks. Consequently, if cross-sectional data had been used, then an individual firm analysis would have been required in order to isolate the grain-handling costs attributable to each model design.

CHAPTER VI

APPLICATION OF THE METHOD

The selection of the elevator models, the calculation of the costs incurred by country elevators in handling grain, and the subsequent fitting of equations to these costs constitute the main part of this chapter. Some potential revenue functions are also discussed. The cost and revenue functions are then related to each other.

General Description of the Model Facilities Budgeted

The ten models and their initial costs for construction and auxiliary equipment were obtained from contractor estimates. The elevators were deemed by the contractor to be typical country elevators in an area bounded roughly by the Rocky Mountains, Missouri River, Mexico, and Canada. Construction costs of the models were exclusive of any areas where union labor would have been a factor.

Each elevator was a vertical concrete type. Standard equipment on most elevators included an overhead electric trucklift, an elevator leg, an electric manlift, a dust fan, an automatic shipping scale, a remotely controlled electric distributor, and a load-out spout. A belt conveyor was added to elevators with a storage capacity of 300,000 bushels or more. Elevators with a storage capacity of 500,000 bushels or higher had a semi-truck dumper and a power shovel. A truck scale and an office were standard equipment on all models. A detailed description of the facilities for each of the ten models is presented in Appendix A.

Relative Importance of Selected Costs

A first approximation of the costs important in country elevator operations was obtained by an examination of the annual audits of cooperative grain elevators. Emphasis is made at this point that such an examination gave only a rough estimation of the importance of these costs, especially since the grain handling function was the primary one under consideration in this study. Costs shown in audit statements were not allocated to the various operating functions. Table VII shows the relative importance of these costs. The data in this table represented the average amounts for 59 cooperative elevators.

Two criteria were used in selecting the audits from which the costs in Table VII were assembled. First, only firms that had an audit on file in the Department of Agricultural Economics covering the 1962 wheat crop were considered. The fiscal year of the firm had to include the period May 2, 1962 to June 29, 1962 to meet the first criterion. Second, the audit had to have a Statement of Wheat Account in order to be chosen. This criterion eliminated cooperative cotton gins, feed associations, lumber cooperatives, and other types of associations that did not have an elevator.

The 59 cooperatives ranged in rated storage capacity from 95,000 to 1,700,000 bushels. All of the firms, with the exception of one, were located in the western half of Oklahoma. Sideline sales volumes fluctuated from a low of $11,000 to a high of $907,000.

TABLE VII

ANNUAL EXPENSE COMPONENTS IN DOLLARS AND AS A PERCENTAGE OF TOTAL EXPENSE, AVERAGE OF 59 COOPERATIVE ELEVATORS: OKLAHOMA, 1962 WHEAT CROP

Expense	Amount		Percentage of Total Expense	
	-Dollars-			
Salaries and Wages				
Manager's Salary	7,335		7.15	
Other Salaries and Wages	38,647	45,982	37.67	44.82
Depreciation		17,765		17.32
Insurance and Bonds		4,724		4.60
Interest		4,785		4.66
Taxes		8,094		7.89
Utilities		3,841		3.74
Telephone and Telegraph		781		.76
Repairs		2,906		2.83
Supplies		2,192		2.14
Advertising		1,330		1.30
Truck Expense		2,552		2.49
Administrative and Selling Expense				
Directors' Fees	437		.43	
Audit Expense	471		.46	
Donations	244		.24	
Dues and Subscriptions	362		.35	
Lease and Rentals	330		.32	
Annual Meeting and Travel	478		.47	
Scale Inspection	280		.27	
General Expense[a]	4,356	6,958	4.25	6.79
Employee Insurance		687		.67
Total		102,597		100.00

[a]Includes postage, yard improvement, fumigant, box rent, educational expense, bank charges, inventory fees, storage expense, uniform expense, freight, burglar alarm service, sedimentation test, rodent extermination, hauling expense, stock show premiums, flowers, shop expense, wheat expense, mill expense, station expense, cleaning and treating expense, fertilizer expense, seed analysis, produce expense, tonnage fees, [illegible], [illegible], elevator expense, retirement expense, collection expense, fuel expense, maintenance contracts, propane, appliance and hardware store expense, inspection and handling, wheat samplers' expense, alfalfa seed expense, service contract, farm supply expense, grinding expense, tractor expense, equipment maintenance, heating, harvest expense, sacks, gas, oil, kerosene, feed tags, elevator inspection, building permit, coopering cars, inspection and service, gasoline plant expense, warehouse expense, demurrage, patronage and sales analysis, soil samples, and filing fee.

Source: Annual audits of 59 cooperative associations.

The expense groupings in Table VII were extracted for the most part from previous research findings, but were not identical with them.[1] A certain amount of subjectivity was involved in deciding upon the expense groupings to be made. The primary basis upon which the cost groupings in Table VII were made was the amount of consistency with which the expenses appeared in the audits. Expenses that did not appear regularly in the audits were included in the category of general expense. The other expenses in Table VII appeared in practically all of the Detail of Expenses statements in each audit.

A superficial inspection of Table VII reveals that salaries and wages and depreciation are the two largest cost components. These two items account for a combined total of over 62 percent of aggregate expenses. Taxes and general expense are the biggest expense items in the remaining group of 18 expense components. No other expenses account for over five percent of the total. The largest of these minor expenses are interest, insurance and bonds, and utilities.

The seven cost items mentioned above accounted for nearly 90 percent of total costs. The remaining 10 percent were distributed between 13 other expense items. Directors' fees and the annual meeting component of annual meeting and travel expense were not incurred by firms operated under private ownership.

---

[1] Larson and Whitney, p. 7.

Cost Components Included in the Analysis

An examination of Table VII in conjunction with several published research studies resulted in a compilation of costs for 16 cost components.[2] These components were selected upon two bases.

First, the cost component must have been relevant to the grain handling function. If the cost was incurred solely because of the existence of a grain storage function or a sideline function, then the expense was not included in the empirical cost budgets.

Second, the amount of the cost must have been a realistic representation of the specific cost component. As discussed in detail later, the estimation of certain components was not deemed feasible because of difficulties in the determination of annual cost figures that would have been useful to elevator operators. These components varied to such a high degree between areas and firms that their inclusion in cost budgets would have had little value for any specific elevator manager or owner.

---

[2] These published studies have been discussed in Chapter IV. Most of the cost components were extracted from the research by Crigler and by Hall, Davis, and Hall. The cost constituents used by Yager and by Thurston and Mutti were similar to those listed in the first two studies.

Each cost component used in the current study and the method of cost calculation are described below.[3] The annual cost budgets for the ten models are presented in Appendix B.

Depreciation of Elevator and Machinery

A straight-line method of depreciation was used. Elevator and machinery costs were grouped together. These two items of equipment were assumed to have a 40-year life. Consequently, the depreciation rate was 2 1/2 percent per year. A zero salvage value was assumed. The annual cost was computed by applying this rate to the contractor estimates of the purchase price of the elevator and machinery.

Depreciation of Office and Scales

Again, a straight-line depreciation method was used. A 20-year life with no salvage value was assumed to exist for the office and scales. The resulting five percent rate of depreciation was applied to the purchase cost estimates that were furnished by the contractor.

---

[3] An accountant from a cooperative auditing service furnished information on the calculation of the following costs: depreciation of elevator, machinery, office, and scales; federal warehouse bond; railroad lease; social security tax; audit expense; annual meeting expense; directors' fees; and interest on capital. An insurance agent for cooperative elevators, who was also a recognized leader in the Oklahoma grain trade, supplied information on the calculation of the following costs: insurance on elevator, machinery, office, and scales; workmen's compensation insurance and comprehensive general liability insurance; federal warehouse bond; fidelity bond; and electric power expense. Additional sources of cost calculation are stated in the discussion of the individual cost components.

Insurance on Elevator and Machinery

Protection against loss on elevator and machinery from fire, explosion, windstorm, and hail was provided by this insurance. The amount of coverage was equal to 90 percent of the initial purchase price. Individual rates per $100 of coverage were $.072 for fire and explosion and $.014 for windstorm and hail. The combined rate of $.086 was applied to the amount of coverage.

Insurance on Office and Scales

The insurance rate was $.382 per $100 of coverage on fire, explosion, windstorm, and hail. Ninety percent of the initial purchase price was the amount of coverage on office and truck scales. The above rate was applied to the amount of coverage.

Workmen's Compensation Insurance and Comprehensive General Liability Insurance

Workmen's compensation insurance covered the employer's liability to the employees under the Oklahoma Workmen's Compensation Law from accidents or sickness arising out of their employment.

Comprehensive general liability insurance covered the employer's liability to the customers and the public from accidents involving bodily injury or property damage.

One-fourth of the employees were assumed to work in the office and three-fourths in the elevator. Under this assumption the insurance rate per $100 of payroll was $3.42.

Payroll expenses were obtained from questionnaires. Subsequently, payroll expenses were adjusted by a regression equation. Application of the rate to the adjusted payroll expense gave the budgeted annual insurance cost.

Federal Warehouse Bond

A federal warehouse bond, rather than a state warehouse bond, was included in each model since discussions with grain elevator specialists indicated the former type to predominate in Oklahoma. Rates per $1,000 of federal warehouse bond were as follows: $5 for first $10,000 of coverage; $2.50 for next $15,000 of coverage; and $1.25 for any coverage in excess of $25,000.

The amount of coverage was $.15 per bushel for the first 1,000,000 bushels of rated capacity; $.10 per bushel for the next 1,000,000 bushels of rated capacity; and $.05 per bushel for all amounts over 2,000,000 bushels of rated capacity. These rates were applied to the amount of coverage in order to compute the cost of the federal warehouse bond for each model.

Railroad Lease

The amount of this expense was constant each year so long as the amount of siding and land leased from the railroad remained the same. Also, the costs of the railroad lease would not vary widely between elevators. The amount of this cost component was fixed at $100 per year in every model.

Fidelity Bond

This bond covered the manager and the employees. Two types of fidelity bonds could be purchased. They were (1) individual schedule bond and (2) blanket position bond. The first type covered one or more named individuals while the second type covered all employees in one blanket coverage.

An average coverage of $15,000 was used in all of the models. The annual rate for the individual schedule bond was $4.50 per $1,000 of coverage per person. For $15,000 of coverage, the annual rate schedule for the blanket position bond is shown in Table VIII.

TABLE VIII

ANNUAL RATES FOR $15,000 OF BLANKET POSITION BOND COVERAGE WITH VARIOUS NUMBERS OF EMPLOYEES

Annual Rate -Dollars-	Number of Employees
151.30	5 or less
162.65	6
174.00	7
185.34	8
196.69	9
208.04	10

Source: Personal interview with an elevator insurance agent.

Calculation of fidelity bond costs revealed that if the firm had only one or two employees, then the individual schedule bond would cost the least amount. However, if there were three or more employees, then bond costs would be lower when the blanket position bond was purchased.

The number of permanent employees at various levels of grain volume handled was obtained from questionnaires. Subsequently, the appropriate bond rate schedule, either for the individual schedule bond or for the blanket position bond, was used to determine the amount of the fidelity bond costs.

Total Salary Expense

A personal interview was conducted with the individual managers of ten elevators located in eight counties in the wheat-producing area of Oklahoma. During the course of this interview, a five-page questionnaire was filled out. The questions in the questionnaire centered around the cost aspects of the individual elevators. Background information on the grain-handling function was obtained from the early sections. In the final section of the questionnaire, the manager was asked to estimate the total number of employees and the total salary at various wheat-handling volumes under the assumption that the only function of the elevator was to handle grain. This estimation was obtained in the manner described below.

From the annual audit the manager was reminded of the number of bushels of wheat that his firm handled for the fiscal year of his firm including the 1962 wheat crop. Subsequently, he was asked how many permanent employees he would hire at this level of wheat handled if he had only a grain-handling function. Simultaneously, the total labor cost, inclusive of permanent and seasonal labor, for this volume was obtained from the manager.

In the following questions each manager was told that all situations involving changes in the amount of wheat handled were assumed to be permanent. In this sense "permanent" denoted that the change was expected to last for several years. An effective government program designed to alter wheat supplies was assumed to be the primary initiating force. A further assumption throughout the interview was that the rated storage capacity of the elevator did not change.

Handling volumes above and below the 1962 level were then obtained. The manager was asked the alternative levels of bushels of wheat handled at which he would add or subtract one or more permanent employees. Following this response, he was asked how much these additions or subtractions would change his labor costs. Both seasonal and permanent labor cost changes were included in this last answer. The final result of the above information was a series of paired observations on total labor costs and wheat handling volumes for ten elevator capacities.

The results of these interviews led to the conclusion that total salary expense for a given elevator was not constant at alternative volume levels of wheat handled. In fact, over many of the volume ranges the labor expense more than doubled from the lowest handling volume to the highest handling volume.

A preliminary inspection of the aggregate total cost curve for each scale of plant led to the conclusion that total salary expenses did not display a realistic relationship between the ten scales of plant. Specifically, certain plants exhibited a higher amount of total costs than other plants at all of the volume levels observed even though these former plants had a lower rated storage capacity. Based upon the method of cost synthesis, such a relationship was not expected since the summation of all nonsalary expenses at a given level of handling volume increased as the scale of plant increased. Consequently, the salary data were adjusted in order to depict the expected relationship between total cost and volume for firms of different capacities. The following discussion relates how this adjustment was made.

A paired observation ot total salary expense and the number of bushels handled was taken from each of the ten elevator models. The selected observation in every case was the manager's estimate of the total salary expense for the quantity of wheat handled for the audit fiscal year encompassing the 1962 wheat crop. Since the other observations for each firm were above and below this selected observation, the use of the latter observation was believed to provide a comparable base from which to adjust the total salary expense. Figure 10 shows the locations of the selected cost-volume points. These points are represented by X's. The numbers beside the X's denote the rated storage capacity of the firm under observation in 100,000 bushel units.

A linear regression line was fitted to the data. This regression line of total salary expense on volume handled is also shown in Figure 10. Observations for only nine of the ten firms were used in computing the equation of the line. The 100,000 bushel capacity elevator was excluded because this firm was operating at a handling volume in excess of 2 1/3 times its capacity. None of the remaining nine firms were operating at a percentage level of capacity that was this large.

The equation for the regression line was

$$\hat{Y} = 24.324238 + \underset{(6.623)^{**}}{.022941X} \qquad R^2 = .862318$$

where:

$\hat{Y}$ = estimated total salary expense in hundreds of dollars;

X = volume of grain handled in hundreds of bushels.

The t ratio shown in parentheses was significant at the one percent level.

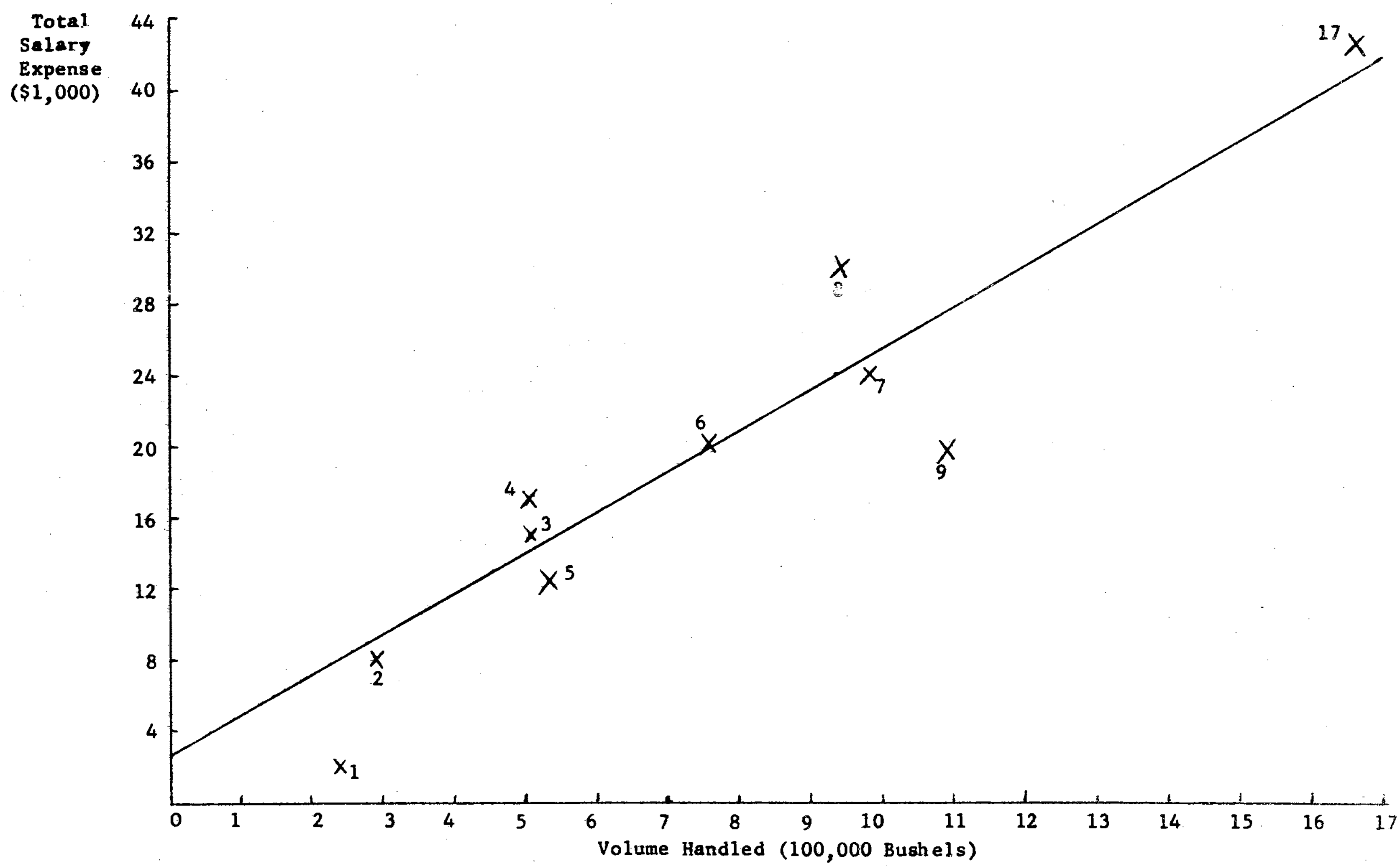

Figure 10. Regression of Total Salary Expense on Volume of Grain Handled.

The ten volume levels shown in Figure 10 were inserted into the regression equation to determine the adjusted total salary expense for each elevator.

In an effort to preserve the managers' estimates of the individual intra-firm salary expense relationships, the following procedure was used. The adjusted total salary expense and the volume of grain handled during the 1962 audit year were used as the base from which the total salary expenses at alternative volume levels were calculated. The managers' estimates of the total salary cost differentials from the unadjusted total salary expense at the alternative nonbase handling volumes were computed for each firm. These differentials were then added or subtracted from the adjusted total salary expense base in order to determine the amount of this expense at the alternative volume levels. Consequently, the relationship between total salary expenses at the alternative volume levels of grain handled was preserved for each firm.

The result of the adjustments was to shift the labor cost curves of the firms without changing the slope of these curves for a given volume level. The adjusted total cost curves are illustrated graphically in the section of this chapter entitled "Examination of Cost Functions."

Social Security Tax

Social Security regulations required the employer to pay a tax of 3 5/8 percent on the wages paid each employee up to $4,800 per employee. Additionally, the employer deducted 3 5/8 percent from the wages paid each employee up to $4,800 per employee. This amount also was paid as a Social Security tax.

Since total salary expense in this study is a gross figure before any tax deductions, the amount of the Social Security tax in the cost budgets is exclusive of the amount of the tax that would be deducted from the wages of the employees. The amount of this cost was computed by applying 3 5/8 percent to the adjusted total salary expense. This method of computation overestimates the level of Social Security taxes to some degree since some salaries would exceed $4,800. However, the manager was assumed to be the only employee whose wages were greater than $4,800. Consequently, the amount of this cost, when compared to the total of all of the cost components, was not large.

Audit Expense

The schedule of auditing charges shown in Table IX was used in this study.

TABLE IX

ANNUAL AUDIT FEE FOR COOPERATIVE GRAIN ELEVATORS OF VARIOUS RATED STORAGE CAPACITIES

Cost	Rated Storage Capacity
Dollars	-1,000 Bushels-
250[a]	100 through 300
350	301 through 600
450	601 through 900
500	1,700

[a]Minimum cost for an audit is $250.

Source: Personal interview with a member of an auditing firm.

Conversation with an employee of a privately owned grain elevator firm indicated that the audit expense of his firm was similar in amount to the cost listed above for cooperative firms. However, in some cases, firms under private ownership might not have an audit made. This point should be considered when comparing the audit expense for a cooperative elevator and a privately owned elevator.

Annual Meeting Expense

The cost of this item, including a dinner and door prizes, was estimated to be \$400 for all models. While the amount of this expense varied with individual elevators, \$400 was considered to be a representative figure for the ten models in the study.

Directors' Fees

An annual cost of \$300 was assumed for all models. This cost was for five directors at \$5 per director per meeting for 12 meetings.

Interest on Capital

The assumption was made that 100 percent of the amount of the purchase price of the elevator and machinery was borrowed at five percent interest. The average length of the borrowing time was assumed to be six years.

The average annual amount of this cost was computed by the following method:

(1) $$C_n = .05\left[p - \frac{1}{6}p(n-1)\right]$$

where

C_n = interest cost in year n

p = purchase price of elevator and machinery

n = year in which interest cost is being computed.

$$(2) \quad \frac{\sum_{n=1}^{6} C_n}{6} = \text{average annual interest cost.}$$

Formula 2 gives the cost figure used in the budgets for the interest on capital expense. The interest cost is reasonable for a firm built within the last few years. However, it would be about one-sixth higher than the interest charge on the average investment over the life of the investment at the five percent interest rate.

Electric Power Expense

The following information was used to compute annual electric power costs:

(1) Forty bushels were elevated per kilowatt-hour of electricity used.[4]

(2) Monthly power rates were: $1.00 total for first 14 KWH; 4.8 cents per KWH for the next 86 KWH; 3.8 cents per KWH for the next 400 KWH; 3.3 cents per KWH for the next 500 KWH; 2.4 cents per KWH for the next 500 KWH; and 2.2 cents per KWH for any amount above 1,500 KWH. The minimum monthly power bill was $1.00 plus 50 cents for each connected horsepower.[5] No demand charge was assumed.

Utilizing the above information, the annual electric power bill was computed as follows: Total annual bushels handled were divided by 12 to obtain average monthly bushels handled. This monthly average was divided

---

[4]This elevation rate was used by Hall, Davis, and Hall, p. 30. Elmer Daniel, Associate Professor of Agricultural Engineering, Oklahoma State University, stated that this was also an accurate rate for country grain elevator operations existing at the time of this study.

[5]These rates were Oklahoma Gas and Electric Company rates for Class C-3 towns. A discussion with a leader in the Oklahoma cooperative elevator industry led to the conclusion that these rates were representative of most cooperative elevators in the state since O. G. and E. served most Oklahoma cooperatives.

by 40 to derive average monthly KWH consumption. The power rate schedule was applied to this consumption to determine the average monthly power cost. Next, the minimum monthly power bill was computed. The connected horsepower for each model used in computing this minimum bill is shown in Appendix A. The largest cost, average monthly power cost or minimum monthly power cost, was multiplied by 12 to obtain the annual electric power expense.

Only one elevation was assumed in the above computations. Therefore, the computed power expense was the absolute minimum that would be expected. Even if more than one elevation had been assumed, there would not be a proportional increase in power costs because of the regressive monthly power rate schedule. A demonstration of the effects of the regressiveness in the rate schedule upon total power costs for hypothetical variations in the number of elevations appears in Appendix C.

Property Tax

Examination of Oklahoma tax information revealed an assessed valuation equal to ten cents per bushel of rated elevator storage capacity. The tax rate applicable to the assessed values varied widely both between and within counties. The location of school district boundaries and the issuance of bonds for local improvements were two factors mentioned by assessors that could cause variation in the rate between two areas.

In an effort to determine the average rate for eight counties in the specialized wheat-producing region of Oklahoma, letters were sent to the county assessors in these counties. Replies were received from seven counties. Nine of the ten elevators whose managers were interviewed for labor cost estimates were located in these counties. The tax rates per $1,000 of assessed valuation for these nine firms ranged from a low of $36.80 to a high of $78.95. The rate did not necessarily increase as the size of firm increased. The average for these firms was approximately $50.00 per $1,000 of assessed valuation. The average rate above was applied to the assessed valuation for each firm. The results were the amounts of the property tax included in the budgets.

Again, emphasis is made that the amount of this tax fluctuated widely between firms. Elevator managers or owners should consult the tax assessor for their specific location in order to determine the exact amount of the tax on their elevator.

Appraisal of Cost Components Included in the Analysis

Mention was made earlier that the ideal requirements for the paired cost-volume observations were not fully satisfied.[6] With the above description of individual costs in mind, a brief appraisal of the extent to which the costs satisfied these requirements follows.

First, the rate of the volume handled within the period, one year in this study, was not expected to have been uniform. Characteristically, country grain elevators received most of their wheat within a period of about two months. Consequently, the use of annual data included periods when high amounts of wheat were handled and periods when low or no amounts of wheat were handled. However, many of the cost components were fixed and, therefore, were incurred during the entire year even

---

[6] See pages 59-60.

though the number of bushels handled would have been relatively low during part of the year.

Second, the observations were paired in the sense that the cost was directly associated with the number of bushels handled. None of the cost figures in the budgets represented costs that were incurred during a time other than the year when the bushels of wheat were actually handled.

Third, the method of cost determination for each scale of plant resulted in a spread of output observations. This spread was not as wide for some scales of plant as it was for others.

Fourth, the data were budgeted under the assumption that prices of the inputs did not change and that all elevator operators possessed an equal amount of technical knowledge.

A final point concerning the cost components used in the current study centered around short-run variations in total costs. In Crigler's study, the assumption was made that short-run total costs were constant.[7] In contrast, short-run labor costs were variable in this study; they more than doubled over the volume range in several of the models. In fact, in at least one model, five of the 16 cost components varied with volume changes. These five costs included: workmen's compensation insurance and comprehensive general liability insurance, fidelity bond, total salary expense, Social Security tax, and electric power expense. While some of these five variable costs were small in comparison to several of the fixed costs, the aggregation of these five costs stressed

[7]Crigler, p. 48.

their importance to total costs in the short run. Over the observed volume range within each model, the lowest and highest total handling cost increases were one percent and 54 percent, respectively. Total handling costs fluctuated less than 10 percent in only two models. Consequently, short-run total costs in the cost budgets did vary considerably with changes in the number of bushels handled.

Cost Components Excluded from the Analysis

No pretense is made that the 16 cost constituents itemized in the cost budgets in this study encompassed all of the relevant grain handling costs incurred by country elevators. However, for various reasons, certain cost items were purposely omitted from the budgets.

The expenses, relevant to the grain handling function, which appeared in most studies of country grain elevator operations, but which were not included in the present study were as follows: repairs, supplies, telephone, advertising, donations, dues and subscriptions, scale inspection, and utilities.

The primary reason for excluding these costs from the analysis was the difficulty that would be encountered in obtaining realistic estimates. Some of the costs were not related to the size of plant. Other costs were expected to fluctuate unpredictably between years. Finally, the amount of these costs attributed to the handling function would be difficult to ascertain in some cases. For example, expenses for repairs or supplies vary greatly between years. An average annual total cost, if used in the cost budgets, would be expected to deviate widely from the actual costs incurred for repairs or supplies in any given year.

Additionally, an estimate of the amount of the repairs or supplies expense attributable to the handling function was difficult to obtain. Usually, expenses shown in the audits were not allocated to the individual functions. If an allocation was made in the audits, it was normally made upon the basis of sales. Consequently, as the total value of sales increased, the amount of total costs allocated to the increased sales in a particular department or function increased. This method of cost allocation was used by elevator accountants.

Telephone rates were based upon the number of telephones within an area. Inspection of elevator capacities revealed no relationship between the number of telephones in an area and the elevator capacity when population was used as an indicator of the relative concentration of telephones. An elevator operator should examine the local rate schedule to approximate the amount of his telephone expense.

Expense estimates for dues and subscriptions, advertising, and donations were considered to be highly subjective. No mandatory amount of these costs existed for any specific handling volume or for any given capacity of elevator. These costs were based upon decisions made by management. Consequently, if an average amount for each of these expenses were used in this study, the averages would not depict the amounts of these costs that should be incurred by an elevator of a specific capacity. For instance, the number of competing elevators within a wheat-producing area could be the basic determinant of these costs rather than the capacity of the elevator or the volume of grain handled.

Scale inspection expense was estimated by an auditor to be under $25 per year. The number of inspections plus the amount of adjustment and repair of the scales fluctuated annually. Due to these fluctuations and the relatively minor importance of the scale expenses, the cost budgets did not include these expense items.

Utilities were normally composed of electric power, lights, heat, and water. These utility expense components seldom were presented individually in the elevator audits examined. Inspection of a previous research study revealed the relative importance of these constituents.[8] Electric power expense was the largest component of total utility expense. Combined expenses for lights, heat, and water were a small fraction of the total utility bill. Based upon the small amounts of these three expenses and the information that would be required to allocate them to the handling function, the decision was made to exclude them from the cost budgets.

The primary reason for listing the basic costs that were excluded from this study was to point out that recognition was made that these costs were incurred. Individual elevator operators should examine these costs in relation to their specific grain-handling operation. These cost components were not included in the cost budgets because their inclusion would not have provided realistic or accurate estimates of their actual levels in the elevator models.

---

[8] Hall, Davis, and Hall.

Examination of Cost Functions

The total costs for the ten elevators at alternative quantities of handling volume were plotted in an effort to determine the form of the functional relationship between total costs and volume. Figure 11 reveals the results of the plotting. Each coordinate point for the individual firms is linearly connected to the next successive point with respect to output. The number beside each line denotes the rated storage capacity in 100,000 bushel units for the respective firms.

The total salary expense component of the total costs shown in Figure 11 has been adjusted by the regression equation described earlier. Inspection of Figure 11 reveals the effect of this adjustment. The connected total cost points for each firm are located above all firms with lower rated storage capacities. This expected relationship was achieved through the adjustment of total salary expense.

A visual inspection of the connected points in Figure 11 led to the belief that the relationship between cost and volume could be linear over the range of the observations. Subsequently, a linear equation was fitted to the observations for each firm by the method of least squares regression. The results of the regression analysis are shown algebraically in Table X and are shown graphically in Figure 12. Again, the numbers beside the plotted equations in Figure 12 denote the rated storage capacities in 100,000 bushel units. The X's and O's in the figure represent the actual observations. Since only two observations were available for the 200,000 bushel capacity firm, no regression equation was computed for that firm.

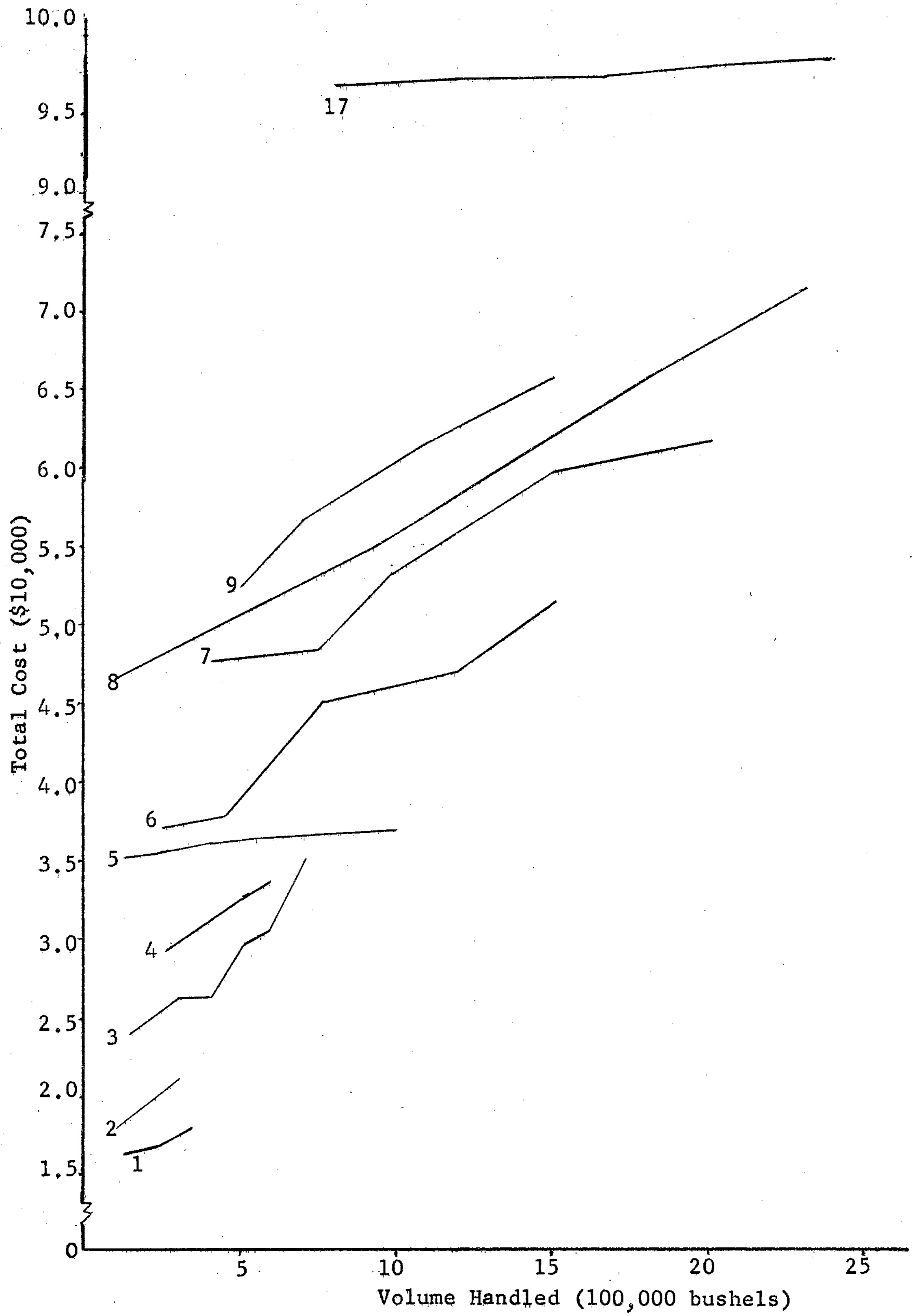

Figure 11. Total Grain Handling Costs for Ten Firms of Varying Rated Storage Capacities.

TABLE X

TOTAL COST EQUATIONS FOR NINE ALTERNATIVE SCALES OF PLANT

Rated Storage Capacity of Firm (100,00 Bushels)	Number of Observations	Total Cost Equation[a]	R^2
1	3	$\hat{Y}$ = 15.277289 + .008064X	.977258
3	6	$\hat{Y}$ = 20.378730 + .018683X	.911590
4	3	$\hat{Y}$ = 26.089373 + .012852X	.999307
5	6	$\hat{Y}$ = 35.087557 + .001988X	.942518
6	5	$\hat{Y}$ = 34.190128 + .011530X	.951785
7	5	$\hat{Y}$ = 43.195927 + .009811X	.941623
8	5	$\hat{Y}$ = 45.081771 + .011493X	.998260
9	4	$\hat{Y}$ = 46.734838 + .013112X	.982858
17	5	$\hat{Y}$ = 96.028693 + .000858X	.903060

[a]$\hat{Y}$ = estimated total cost in thousands of dollars; X = quantity of grain handled in thousands of bushels.

With one exception, the intercept values denoting fixed costs revealed a positive relationship with changes in plant capacity. In the exceptional case, the intercept value for the 500,000 bushel capacity elevator exceeded the value for that of the 600,000 bushel capacity elevator. Since the intercept values represented an extrapolation of the data beyond the observed range of observations the negative relationship between intercept values and plant capacities might not exist in reality. For example, the "a" value for the 600,000 bushel capacity model could lie above the same value for the 500,000 bushel capacity model if total costs for the former firm flattened out at volume levels below the range of actual observations. Inspection of the connected

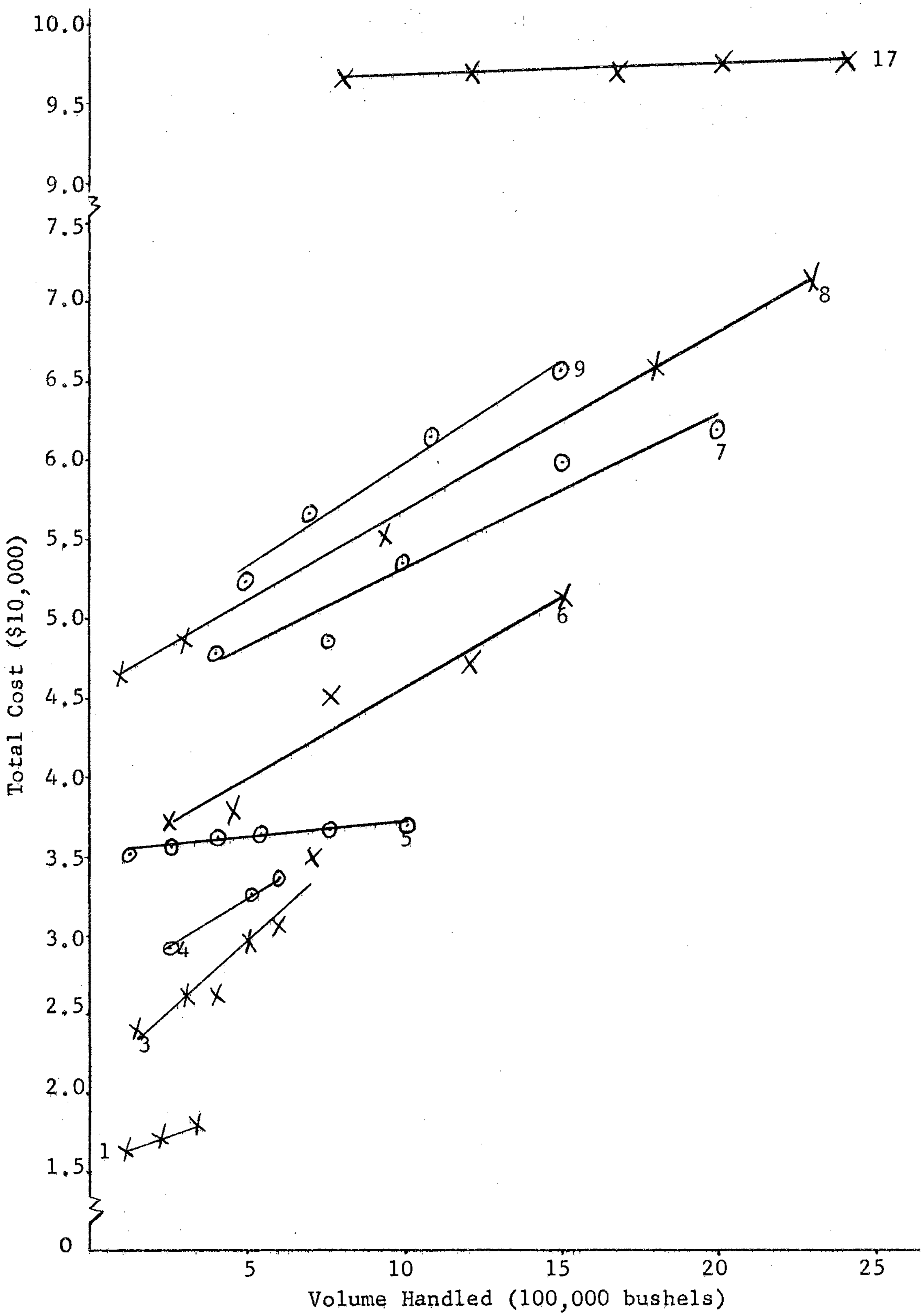

Figure 12. Regression of Total Grain Handling Costs on Volume of Grain Handled for Nine Firms of Varying Rated Storage Capacities.

points in Figure 11 for these two firms indicates that this relationship could be tenable.

Emphasis is made that the linear relationship between costs and volume for each firm depicted in Figure 12 is only over the observed range of the data. Beyond some level of volume handled, inefficiencies would be expected to exist and, therefore, cause the total cost curve to increase at an increasing rate. Also, due to the discrete characteristic of the permanent labor component of total salary expense, the linear total cost relationship would be expected to be discontinuous at the levels where the number of permanent employees was changed.

Mention is made at this point that the linear total cost curves shown in Figure 12 result in constant average variable cost curves. This type of average variable cost curve would be identical with the horizontal segment of the average variable cost curve suggested by Bain.[9] The smaller the percentage of total fixed cost compared with linear total variable cost, the less will be the slope of the average total cost curve. The percentage will become smaller as output is increased.

To discuss the above line of reasoning in more detail, the linear total cost curves for each firm result in an average total cost curve of the following form:

$$ATC = \frac{a}{Q} + b$$

[9] See Figure 7.

where:

ATC = average total cost, and

Q = quantity of grain handled.

An average total cost curve of this type has been mentioned earlier by Johnston.[10] The empirical analysis of the current study suggests an average total cost curve similar to this type. Over the range of the data, the fixed cost component accounts for a small enough percentage of the linear total cost that average total cost tends toward horizontality in most cases. Marginal costs which are constant and equal to average variable costs also result from the linear total cost model. Average total costs asymptotically approach these latter two cost concepts as the volume of grain handled increases.

An indication of the variation of the "b" values for each firm about the mean "b" coefficient for the firms was obtained by compution of the interval containing two standard deviations (s_b) above and below the mean "b" value. The 200,000 bushel capacity firm was included in this procedure by computing the slope of a line connecting the two observations for this firm.

The computions resulted in:

$$s_b = \sqrt{\sum_{i=1}^{10} \frac{(b_i - \bar{b})^2}{n-1}} = .005709$$

The interval containing plus or minus two s_b from $\bar{b}$ was (-.000895, +.021941). Consequently, this interval containing approximately 95 percent of the observations would include "b" values that were zero.

---

[10] See pages 36-37.

The variability of the sample means about the mean value of the distribution of many sample means is indicated by the standard error of the sample mean ($s_{\bar{b}}$).

The calculations showed:

$$s_{\bar{b}} = \sqrt{\frac{\sum_{i=1}^{10} (b_i - \bar{b})^2}{n(n-1)}} = \frac{.005709}{\sqrt{n}} = .001805$$

The interval containing plus or minus two $s_{\bar{b}}$ from the mean was (+.006913, +.014133). Therefore, values of $\bar{b}$ equal to zero were not included in this interval which contains approximately 95 percent of the sample means.

Graphical inspection of Figure 12 indicates that the slopes of several of the total cost equations might not differ significantly from each other. An F test was conducted to test for the equality of the slopes (m) of the firms.

In using the F test, the series of observations for each firm were the slopes of the lines connecting the observed cost-volume points in Figure 11. Computation of these slopes resulted in a total of 34 "m" values for all of the ten firms combined. Table XI shows the calculated "m" values. The results of the F test are summarized in Table XII. The tabulated $F_{.05}$ was 2.30 for 9 and 24 degrees of freedom. Since the computed F was smaller than the tabulated F, the hypothesis that the means of the "m" values among firms were equal was not rejected.

However, a test for significant differences of the average "m" values between individual firms was made. The test used was Kramer's[11]

---

[11] Clyde Young Kramer, "Extension of Multiple Range Tests to Group Means with Unequal Numbers of Replications," __Biometrics__, 12 (1956), pp. 307-310.

TABLE XI

CALCULATED "m" VALUES BETWEEN COORDINATES OF TOTAL COST AND VOLUME HANDLED FOR FIRMS OF TEN ALTERNATIVE CAPACITIES

Rated Storage Capacity of Firm (100,000 Bushels)	Calculated "m" Values[a]				
1	.005357	.011547			
2	.016839				
3	.014273	.000000	.030636	.012230	.043420
4	.013192	.011573			
5	.003000	.003927	.001215	.001438	.001404
6	.003745	.023012	.004841	.014377	
7	.002449	.020670	.012484	.003762	
8	.010700	.010002	.012707	.011254	
9	.021490	.012070	.011048		
17	.000400	.000344	.001603	.001338	

[a]Each "m" value is calculated from the cost budgets in Appendix B and denotes the dollar change in total cost per bushel change in the volume of grain handled. The "m" values from left to right in each row result from ascending quantities of volume handled.

TABLE XII

F TEST FOR TESTING DIFFERENCES AMONG "m" COEFFICIENTS FOR TEN ELEVATOR CAPACITIES

Source of Variation	d.f.	SS	MS	F
Among Firms	9	.00129185	.00014354	2.010
Within Firms	24	.00171361	.00007140	
Total	33	.00300546		

adaptation of Duncan's[12] new multiple range test. Duncan's test can be used whether F is significant or not.[13] A summary of the results of the test is shown in Table XIII.

Few differences in mean "m" values between firms are indicated in Table XIII. In fact, the 300,000 bushel capacity elevator was the only firm with a mean "m" value that differed significantly from the mean "m" values of the other firms. The mean "m" value for this elevator differed from that of the 1,700,000 bushel capacity firm and from that of the 500,000 bushel capacity firm. Inspection of Figures 11 and 12 reveals that the curves for the latter two firms are relatively horizontal while the curves for the former firm are relatively steep. However, there were seven firms which did not differ significantly from the 300,000 bushel capacity firm, and yet these same seven firms did not differ significantly from the 500,000 and 1,700,000 bushel capacity firms. The basic cause for the relatively small slope of the 500,000 and 1,700,000 bushel capacity firms stems from the relatively small estimated response of total salary expense to changes in the quantities of grain handled by these firms.

Emphasis is made that the 1,700,000 bushel model has almost twice the storage capacity of the next largest model. The low response of total salary expense to changes in handling volume for this largest

---

[12] David B. Duncan, "Multiple Range and Multiple F Tests," Biometrics, 11 (1955), pp. 1-42.

[13] Robert G. D. Steel and James H. Torrie, Principles and Procedures of Statistics (New York, 1960), pp. 107-108.

TABLE XIII

NEW MULTIPLE RANGE TEST FOR TESTING DIFFERENCES BETWEEN FIRMS WITH RESPECT TO MEAN "m" VALUES OF EACH FIRM FOR VOLUME HANDLED--TOTAL COST COORDINATES[a]

	Rated Storage Capacity of Firm[b] (100,000 Bushels)									
	17	5	1	7	8	6	4	9	2	3
Mean "m" Value	.000921	.002197	.008452	.009841	.011166	.011494	.012382	.014869	.016839	.020112

[a]Test is for 95 percent probability level.

[b]Firms are arranged in order of ascending size of mean "m" values.

Note: Any two means not underscored by the same line are significantly different. Any two means underscored by the same line are not significantly different.

firm could be due to factors peculiar to firms of this size. For example, management might not visualize wide fluctuations in the permanent labor force corresponding to fluctuations in handling volume because the number of permanent employees required to maintain the elevator facilities was large. The total cost budget for this largest firm indicates no alteration in the permanent labor force with volume changes. In fact, when the schedule was taken for this firm the interviewee specifically emphasized that seasonal labor was considered to be the only variable expense component of total labor costs.

In the following section the cost functions described above are related to suggested revenue functions.

Handling Volumes for Alternative Goals

To recapitulate, the basic objective of the study was to determine the costs of handling grain at alternative handling volumes for several elevator storage capacity models. Each model was assumed to have only a grain handling function. Consequently, in the ensuing synthesis of costs and revenues, the functions arising from the latter concepts were only suggestive of reality. Revenue functions were discussed solely from the point of view that they aided in depicting some of the ramifications of the study upon firm goals. A complete verification of the revenue charges was not made.

Total costs are converted into average costs in this section. Division of the total cost equations by the quantity of grain handled results in this conversion. The average costs over the range of observations for the nine total cost equations are shown graphically in

Figure 13. The budgeted average costs are presented in Appendix B. As before, the curves are identified by numbers denoting rated storage capacities in 100,000 bushel units. In the budgets, the highest short-run average cost, 46.54 cents per bushel, and the lowest short-run average cost, 3.09 cents per bushel, were incurred by the 800,000 and 700,000 bushel capacity models, respectively. The respective handling volumes were 100,000 and 2,000,000 bushels.

An average revenue function is also shown in Figure 13. This function is constant and equal to 5.75 cents per bushel.[14] The rate was for wheat received by truck on a commingled basis.[15] Loading out charges were the same for truck, rail, or water. Consultation with grain specialists indicated that handling charges tended toward the level specified under the Uniform Grain Storage Agreement.

The achievement of identical goals by the individual firms would result in different quantities of grain handled by each firm. For example, if the common goal of the firms was to maximize profits, then each firm would desire to handle the maximum quantity in its observed range shown in Figure 13. This action would be rational for the following reasons: Since average costs of each firm are decreasing throughout the observed ranges, marginal costs must be below average costs. Therefore, the handling charge (marginal revenue) would exceed marginal cost at the maximum handling volume over the observed ranges for each

---

[14] Schedule of Rates, 1960 Supplement to Uniform Grain Storage Agreement, U. S. Department of Agriculture, Commodity Stabilization Service, Commodity Credit Corporation, May 17, 1960.

[15] James R. Enix, Oklahoma State University Extension Wheat Marketing Specialist, indicated that this method of shipment to the country point and method of receipt of the shipments were prevalent for wheat in Oklahoma.

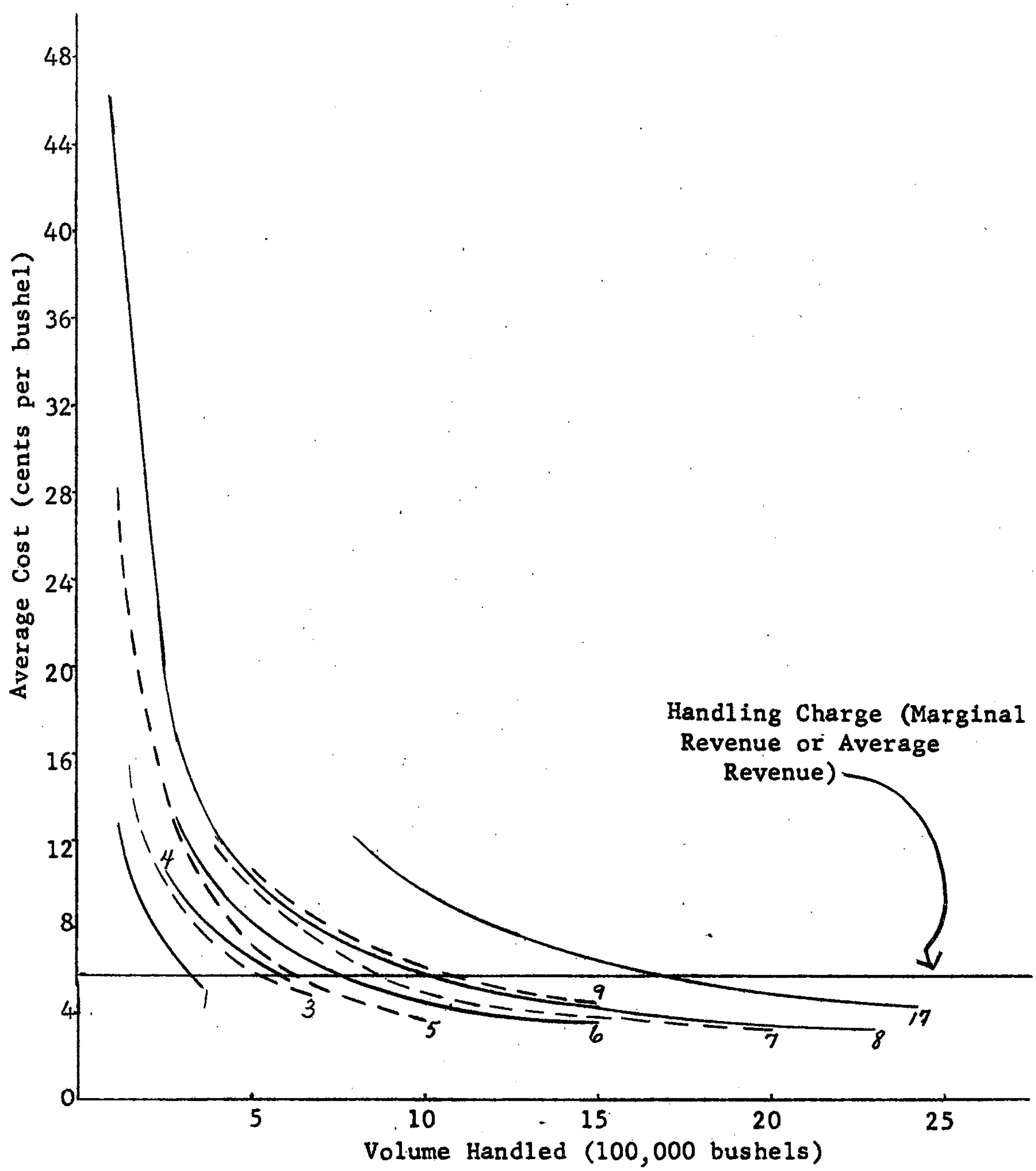

Figure 13. Calculated Average Cost Curves for Nine Firms of Varying Rated Storage Capacities.

firm because marginal revenue exceeds average cost at this volume. Furthermore, since at this volume average revenue (handling charge) exceeds average cost, total revenue exceeds total cost. Consequently, total profits would be maximized, and not minimized, when each firm handled the maximum volume in its observed range.

If the maximization of handling revenues subject to a minimum profit constraint was the objective of each firm, then as soon as the constraint was satisfied each firm would desire to handle the maximum observed quantities of wheat. As under the first goal, handling volume would be maximized. Such action assumes the constraint was satisfied before the maximum observed handling volumes were reached.

Under the alternative firm goals stated above the decreasing average costs over the volume ranges of the data shown in Figure 13 would result in individual elevators striving to handle the maximum quantities within their respective ranges.

In this chapter the costs and revenues were examined for the grain handling function only. In the following chapter the policy implications of the study are extended to include the sideline and grain storage functions. The relevance of the study to governmental policy decisions also is discussed.

CHAPTER VII

RELATION OF RESULTS TO DECISION MAKING

Attainment of the primary objective of this study required a determination of costs for the handling function only. However, reality dictated the inclusion of costs for the sideline function and for the grain storage function. Country grain elevators did store wheat and other grains. Sidelines did exist or had been expanded in order to achieve a more efficient utilization of certain resources. Labor inputs were a major resource in this category. Emphasis was made previously that both seasonal and full time labor were treated as variable factors of production. Notwithstanding this method of treatment, at most levels of grain volume handled a certain amount of permanent labor time would be expected to be underutilized. Certain key employees could not be hired and released in cycles throughout the year merely in relation to when they were needed for the grain-handling function. The addition of sidelines provided a means of utilizing this type of labor more efficiently during slack seasons of grain-handling volume. The fact that the majority of the grain was handled during a period of two to three months in the year rendered this method of labor utilization especially important.

Therefore, since grain storage and sidelines exist for reasons other than to influence grain handling receipts, the subsequent discussion will concentrate upon the relevance of these former two functions to the grain-handling function. Some suggested effects of changes in handling volume from both the individual and the aggregate point of view also will be noted.

Firm Decisions

The discussion in this section focuses upon means of increasing the volume of grain handled in the event that decreases in the initial volume occurred. The starting point of these decreases was assumed to be near the center of the observed volume ranges for each of the nine scales of plant. However, under a total profit-maximizing objective, increases in handling volume up to the maximum observed volume shown by the cost curve for each firm would be desired. Accordingly, the means of increasing handling volume would remain relevant regardless of whether or not a decrease in the quantity of grain handled was assumed.

Alterations in total wheat production would be expected to show positive effects upon the resultant changes in the quantity of wheat handled by country elevators. If the alterations were on a permanent basis, where "permanent" is as defined earlier,[1] then what consequential actions would be followed by country elevator operators?

The degree to which the alteration in production changed the amount of grain handled by elevators would be a factor of prime importance in any answer to the above question. For example, reference to the average cost curves in Figure 13 shows that profits could be made from the handling function provided that the firms are handling grain in excess

---

[1]See page 75.

of that shown by the points of intersection of their respective average cost curves with the constant average revenue (handling charge) function. Assume that a decrease in production occurred and, therefore, that the quantity of grain handled declined. If the reduced handling volume did not result in average costs in excess of the handling charge, then firm profits still would be possible. However, if the objective of the firm were to maintain a specified per unit profit margin, then the reduction in the quantity of grain handled could result in per unit margins less than those specified.[2] Two possible consequential actions by the individual firms follow. For illustrative purposes, the specified per unit margins are assumed to occur at the original levels in handling volume for each firm.

First, a firm could reduce its handling charge in an effort to obtain more handling volume. The initial effects of this action would be to lower per unit profit margins. However, the operator might have predicted that his lowered handling charge would increase handling volume enough to offset the reduction in handling volume. If his predictions were correct, then he would be able to maintain or increase his original per unit profit margins by handling more grain than he was handling before the reduction in handling volume.

For instance, assume that the 800,000 bushel storage capacity elevator is handling 1,400,000 bushels of wheat annually. With a handling

---

[2]The fact that maximization of total profit does not require the maximization of profit per unit is noted in Leftwich, p. 177. Per unit profits are discussed in this study only because many elevators sought to increase their margins of average revenue over average cost.

charge of 5.75 cents per bushel, the profit margin corresponding to this handling volume is 1.38058 cents per bushel. Now assume that a decrease in wheat production reduces annual handling volume to 1,300,000 bushels. The resultant profit margin, assuming that the handling charge did not change, would be 1.13288 cents per bushel. If the operator reduced the handling charge to five cents per bushel in an effort to increase handling volume and maintain the initial margin of 1.38058 cents per bushel, then the volume would have to increase to 1,825,080 bushels. In the event that handling volume exceeded this level, then profit margins would exceed 1.38058 cents per bushel.

Second, an expansion of existing sideline offerings could be made. The objective of this expansion would be to increase the quantity of grain handled and, hence, the per unit profit margins. As noted previously, elevator operators indicated that the addition of sideline merchandise to their operations provided an incentive for producers to bring their grain to these elevators. Producers have demanded more sidelines and, subsequently, they have received an increased amount of these additional services.

Third, storage rates could be reduced in an effort to increase handling volume. However, elevator operators indicated that the addition of sidelines would be a more effective way to obtain this increase.

The results of the study indicate the efficiency of the components of average cost for the handling function. For example, receipts from handling related to the total salary expense would give information concerning the amount of revenue that labor was contributing to the handling function. If the amount was below a level desired by the elevator operator, then sideline sales or the amount of grain stored could be expanded to raise the contribution of labor to the revenues from the overall operation of the firm.

All of the above comments pertaining to the possible ways of increasing the volume of grain handled should be construed from the viewpoint of their effects upon the composite operation of each elevator. An expansion in handling volume should be carried out only if the overall profits of the firm are enhanced.

Governmental Actions

The relevance of the study to policies and actions at the governmental level was described briefly in Chapter II. In recapitulation, information on handling costs and revenues permitted the effects of production controls upon profit positions from handling to be determined. Governmental programs could be designed with the objective of achieving a predetermined profit position. In reality this predetermined position only would be approximated since exogenous variables such as weather and technology would affect the amount of grain production.

The results of this study show that differences in the costs of handling grain existed for firms of different rated storage capacities at identical handling volumes. A direct consequence of these differences would be the need for selective production control programs. "Selective" in this situation refers to the application of grain production controls upon the basis of the capacity of the elevator that was serving a particular geographical location.

For example, in Figure 13, consider the following capacity models: 600,000 bushels; 700,000 bushels; 800,000 bushels; and 900,000 bushels. Furthermore, consider reductions in handling volume from a base of 1,500,000 bushels handled. As volume is reduced from this base, the first firm to incur losses from the handling function would be the 900,000 bushel capacity model. As expected, subsequent volume reductions would result in the following order of initial loss incurrence: second - 800,000 bushel model; third - 700,000 bushel model; and fourth - 600,000 bushel model.

These various levels of loss incurrence enable the smaller firms, in contrast to the larger firms, to handle lower quantities of grain while still being able to realize a profit. Consequently, a determination of handling costs and revenues gives governmental policymakers an insight into the effects of supply control programs upon grain-handling profits at alternative amounts of elevator storage capacity.

A knowledge of the present location of the firms on their respective short-run average cost curves should be considered in any recommended grain supply reduction programs. If the firms are to incur profits, then each firm must operate at a point on its short-run average cost curve that is to the right of the intersection of this curve with the handling charge function. The smaller this distance is for an individual firm, then the smaller is the amount of supply reduction the firm can encounter in comparison to other firms, if the firm is to continue to receive a profit.

To illustrate, consider the 600,000; 700,000; 800,000; and 900,000 bushel capacity models in Figure 13. If each of these models were initially handling 1,500,000 bushels and receiving a handling charge of 5.75 cents per bushel, then the volume handled could be decreased by 756,251; 594,216; 520,111; and 447,129 bushels, respectively, before any of the models would incur losses.

For another example concerning information needed for supply reduction programs, consider the data in Table XIV. In this table the assumption is made that the handling volume of each firm is 1.4 times the rated storage capacity. Table XIV demonstrates that the larger firms can encounter greater decreases in handling volume before breaking even. In contrast, the three smallest firms require handling volumes in excess of 1.4 of their rated storage capacities if they are to break even.

TABLE XIV

FLEXIBILITY IN HANDLING VOLUMES OF FIRMS OPERATING AT 140 PERCENT OF RATED STORAGE CAPACITY

Rated Storage Capacity	Handling Volume (1.4 x Rated Storage Capacity)	Break-even Point[a] (Average Cost = Handling Charge)	Excess Over Break-even Point	
(100,000 Bushels)	- Bushels -		(Bushels)	(Percent)
1	140,000	309,032	-169,032	-55
3	420,000	524,995	-104,995	-20
4	560,000	584,335	-24,335	-4
5	700,000	632,072	67,928	11
6	840,000	743,749	96,251	13
7	980,000	905,784	74,216	8
8	1,120,000	979,889	140,111	14
9	1,260,000	1,052,871	207,129	20
17	2,380,000	1,695,362	684,638	40

[a]The handling charge is 5.75 cents per bushel.

The above discussion emphasizes the need for cost and revenue information on elevators of various rated storage capacities if the effects of governmental supply controls upon profits of the elevators are to be determined.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

An imbalance between grain production and elevator storage capacity existed in Oklahoma at the time of this study. Increases in grain production were exceeded by increases in elevator storage space. The resultant situation of overcapacity followed.

Wheat, grain sorghum, barley, oats, soybeans, and corn were the principal grains handled and stored by grain elevators. Wheat was the most important of these grains. A 1947-1961 average indicated that total wheat production and value of wheat production in Oklahoma relative to these five other grains handled by elevators were 69 and 77 percent, respectively, Upon the bushel basis of farm sales in a 1955-1961 average, wheat accounted for 78 percent of total sales relative to the same five grains. Interviews with elevator managers in the summer of 1963 indicated that wheat accounted for 75 to 100 percent of the quantity of their total grain stored. For these reasons wheat was the grain under primary emphasis in the operations of country elevators.

During the 1951-1963 period the estimated capacity of off-farm commercial grain storage facilities in Oklahoma increased 165 percent. The amount of grain stored on farms in Oklahoma was estimated to be less than ten percent of the total grain stored. In 1963, Commodity Credit Corporation did not own any storage space in Oklahoma.

Three major incentives for the erection of new storage space during the 1950's included: (1) occupancy contracts, (2) accelerated amortization, and (3) storage and handling agreements on Commodity Credit Corporation grain. At the time of the study, only the last feature was in effect, and the rate structure under it had been revised downward.

Country grain elevators characteristically have three basic operating functions. These include: (1) the grain merchandising or handling function, (2) the grain storage function, and (3) the sideline function. In this research study, only the costs of handling grain were analyzed.

The Commodity Credit Corporation stored large quantities of wheat in country elevators. Since wheat production exceeded utilization, decreased wheat production through supply control programs appeared logical. Conversely, technological improvements in production or the absence of supply control could increase wheat production. These factors could result in variations in the quantity of grain handled or stored by country elevators.

The possibility of handling volume variations led to the objective of the study. The objective was to determine the handling costs for northwestern Oklahoma elevators of different rated storage capacities at various levels of grain handled. Each elevator was assumed to have only a grain-handling function. Additionally, only single-unit models were considered.

Since country elevators were characterized by: (1) a situation of overcapacity relative to grain supplies, and (2) a situation in which the elevators had several years of useful life remaining, the short-run period was the opportune time period for analysis. The erection of new scales of plant was not expected for several years. Segments of the short-run cost curves were computed in order to determine realistically possible fluctuations in handling costs from 1962 levels. Economies of scale were not directly under consideration.

Grain handling costs were determined for ten models of different rated storage capacities. The capacity of the first nine models ranged from 100,000 bushels through 900,000 bushels. Interim models were in multiples of 100,000 bushels. The tenth model was a 1,700,000 bushel capacity plant. Costs were computed for handling volumes above and below 1962 levels.

A cost budgeting approach was used. Sixteen cost components were budgeted for the grain handling function in each model. Estimates of the amount of each component were obtained from personal interviews with elevator managers and from consultation with agricultural specialists.

Regression equations were fitted to the data on costs and handling volumes. A suggested level of the revenue function from grain handling was made. Subsequently, alternative profit goals of the firm and possible governmental grain production policies were discussed.

Findings and Results

A wide amount of variation was noted in the total handling costs between different handling volumes among the models. The increases in total handling costs between the extremes of the observed volume ranges in the models were one percent and 54 percent for the lowest and highest total cost differences, respectively. Only two firms revealed a total cost fluctuation less than ten percent. One point was evident: Over the observed ranges in volume handled the total costs were not constant within individual firm models. This result was in contrast with the study by Crigler in which short-run total costs were constant.

Examination of the 16 cost components revealed that the summation of total salary expense and depreciation expense accounted for the highest percentage of total costs. This fact was apparent in all of the models and at all levels of handling volume. Also, in all instances total salary expenses exceeded combined depreciation expenses on elevator, machinery, office, and scales. Consequently, the cost of permanent and seasonal labor was found to be of primary importance in the grain-handling function of country elevator operations.

Elevator managers' estimates of total salary expenses for the quantities of wheat handled in the audit fiscal years including the 1962 wheat crop indicated the existence of a linear relationship between these two variables. Consequently, a linear equation was fitted to the data. This equation was used as a base from which to adjust the total salary expenses in the cost budgets. The resultant adjusted total cost curve for each firm was located above the total cost curves of all other firms with lower rated storage capacities.

Based upon the cost budgets, short-run total costs for the ten scales of plant were linear. Therefore, short-run marginal costs were constant. Also, the resultant short-run average costs decreased throughout the entire range of observations. Due to the discrete characteristic of the permanent labor component of total salary expense, the linear total cost relationship was expected to be discontinuous at the levels where the number of permanent employees was changed.

An average of the slopes connecting the total cost and volume handled coordinates was computed for each firm. The average slope of the 300,000 bushel storage capacity firm differed significantly from the average slope of the 1,700,000 bushel and 500,000 bushel storage capacity firms. However, there were seven firms which did not differ significantly from the 300,000 bushel capacity firm. Also, these same seven firms did not differ significantly from the 500,000 and 1,700,000 bushel capacity firms.

A possibility of some of the regression coefficients in the equations being equal to zero was evident. Two standard deviations from the mean "b" value of the ten firms included "b" values equal to zero. But an interval of two standard errors of the sample mean did not include sample means equal to zero. The mean "b" value was not zero.

The highest short-run average cost was encountered by the 800,000 bushel storage capacity model at a level of 100,000 bushels of grain handled. Cost was 46.54 cents per bushel.

Short-run average cost was lowest at 3.09 cents per bushel in the 700,000 bushel capacity model at a handling volume of 2,000,000 bushels.

Upon the basis of the cost equations, a suggested level of handling charges, and several hypothetical levels of handling volume some reduction in handling volume appeared possible before most of the firms would have encountered losses from the handling function.

Limitations of the Study

The following points should be considered in the application of the results to policy decisions.

First, only the grain handling function was analyzed. Realistically, elevator operations included a sideline function and a grain storage function.

Second, some costs were omitted purposely from the cost budgets. Individual elevator operators need to examine their specific location and facilities in order to determine the amount of these costs.

Third, some firms were multiple-unit organizations. Costs for this type of organizational structure could have differed from the single-unit structure analyzed in the present study.

Fourth, total costs were expected to vary between private firms and cooperative firms. This study included certain costs that would not be incurred by firms operated under private ownership. Additionally, rates for certain expenses could have varied between firms operated under these two types of ownership.

Fifth, in a dynamic framework the amount of the cost components could change. Consequently, a reappraisal of each cost item should be made in the future if the study is to depict costs accurately for a later time period.

Need for Further Study

Certain areas are suggested for detailed study. These are designed to gain additional insight into the costs of country grain elevator operations.

In order to determine the degree of the differences in costs due to type of ownership, a comparative cost study of privately owned firms versus cooperatively owned firms could be made. The results of such a study would be useful in determining the cost components that were identical in amount under both types of ownership. Then, mention could be made that nonidentical components should be computed upon the basis of ownership type.

In the Oklahoma grain elevator economy the need for a detailed study of the three operating functions was paramount in importance. A synthesis of the three basic operating functions could be used to portray the overall firm operations. Caution should be exercised in this approach since the three functions can be combined at numerous levels of operation for each function. Costs could be determined at various operating levels for the two grain functions. Subsequently, the sideline function could be added to utilize any residually underemployed factors of production.

SELECTED BIBLIOGRAPHY

Bain, Joe S. Industrial Organization. New York: John Wiley and Sons, Incorporated, 1959.

__________. Price Theory. New York: Henry Holt and Company, 1952.

Baumol, William J. Business Behavior, Value and Growth. New York: Macmillan, 1959.

Boulding, Kenneth E. Economic Analysis. Third edition. New York: Harper and Brothers, 1955.

Crigler, T. P. "A Method of Economic Analysis for Decision Making by Cooperative Elevator Associations." Stillwater: (unpub. Ph.D. dissertation, Oklahoma State University, 1958).

Due, John F., and Robert W. Clower. Intermediate Economic Analysis. Fourth edition. Homewood, Illinois: Richard D. Irwin, Incorporated, 1961.

Duncan, David B. "Multiple Range and Multiple F Tests." Biometrics, 11 (1955), 1-42.

Ezekiel, Mordecai and Karl A. Fox. Methods of Correlation and Regression Analysis. Third Edition. New York: John Wiley and Sons, Incorporated, 1959.

Hall, Thomas E., Walter K. Davis, and Howard L. Hall. New Local Elevators. Washington: U. S. Department of Agriculture, Farmer Cooperative Service, Service Report 12, 1955.

Hoel, Paul G. Introduction to Mathematical Statistics. Second edition. New York: John Wiley and Sons, Incorporated, 1954.

Johnston, John. Statistical Cost Analysis. New York: McGraw-Hill Book Company, Incorporated, 1960.

Klein, John J., et al. The Oklahoma Economy. Stillwater: Economic Research Series No. 1, 1963.

Kramer, Clyde Young. "Extension of Multiple Range Tests to Group Means with Unequal Numbers of Replications." Biometrics, 12 (1956), 307-310.

Larson, Adlowe L. "Adjustments Facing Grain Storage Operators." Oklahoma Current Farm Economics, 35 (1962), 37-43.

__________, and Nellis A. Briscoe. Some Effects of Wheat Policy on the Oklahoma Wheat Marketing Industry. Stillwater: Oklahoma Agricultural Experiment Station Bul. B-521, 1959.

Larson, Adlowe L., Thomas E. Hall, Howard S. Whitney, and Charles H. Meyer. Comparative Costs of Grain Storage on Farms and in Elevators. Stillwater: Oklahoma Agricultural Experiment Station Bul. B-349, 1950.

Larson, Adlowe L., and Howard S. Whiteney. Relative Efficiencies of Single-Unit and Multiple-Unit Cooperative Elevator Organizations. Stillwater: Oklahoma Agricultural Experiment Station Bul. B-426, 1954.

Leftwich, Richard H. The Price System and Resource Allocation. Revised edition. New York: Holt, Rinehart and Winston, 1960.

Liebhafsky, Herbert H. The Nature of Price Theory. Homewood, Illinois: The Dorsey Press, Incorporated, 1963.

Marshall, Alfred. Principles of Economics. Eighth edition. New York: St. Martin's Press, 1959.

Meinken, Kenneth W. The Demand and Price Structure for Wheat. Washington: U. S. Department of Agriculture, Technical Bul. No. 1136, 1955.

Oklahoma Crop and Livestock Reporting Service, Office of the Agricultural Statistician, Oklahoma City, Selected Annual Reports.

Oklahoma State University Extension Service. Commercial Grain Warehouses in Oklahoma. Stillwater: January 1, 1961.

Phillips, Richard. "Empirical Estimates of Cost Functions for Mixed Feed Mills in the Midwest." Agricultural Economics Research, VIII (January, 1956), 1-8.

Ryan, William J. L. Price Theory. London: Macmillan and Company Limited, 1958.

Shepherd, Geoffrey S., Allen B. Richards, and John T. Wilkin. Some Effects of Federal Grain Storage Programs on Grain Storage Capacity, Grain Stocks and Country Elevator Operations. Lafayette, Indiana: North Central Regional Publication No. 114, 1960.

Steel, Robert G. D., and James H. Torrie. Principles and Procedures of Statistics. New York: McGraw-Hill Book Company, Incorporated, 1960.

Stollsteimer, J. F., R. G. Bressler, and J. N. Boles. "Cost Functions from Cross-Section Data--Fact or Fantasy?" *Agricultural Economics Research*, XIII (1961), 79-88.

Thurston, Stanley K., and R. J. Mutti. *Cost-Volume Relationships for New Country Elevators in the Corn Belt*. Washington: U. S. Department of Agriculture, Farmer Cooperative Service, Service Report 32, 1957.

U. S. Department of Agriculture. *Agricultural Statistics*. Washington: Selected Issues.

__________, State Board of Agriculture and Statistical Reporting Service. *Oklahoma Agriculture*. Oklahoma City: Selected Issues.

__________, Commodity Stabilization Service, Commodity Credit Corporation. *Schedule of Rates*, 1960 Supplement to Uniform Grain Storage Agreement, May 17, 1960.

__________, Economic Research Service. *The Wheat Situation*. Washington: Selected Issues.

Yager, Francis P. *Country Elevators - Cost-Volume Relations in the Spring Wheat Belt*. Washington: U. S. Department of Agriculture, Farmer Cooperative Service, Service Report 63, 1963.

APPENDIXES

APPENDIX A, TABLE I

MACHINERY DESCRIPTION AND HORSEPOWER OF MOTORS FOR GRAIN ELEVATORS OF VARIOUS CAPACITIES

Rated Storage Capacity - Bushels -	Machinery	Horsepower
100,000	1-5,000 bu. per hr. leg	30.0
	1-truck lift	7.5
	1-man lift	1.5
	1-dust fan	3.0
	1-10 bu. automatic scale (2,250 bu. per hr.)	
	1-50'x10' truck scale (50 ton capacity)	
	Total horsepower	42.0
200,000	1-6,000 bu. per hr. leg	40.0
	1-truck lift	7.5
	1-man lift	1.5
	1-dust fan	3.0
	1-15 bu. automatic scale (3,600 bu. per hr.)	
	1-distributor	.5
	1-50'x10' truck scale (50 ton capacity)	
	Total horsepower	52.5
300,000	1-7,000 bu. per hr. leg	50.0
	1-truck lift	7.5
	1-man lift	1.5
	1-dust fan	5.0
	1-conveyor from track	5.0
	1-25 bu. automatic scale (6,000 bu. per hr.)	
	1-distributor	.5
	1-50'x10' truck scale (50 ton capacity)	
	Total horsepower	69.5

APPENDIX A, TABLE I (Continued)

Rated Storage Capacity	Machinery	Horsepower
- Bushels -		
400,000	1-9,000 bu. per hr. leg	60.0
	1-truck lift	7.5
	1-man lift	1.5
	1-dust fan	7.5
	1-conveyor from track	5.0
	1-25 bu. automatic scale (6,000 bu. per hr.)	
	1-distributor	.5
	1-50'x10' truck scale (50 ton capacity)	
	Total horsepower	82.0
500,000 through 1,000,000	1-9,000 bu. per hr. leg	60.0
	1-semitruck dumper (2-25 HP motors)	50.0
	1-manlift	1.5
	1-dust fan	7.5
	1-conveyor from track	5.0
	1-conveyor from truck	5.0
	1-topbelt conveyor	15.0
	1-bottom belt conveyor	10.0
	1-power shovel	7.5
	1-25 bu. automatic scale (6,000 bu. per hr.)	
	1-distributor	.5
	1-50'x10' truck scale (50 ton capacity)	
	Total horsepower	162.0
1,700,000	2-10,000 bu. per hr. legs (75 HP each)	150.0
	2-dust fans for legs (10 HP each)	20.0
	1-man lift	7.5
	1-semitruck dumper (2-25 HP motors)	50.0
	1-power shovel	10.0
	2-belt conveyors (5 HP each)	10.0
	1-belt conveyor	25.0
	1-belt conveyor	20.0
	2-distributors (.5 HP each)	1.0
	1-car puller	40.0
	1-2,500 bu. hopper-type scale	
	1-50'x10' truck scale (50 ton capacity)	
	Total horsepower	333.5

Source: Contractor estimates.

APPENDIX B, TABLE I

ANNUAL COST BUDGET FOR A GRAIN ELEVATOR WITH RATED STORAGE CAPACITY OF 100,000 BUSHELS

Expense	Quantity Handled[a] (Bushels) 120,000	239,840	339,000
	- Dollars -		
Depreciation (elevator & machinery) (Cost: $100,000)	2,500	2,500	2,500
Depreciation (office & scales) (Cost: $20,000)	1,000	1,000	1,000
Insurance (elevator & machinery)	77	77	77
Insurance (office & scales)	69	69	69
Federal Warehouse Bond	62	62	62
Workmen's Compensation Insurance and Comprehensive General Liability Insurance	251	271	306
Railroad Lease	100	100	100
	(1)	(1)	(1)
Fidelity Bond	68	68	68
Total Salary Expense	7,334	7,934	8,934
Social Security Tax[b]	266	288	324
Audit Expense	250	250	250
Annual Meeting Expense	400	400	400
Directors' Fees	300	300	300
Interest on Capital	2,917	2,917	2,917
Electric Power Expense	252	252	326
Property Tax	500	500	500
Total Cost	16,346	16,988	18,133
Average Cost	.1362	.0708	.0535

[a]Figures in parentheses indicate number of permanent employees.

[b]Includes only amount paid by employer and does not include amount to be deducted and paid from total salary expense.

APPENDIX B, TABLE II

ANNUAL COST BUDGET FOR A GRAIN ELEVATOR WITH RATED STORAGE CAPACITY OF 200,000 BUSHELS

Expense	Quantity Handled[a] (Bushels) 100,000	294,669
	- Dollars -	
Depreciation (elevator & machinery) (Cost: $140,000)	3,500	3,500
Depreciation (office & scales) (Cost: $20,000)	1,000	1,000
Insurance (elevator & machinery)	108	108
Insurance (office & scales)	69	69
Federal Warehouse Bond	94	94
Workmen's Compensation Insurance and Comprehensive General Liability Insurance	212	314
Railroad Lease	100	100
	(1)	(1)
Fidelity Bond	68	135
Total Salary Expense	6,192	9,192
Social Security Tax[b]	224	333
Audit Expense	250	250
Annual Meeting Expense	400	400
Directors' Fees	300	300
Interest on Capital	4,083	4,083
Electric Power Expense	327	327
Property Tax	1,000	1,000
Total Cost	17,927	21,205
Average Cost	.1793	.0720

[a]Figures in parentheses indicate number of permanent employees.

[b]Includes only amount paid by employer and does not include amount to be deducted and paid from total salary expense.

APPENDIX B, TABLE III

ANNUAL COST BUDGET FOR A GRAIN ELEVATOR WITH RATED STORAGE CAPACITY OF 300,000 BUSHELS

Expense	Quantity Handled[a] (Bushels)					
	150,000	300,000	400,000	508,011	600,000	700,000
	- Dollars -					
Depreciation (elevator & machinery) (Cost: $185,000	4,625	4,625	4,625	4,625	4,625	4,625
Depreciation (office & scales) (Cost: $20,000)	1,000	1,000	1,000	1,000	1,000	1,000
Insurance (elevator & machinery)	143	143	143	143	143	143
Insurance (office & scales)	69	69	69	69	69	69
Federal Warehouse Bond	112	112	112	112	112	112
Workmen's Compensation Insurance and Comprehensive General Liability Insurance	311	379	379	482	516	653
Railroad Lease	100	100	100	100	100	100
	(1)	(1)	(1)	(1)	(1)	(1)
Fidelity Bond	68	68	68	135	135	135
Total Salary Expense	9,086	11,086	11,086	14,086	15,086	19,086
Social Security Tax[b]	329	402	402	511	547	692
Audit Expense	250	250	250	250	250	250
Annual Meeting Expense	400	400	400	400	400	400
Directors' Fees	300	300	300	300	300	300
Interest on Capital	5,396	5,396	5,396	5,396	5,396	5,396
Electric Power Expense	429	429	429	459	514	574
Property Tax	1,500	1,500	1,500	1,500	1,500	1,500
Total Cost	24,118	26,259	26,259	29,568	30,693	35,035
Average Cost	.1608	.0875	.0656	.0582	.0512	.0500

[a]Figures in parentheses indicate number of permanent employees.

[b]Includes only amount paid by employer and does not include amount to be deducted and paid from total salary expense.

APPENDIX B, TABLE IV

ANNUAL COST BUDGET FOR A GRAIN ELEVATOR WITH RATED STORAGE CAPACITY OF 400,000 BUSHELS

Expense	Quantity Handled[a] (Bushels) 250,000	506,589	600,000
	- Dollars -		
Depreciation (elevator & machinery) (Cost: $230,000)	5,750	5,750	5,750
Depreciation (office & scales) (Cost: $20,000)	1,000	1,000	1,000
Insurance (elevator & machinery)	178	178	178
Insurance (office & scales)	69	69	69
Federal Warehouse Bond	131	131	131
Workmen's Compensation Insurance and Comprehensive General Liability Insurance	375	481	515
Railroad Lease	100	100	100
	(1)	(2)	(2)
Fidelity Bond	68	135	135
Total Salary Expense	10,954	14,054	15,054
Social Security Tax[b]	397	509	546
Audit Expense	350	350	350
Annual Meeting Expense	400	400	400
Directors' Fees	300	300	300
Interest on Capital	6,708	6,708	6,708
Electric Power Expense	504	504	514
Property Tax	2,000	2,000	2,000
Total Cost	29,284	32,669	33,750
Average Cost	.1171	.0645	.0562

[a]Figures in parentheses indicate number of permanent employees.

[b]Includes only amount paid by employer and does not include amount to be deducted and paid from total salary expense.

APPENDIX B, TABLE V

ANNUAL COST BUDGET FOR A GRAIN ELEVATOR WITH RATED STORAGE CAPACITY OF 500,000 BUSHELS

Expense	Quantity Handled[a] (Bushels)					
	125,000	250,000	400,000	531,669	750,000	1,000,000
	- Dollars -					
Depreciation (elevator & machinery)(Cost: $275,000)	6,875	6,875	6,875	6,875	6,875	6,875
Depreciation (office & scales)(Cost: $20,000)	1,000	1,000	1,000	1,000	1,000	1,000
Insurance (elevator & machinery)	213	213	213	213	213	213
Insurance (office & scales)	69	69	69	69	69	69
Federal Warehouse Bond	150	150	150	150	150	150
Workmen's Compensation Insurance and Comprehensive General Liability Insurance	464	476	495	500	507	514
Railroad Lease	100	100	100	100	100	100
	(2)	(2)	(2)	(2)	(2)	(2)
Fidelity Bond	135	135	135	135	135	135
Total Salary Expense	13,579	13,929	14,479	14,629	14,829	15,029
Social Security Tax[b]	492	505	525	530	538	545
Audit Expense	350	350	350	350	350	350
Annual Meeting Expense	400	400	400	400	400	400
Directors' Fees	300	300	300	300	300	300
Interest on Capital	8,021	8,021	8,021	8,021	8,021	8,021
Electric Power Expense	504	504	504	504	603	740
Property Tax	2,500	2,500	2,500	2,500	2,500	2,500
Total Cost	35,152	35,527	36,116	36,276	36,590	36,941
Average Cost	.2812	.1421	.0903	.0682	.0488	.0369

[a]Figures in parentheses indicate number of permanent employees.

[b]Includes only amount paid by employer and does not include amount to be deducted and paid from total salary expense.

APPENDIX B, TABLE VI

ANNUAL COST BUDGET FOR A GRAIN ELEVATOR WITH RATED STORAGE CAPACITY OF 600,000 BUSHELS

Expense	Quantity Handled[a] (Bushels) 250,000	450,000	757,707	1,200,000	1,500,000
	- Dollars -				
Depreciation (elevator & machinery) (Cost: $315,000)	7,875	7,875	7,875	7,875	7,875
Depreciation (office & scales) (Cost: $20,000)	1,000	1,000	1,000	1,000	1,000
Insurance (elevator & machinery)	244	244	244	244	244
Insurance (office & scales)	69	69	69	69	69
Federal Warehouse Bond	169	169	169	169	169
Workmen's Compensation Insurance and Comprehensive General Liability Insurance	428	452	678	746	883
Railroad Lease	100	100	100	100	100
	(2)	(2)	(3)	(3)	(4)
Fidelity Bond	135	135	151	151	151
Total Salary Expense	12,515	13,215	19,815	21,815	25,815
Social Security Tax[b]	454	479	718	791	936
Audit Expense	350	350	350	350	350
Annual Meeting Expense	400	400	400	400	400
Directors' Fees	300	300	300	300	300
Interest on Capital	9,188	9,188	9,188	9,188	9,188
Electric Power Expense	984	984	984	984	1,015
Property Tax	3,000	3,000	3,000	3,000	3,000
Total Cost	37,211	37,960	45,041	47,182	51,495
Average Cost	.1488	.0844	.0594	.0393	.0343

[a]Figures in parentheses indicate number of permanent employees.

[b]Includes only amount paid by employer and does not include amount to be deducted and paid from total salary expense.

APPENDIX B, TABLE VII

ANNUAL COST BUDGET FOR A GRAIN ELEVATOR WITH RATED STORAGE CAPACITY OF 700,000 BUSHELS

Expense	Quantity Handled[a] (Bushels)				
	400,000	750,000	983,000	1,500,000	2,000,000
	- Dollars -				
Depreciation (elevator & machinery) (Cost: $355,000)	8,875	8,875	8,875	8,875	8,875
Depreciation (office & scales) (Cost: $20,000)	1,000	1,000	1,000	1,000	1,000
Insurance (elevator & machinery)	275	275	275	275	275
Insurance (office & scales)	69	69	69	69	69
Federal Warehouse Bond	188	188	188	188	188
Workmen's Compensation Insurance and Comprehensive General Liability Insurance	673	701	854	1,060	1,111
Railroad Lease	100	100	100	100	100
	(3)	(3)	(4)	(5)	(5)
Fidelity Bond	151	151	151	151	151
Total Salary Expense	19,683	20,483	24,983	30,983	32,483
Social Security Tax	714	743	906	1,123	1,178
Annual Meeting Expense	400	400	400	400	400
Directors' Fees	300	300	300	300	300
Interest on Capital	10,354	10,354	10,354	10,354	10,354
Electric Power Expense	984	984	984	1,015	1,290
Property Tax	3,500	3,500	3,500	3,500	3,500
Total Cost	47,716	48,573	53,389	59,843	61,724
Average Cost	.1193	.0648	.0543	.0399	.0309

[a]Figures in parentheses indicate number of permanent employees.

[b]Includes only amount paid by employer and does not include amount to be deducted and paid from total salary expense.

APPENDIX B, TABLE VIII

ANNUAL COST BUDGET FOR A GRAIN ELEVATOR WITH RATED STORAGE CAPACITY OF 800,000 BUSHELS

	Quantity Handled[a] (Bushels)				
Expense	100,000	300,000	942,195	1,800,000	2,300,000
			- Dollars -		
Depreciation (elevator & machinery)(Cost; $395,000)	9,875	9,875	9,875	9,875	9,875
Depreciation (office & scales)(Cost: $20,000)	1,000	1,000	1,000	1,000	1,000
Insurance (elevator & machinery)	306	306	306	306	306
Insurance (office & scales)	69	69	69	69	69
Federal Warehouse Bond	206	206	206	206	206
Workmen's Compensation Insurance and Comprehensive General Liability Insurance	549	617	822	1,164	1,335
Railroad Lease	100	100	100	100	100
Fidelity Bond	151	151	151	151	151
Total Salary Expense	16,047	18,047	24,047	34,047	39,047
Social Security Tax[b]	582	654	872	1,234	1,415
Audit Expense	450	450	450	450	450
Annual Meeting Expense	400	400	400	400	400
Directors' Fees	300	300	300	300	300
Interest on Capital	11,521	11,521	11,521	11,521	11,521
Electric Power Expense	984	984	984	1,180	1,455
Property Tax	4,000	4,000	4,000	4,000	4,000
Total Cost	46,540	48,680	55,103	66,003	71,630
Average Cost	.4654	.1623	.0585	.0367	.0311

[a]Figures in parentheses indicate number of permanent employees.

[b]Includes only amount paid by employer and does not include amount to be deducted and paid from total salary expense.

APPENDIX B, TABLE IX

ANNUAL COST BUDGET FOR A GRAIN ELEVATOR WITH RATED STORAGE CAPACITY OF 900,000 BUSHELS

Expense	Quantity Handled[a] (Bushels) 500,000	700,000	1,090,318	1,500,000
	- Dollars -			
Depreciation (elevator & machinery)(Cost: $435,000)	10,875	10,875	10,875	10,875
Depreciation (office & scales)(Cost: $20,000)	1,000	1,000	1,000	1,000
Insurance (elevator & machinery)	337	337	337	337
Insurance (office & scales)	69	69	69	69
Federal Warehouse Bond	225	225	225	225
Workmen's Compensation Insurance and Comprehensive General Liability Insurance	651	788	939	1,082
Railroad Lease	100	100	100	100
	(2)	(3)	(4)	(5)
Fidelity Bond	135	151	151	151
Total Salary Expense	19,045	23,045	27,445	31,645
Social Security Tax[b]	690	835	995	1,147
Audit Expense	450	450	450	450
Annual Meeting Expense	400	400	400	400
Directors' Fees	300	300	300	300
Interest on Capital	12,688	12,688	12,688	12,688
Electric Power Expense	984	984	984	1,015
Property Tax	4,500	4,500	4,500	4,500
Total Cost	52,449	56,747	61,458	65,984
Average Cost	.1049	.0811	.0564	.0440

[a]Figures in parentheses indicate number of permanent employees.

[b]Includes only amount paid by employer and does not include amount to be deducted and paid from total salary expense.

APPENDIX B, TABLE X

ANNUAL COST BUDGET FOR A GRAIN ELEVATOR WITH RATED STORAGE CAPACITY OF 1,700,000 BUSHELS

	Quantity Handled[a] (Bushels)				
Expense	800,000	1,200,000	1,665,701	2,000,000	2,400,000
	- Dollars -				
Depreciation (elevator & machinery) (Cost: $735,000)	18,375	18,375	18,375	18,375	18,375
Depreciation	1,000	1,000	1,000	1,000	1,000
Insurance (elevator & machinery)	569	569	569	569	569
Insurance (office & scales)	69	69	69	69	69
Federal Warehouse Bond	331	331	331	331	331
Workmen's Compensation Insurance and Comprehensive General Liability Insurance	1,380	1,385	1,390	1,407	1,424
Railroad Lease	100	100	100	100	100
	(8)	(8)	(8)	(8)	(8)
Fidelity Bond	185	185	185	185	185
Total Salary Expense	40,345	40,495	40,645	41,145	41,645
Social Security Tax[b]	1,463	1,468	1,473	1,492	1,510
Audit Expense	500	500	500	500	500
Annual Meeting Expense	400	400	400	400	400
Directors' Fees	300	300	300	300	300
Interest on Capital	21,438	21,438	21,438	21,438	21,438
Electric Power Expense	2,013	2,013	2,013	2,013	2,013
Property Tax	8,500	8,500	8,500	8,500	8,500
Total Cost	96,968	97,128	97,288	97,824	98,359
Average Cost	.1212	.0809	.0584	.0489	.0410

[a]Figures in parentheses indicate number of permanent employees.

[b]Includes only amount paid by employer and does not include amount to be deducted and paid from total salary expense.

APPENDIX C

THEORETICAL EFFECTS OF A REGRESSIVE RATE SCHEDULE UPON TOTAL ELECTRIC POWER COSTS

The impact of a decline in power rates per KWH for increased levels of KWH consumption is exemplified in Table I of this appendix. These increases in KWH consumption are reflected by a series of hypothetical upward shifts in the number of elevations.[1] The effect of the minimum monthly power bill is not included in this discussion.

Using any one of the four levels of the quantities of grain handled as the initial point of departure, the percentage increases in the number of elevations exceed the corresponding percentage increases in total electric power costs.

For example, if 100,000 bushels were elevated only one time, then the associated total annual costs would be $110.76. Successive 25 percent increases in the number of elevations result in a series of increases in annual power costs of approximately 21 percent. The cumulative effect of this four percent differential can be noted by comparing the increase in total annual costs for one elevation and two

---

[1]The term "elevations" refers to the number of times the total quantity of bushels going in and out of the elevator is moved (elevated). These elevations are via the "leg" from one bin unit to another or for any other specific movement. The power source of the "leg" is typically from large three-phase electric motors.

elevations. In this case, a 100 percent rise in the number of elevations is accompanied by a rise of only 86 percent in total annual power costs. Consequently, annual costs have increased from $110.76 to only $206.16.

Based upon the schedule of power rates and the assumption of a 40 bushel elveation rate per KWH all quantities elevated <u>in excess of</u> 60,000 bushels per month (720,000 bushels per year) would be charged at a rate of 2.2¢ per KWH. However, the regressive rate effect upon all quantities <u>under</u> these amounts causes the percentage increases in the number of elevations to exceed the percentage increases in total power costs regardless of the number of bushels elevated. Again, minimum monthly power costs are excluded from the discussion.

The effect of the regressive power rate schedule upon the relationship between total annual power costs and the number of elevations is shown in the table for three alternative initial handling volumes.

APPENDIX C, TABLE I

TOTAL ANNUAL ELECTRIC POWER COSTS ASSOCIATED WITH ALTERNATIVE NUMBERS OF ELEVATIONS AND OF BUSHELS HANDLED[a]

Number of Elevations[b]	Annual Quantity Handled[c] (Bushels) 100,000	900,000	1,700,000	2,400,000
	- Dollars -			
1.00	110.76	684.96	1,125.00	1,509.96
1.25	134.52	808.68	1,358.64	1,839.96
(25)	(21)	(18)	(21)	(22)
1.50	158.28	932.28	1,592.28	2,169.96
(50)	(42)	(36)	(42)	(44)
1.75	181.92	1,056.12	1,826.28	2,499.96
(75)	(64)	(54)	(62)	(66)
2.00	206.16	1,179.96	2,059.92	2,829.96
(100)	(86)	(72)	(83)	(87)

[a]Minimum monthly power costs are not considered in this table. For the monthly power rates, see page 82 of the text.

[b]Numbers in parentheses are percentage increases in elevations from the number at the top of the column.

[c]Numbers in parentheses are percentage increases in total cost from the total cost at the top of each column.

VITA

Edward McCrory Corley

Candidate for the Degree of

Doctor of Philosophy

Thesis: ESTIMATED EFFECTS OF VARIATIONS IN WHEAT PRODUCTION UPON COST LEVELS OF COUNTRY ELEVATORS IN NORTHWESTERN OKLAHOMA

Major Field: Agricultural Economics

Biographical:

Personal Data: Born in Mattoon, Illinois, January 11, 1935, the son of Guy and Margaret McCrory Corley.

Education: Attended grade school in Charleston, Illinois; graduated from Charleston Community High School in 1953; received the Bachelor of Science degree from Colorado State University, Fort Collins, Colorado, with a major in Agricultural Economics, in June, 1957; received the Master of Science degree from the University of Illinois, Urbana, Illinois, with a major in Agricultural Economics, in August, 1958; engaged in post graduate study toward the degree of Doctor of Philosophy at Oklahoma State University, Stillwater, Oklahoma, from January, 1961, to the present.

Professional Experience: Served with the United States Army from September, 1958, to September, 1960; employed as Research Assistant in the Department of Agricultural Economics, Oklahoma State University, Stillwater, Oklahoma, from January, 1961 to the present.