MARKETING OF FARM WOODLOT PRODUCTS

IN EASTERN OKLAHOMA

By

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CHAPTER I

PROBLEM SETTING

A. INTRODUCTION

The problem of low-farm income in any area is composed of many facets. This study will investigate only a small segment of this low-income problem. But to understand this segment, it must be placed in perspective with the more important facets of the general problem of low-farm income.

In this study of the problem there are three major factors to be related. These are farm income, forest resources, and forest markets. Farm income is in part dependent upon resources. But production and markets must develop simultaneously to increase incomes from increased resource use. The growth of income and one product such as wood and its market may generate growth in other products and their markets with concomitant further increases in farm income.

The primary purpose of improving the level of income in an area is to improve the welfare of not only that area but of the state and nation. Since eastern Oklahoma is a low-income area of the United States, any measure to improve the incomes of families in this sector must necessarily result in affecting the economy of the nation, regardless of how minute the change may be.

The following chapters will concentrate on the forest markets of the area. But to place the study in perspective with the more indirect aspects of the low-farm income problem, the nature of this problem and the extent of forest resources in the area must first be examined.

B. PRESENT SITUATION

1. Low Income -

Eastern Oklahoma farm families have relatively low incomes, a problem also found in other areas of the United States. Action to relieve this situation has recently been of major importance.

W. E. Hendrix states why the nation as a whole should be concerned with the low-income problem:

> If the low incomes now observed in American agriculture are a result of the underemployment and underdevelopment of the resources these low-income people have, including their personal abilities, then they represent for the rest of the economy a loss of otherwise available markets for the goods and services that it has the capacity to produce. The loss of these potential markets, in turn, means for the rest of the nation's people a lower level of employment and income and a lower level of living than they would otherwise have.[1]

In his 1954 report to Congress, President Eisenhower made policy recommendations for action on rural poverty in the United States. Emphasis has been placed on research to study the low-income problem especially by land grant colleges.

More than a fourth of the farm families in the United States have low earnings. In 1950, there were roughly 5.4 million farm operator families of which about 1.5 million had cash incomes under $1,000. Five-eights (225 areas) of the total number of economic areas had median incomes of $1,500 or more. One-eighteenth (20 areas) of the total number

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[1] W. E. Hendrix, "The Problem of the Low Farm Incomes," In Aly, B., and Rogge, E. A., ed. <u>American Farm Policy</u>, Vol. 1, (National University Extension Association Discussion and Debate Manual No. 30, Columbia, Mo., 1956), p. 214.

of economic areas with median incomes of $1,500 or more are found in the 13 southern states. Only 3 of Oklahoma's thirteen economic areas have median incomes of $1,500 or more. Fifty-one of the nation's economic areas have median incomes of less than $1,000.

Criteria to examine the standards of living of farm families were developed by the United States Department of Agriculture.[2]

The degree of seriousness of the low-income problem of counties was classified as moderate, substantial or serious by these criteria. The classification of the low-income problem counties was as follows:

Moderate--any one of the three standards was present;

Substantial--any two of the three standards were present;

Serious--all three standards were present.

Thirty-eight counties in Oklahoma have a rural low-income problem by this classification (Figure 1). No counties are in the "substantial class" in Oklahoma. In Figure 1, the 29 counties classed as moderate are cross-hatched and the 9 counties classed as serious are shaded. The 9 counties classed as serious are included in this study.

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[2] Criteria for 1949; 1. A residual farm income to operator and family labor in 1949 of less than $1,000 provided the state economic area had a level of living index below the average for the region and had 25 percent or more of its commercial farms classified as "low production." Residual income to operator and family represents the income (including value of home use) above operating expenses and a return to capital invested in land and machinery. 2. A level of living index in the lowest fifty of the nation. Items in the index include (1) percentage of farms with electricity, (2) percentage of farms with telephones, (3) percentage of farms with automobiles, and (4) average value of products sold. 3. "Low production" farms comprising 50 percent or more of the commercial farms. Low-production farms are those with sales of $250-$2,499 with the operator not working off farm as much as 100 days and farm sales exceeding family income from other sources.

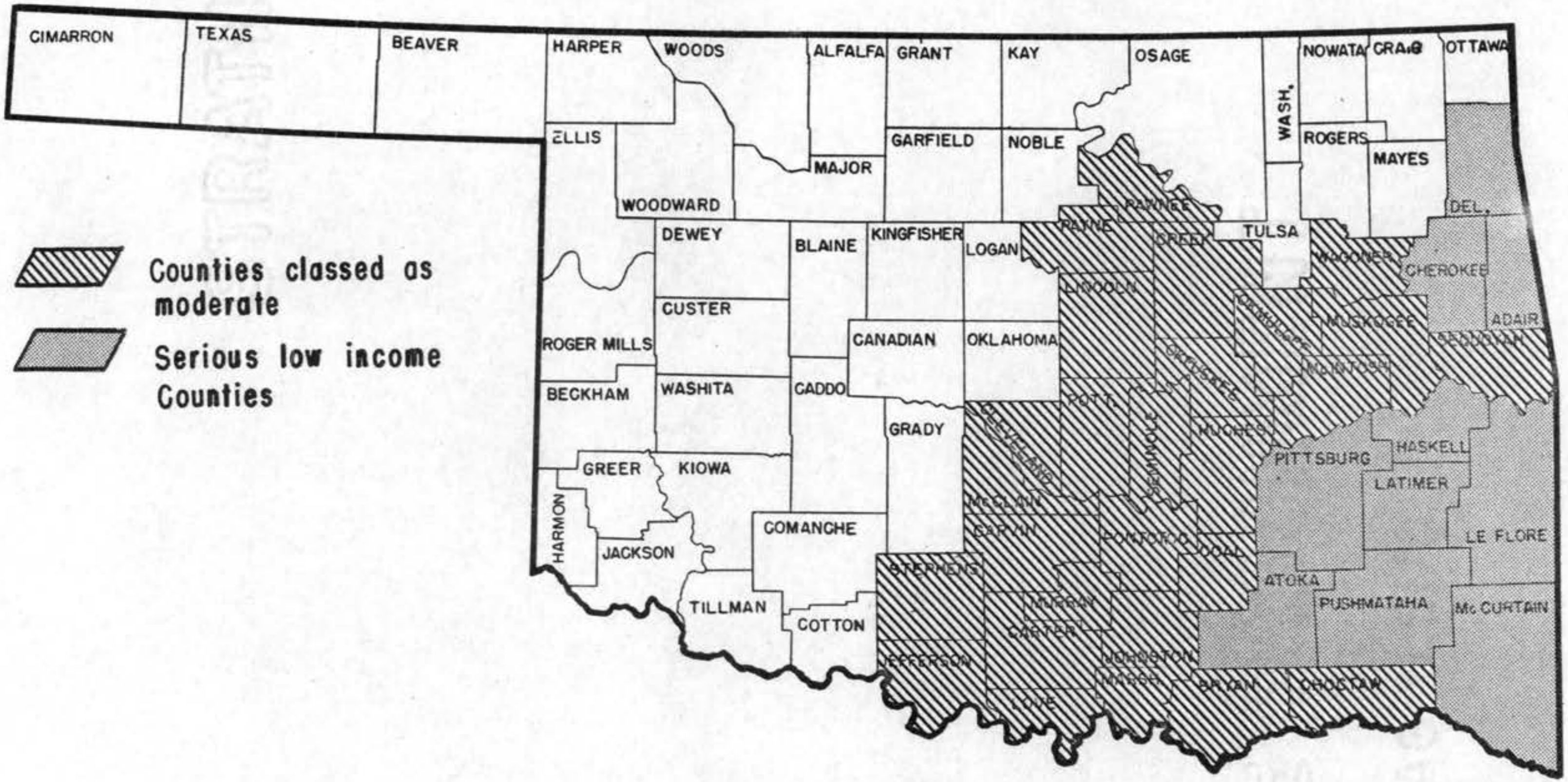

Figure I. Counties in Oklahoma with Serious and Moderate Rural Low Income Problem-1949

In 1957, a similar delineation of the low-income area was prepared by the United States Department of Agriculture (Figure II). The criteria used was necessarily different from that of 1949 as data on residual income was not available for 1954.[3] Eleven counties meeting both criterion are shaded. The counties in criterion one only are dotted and those counties classed in criterion two only are cross-hatched.

Even though the classifications used in preparing the two maps are somewhat different, there remains a similarity in the delineation of the low-income counties. The use of readily available data based on the 1954 census, provides more recent information on the low-income farming areas. With the exception of Muskogee County, all counties in this study are classed as low-income farming areas in both 1949 and 1954.

In summary, the low farm income problem is serious nationally, and one of the areas of its concentration is eastern Oklahoma. The next section will examine whether forest resources in this area offer any hope of a partial solution. Certainly, help from any quarter would be welcome.

2. Forest Resources -

While eastern Oklahoma farm families have inferior incomes, they have the major forest resources. As a result of the recent Timber Resource Review conducted by the United States Forest Service in 1952, we know that nearly one-fourth (10,329,000 acres) of the state is forested land and that 5,907,000 acres of this land contains timber that can be converted

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[3]Criteria for 1954; 1. Lowest 500 counties ranked by level of living of farm operator families. 2. 500 counties with largest proportion of commercial farms having sales of farm products valued at less than $2,500.

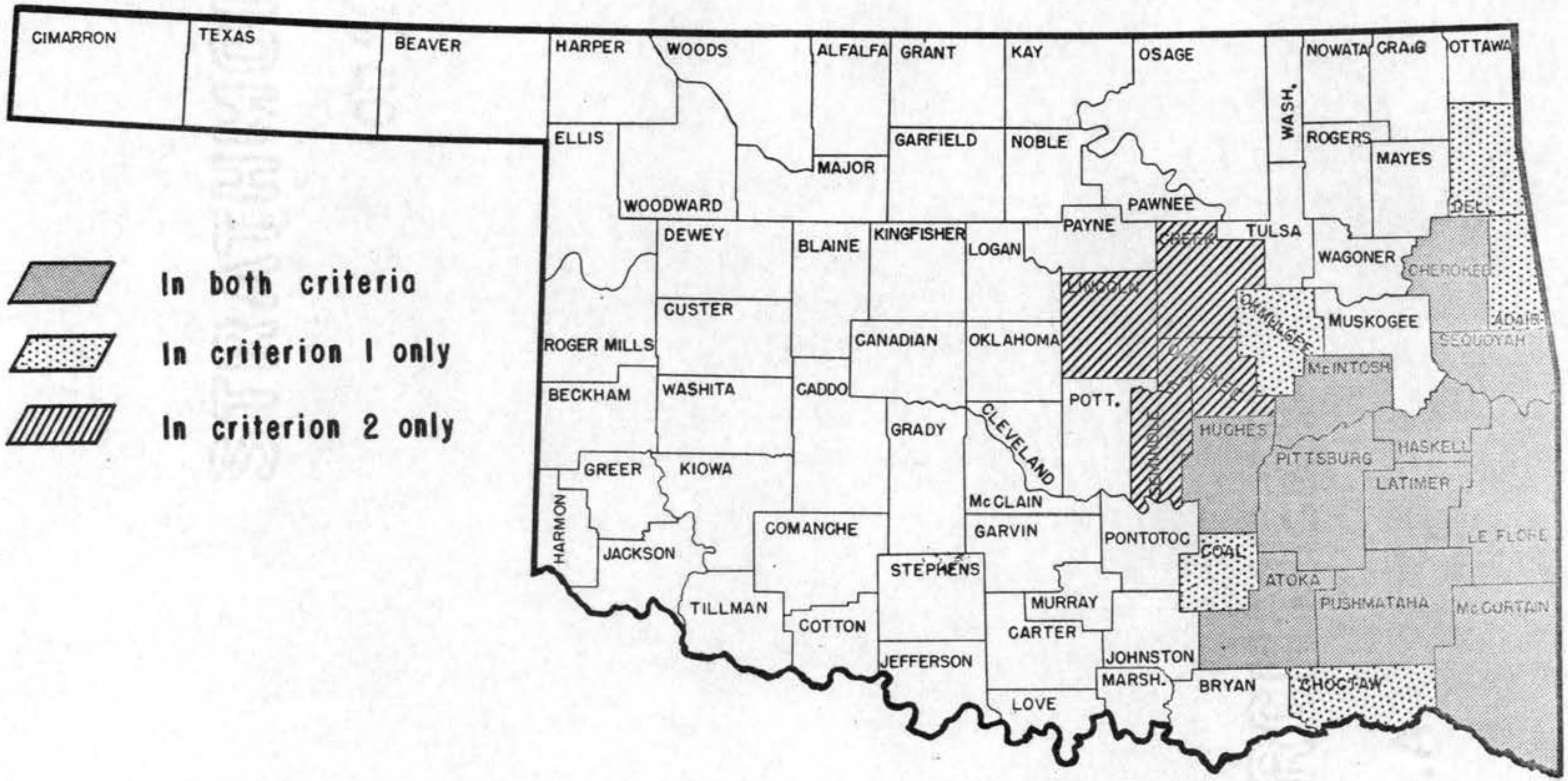

Figure II. Counties with Lowest Farm Income and Levels of Living, 1954, USDA, ARS and AMS, Neg. DN-1003 into lumber.[4] In addition, the timber cut from live sawtimber was 152,235,000 board feet. Pulpwood production has increased by 95.5 percent from 38,100 cords in 1955 to 74,500 cords in 1956.[5]

A publication, Oklahoma Forest Facts for 1956, states that the products of Oklahoma's wood-using industries are valued in excess of $50 million a year.[6] About $17 million are paid annually in wages to workers in these industries. According to the report, there are 445 industrial establishments in Oklahoma which are dependent on products of the forest. This number of establishments includes 297 sawmills. Approximately 5,000 persons are full-time employees in Oklahoma's wood-using industries. In the state, there is about 6.5 billion board feet of timber in trees of sawtimber size. Hardwoods comprise about two-thirds of the sawtimber volume. These statistics are primarily concerned with the commercial forest land of eastern Oklahoma.[7]

It is evident that the forest industries of Oklahoma are important in the state's economy. The income derived from forest production or any other single resource may make up a large portion of a family's income in this low-income area.

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[4] Timber Resource Review, Chapter IX, U.S.D.A., Forest Service, (Washington, D. C., September, 1955), p. 1,5.

[5] Joe F. Cristopher and Martha E. Nelson, "1956 Pulpwood Production in the South," U.S.D.A., Southern Forest Exp. Sta., Forest Survey Release 80, (New Orleans, Louisiana, June, 1957), p. 2.

[6] Oklahoma Forest Facts, 1956 Edition, published by American Forest Products Industries, Inc., (Washington, D. C.) p. 2.

[7] Commercial forest land as defined by the United States Forest Service, is that forest land which is (a) producing, or is physically capable of producing, usable crops of wood (usually sawtimber), (b) economically available now or prospectively, and (c) not withdrawn from timber utilization.

Figure III illustrates the distribution of the species of wood in eastern Oklahoma. It can be seen that the major pine resources are located in four counties of eastern Oklahoma. Although the figure fails to reveal any other pine areas, some small areas in other counties have a limited amount of this wood species. Outside of the southeast section, hardwoods are the primary timber species. The term hardwood is used to mean all species other than pine.

C. GENERAL OBJECTIVES

1. Improve incomes--As is true with most economic studies, one of the objectives is to increase the level of income or economic welfare for the segment being studied. To see how forest resources and forest markets can improve, if at all, income in eastern Oklahoma is of prime importance. The potential contribution of the forest industry to the income of farm families in eastern Oklahoma will be ascertained. This objective is, however, only indirectly attempted. The study will concentrate directly on a small number of factors contributing to the incomes of the area involved as follows.

2. Describe forest markets--A description of the existing structure and performance of forest markets will be developed. Information concerning the structure and performance of forest markets has been lacking for eastern Oklahoma.

3. Increase market knowledge of buyers and sellers--One of the major factors which contributes to imperfect competition is the lack of knowledge. With resource owners and buyers uninformed, the resource may return less income to its owner than would otherwise be possible. The lack of knowledge in eastern Oklahoma concerning outlets for forest

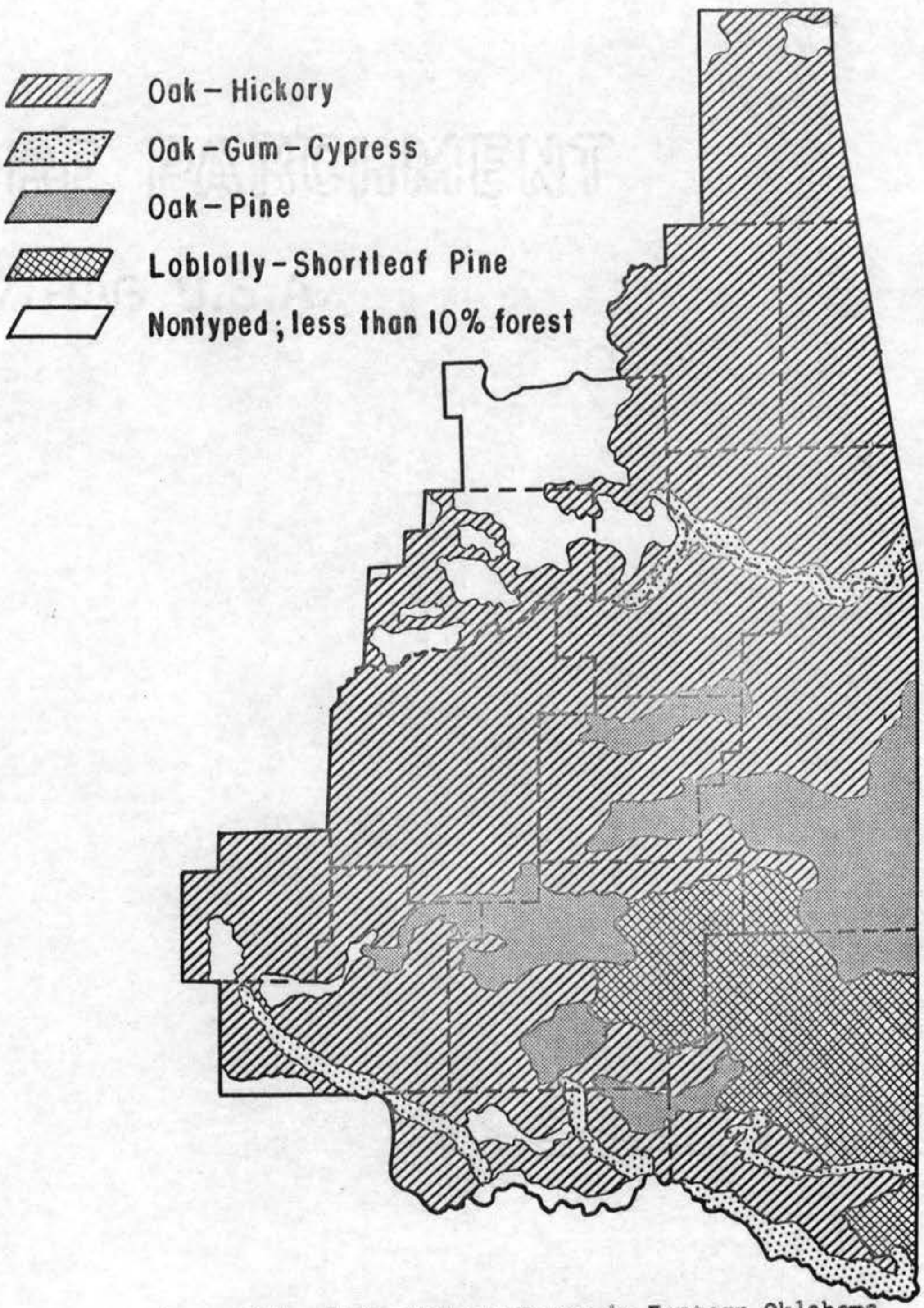

Figure III. Major Forest Types in Eastern Oklahoma resources has been prevalent for many years. By increasing knowledge, it is reasonable to assume that the result would be improved markets for forest resources.

4. Estimate market capacity in relation to production potential--There is no logical way of determining the current market capacity of the forest industry in eastern Oklahoma from published data. This study will attempt to estimate the potential production capacity of eastern Oklahoma and determine the current capacity of the forest markets. This will also include the ability of the existing market to process the potential production. If the current market is inadequate, the necessary changes in the market structure and performance will be determined.

5. Measure variability in firm cost efficiency--Determine how much variability is present within these similar types of firms. No estimate of the variability existing in the costs of similar firms is yet available.

The following chapter will define the more specific objectives of this study. It will also include a brief discussion of studies which have been made concerning the low-income problem and forest markets.

CHAPTER II

PROBLEM ANALYSIS

A. LOW INCOME THESES

1. General

Three objectives have been of primary concern in past research on the low-income problem. These are: (1) to develop measurements of the low-income problem, (2) to explain the development of rural low-income areas in the United States, and (3) to propose and examine alternative solutions. These objectives have gained recently in importance to economists. Many hypotheses have been developed to attain the second objective. Among these, the following are outstanding in recent literature and relevant to this study.

Professor W. H. Nicholls believes that the peculiar political and social history of our nation accounts for the origin of rural poverty.[1] Low-income rural areas remain poor because they are outside of the mainstream of economic progress. A long period of economic and cultural isolation resulted after early settlement in these areas. As a result, small subsistence farming was established. The domination of a state by larger and wealthier land owners caused political neglect of transportation and educational needs in southern communities.

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[1] W. H. Nicholls, "The South's Low-Income Problem," Farm Policy Forum, Vol. 8, No. 4 (Ames, Iowa State College Press, Spring, 1956), p. 13-19.

According to Nicholls, industrial-urban development of rural areas speeds readjustments towards higher productivity and incomes in agriculture because: (1) it is easier to get these underemployed farm people to change occupations than residence, (2) the drain on local capital is avoided, (3) industrialization brings capital which allows financial institution provide local agriculture with capital resources to increase farm size and efficiency, (4) improvement of the quality of human resources and stimulation of further economic development will result, and (5) new markets which are more efficient and competitive are created for locally-produced farm products and for the factors of farm production. This will stimulate development of resources which are adapted to the low-income areas. The improvement of forest land in the low-income counties can result from these more efficient and competitive markets.

W. E. Hendrix believes the low-income areas have existed because people in these areas have limited capital wealth and limited backgrounds of training and experience.[2] Hendrix believes we can alleviate the low-income problem by taking fuller cognizance in administering the agricultural agencies and programs which are already available. Two major changes must take place to raise the income of these people: (1) Improvement in the type, size and method of farming, and (2) move many of the people to more remunerative non-farm employment. He states that

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[2] W. E. Hendrix, "The Problem of Low-Income Farms," in B. Aly and E. A. Rogge, ed. American Farm Policy, Vol. 1 (National University Extension Association Discussion and Debate Manual No. 30, Columbia, Mo., 1956), p. 211.

many of the low-income farm people are too far along in age or their occupational handicaps are too great for them to move to non-farm jobs. Also, improvement in the low-income areas must be associated by changes in the types and sizes of farming, marketing and farm product processing facilities, and changes in tenure and credit. In some of the low-income areas, capital limitations inhibit the small farmer's competition with the larger farmer's.

In summary, the general attack on the low farm income problem has been very broad in scope. But some more specific theses have been advanced with regard to special crops and the low-income problem.

2. Specialty crops

The development of special crops in low-income areas has been suggested by some economists. This, they believe, can bring about the initiation of income raising processes which will perpetuate and in so doing will improve the level of living in the low-income areas. Hendrix believes that aggressive action aimed at exploiting such farm-improvement opportunities as now exist, even when these are small, may also help to spark the longer-run structural changes that are needed in low-income farm areas.[3] He states that the failure to exploit available opportunities because they are small or because they are immediately available to only a few low-income farmers, may be equivalent to adopting a policy of perpetuating the low-income problem because it cannot be solved in a single-step operation.

[3] W. E. Hendrix, "The Problem of the Low Farm Incomes", p. 217.

An example of exploitation of existent farm-improvement opportunities is being initiated in Latimer County. A program designed to improve the forestry on farms in this county is being developed under the guidance of the Extension Service. This is a step toward improving the incomes of farmers by using otherwise unproductive land. The development of income-raising cash crops applies not only to forestry but to other farm products of the low-income areas.

In addition to the better use of land, special crops bring about additions to income in the marketing sectors. The specialty crops give added need for the development of aggressive approaches because such programs already have the social sanction by both farm and nonfarm sectors of the economy, and most of the institutional framework for implementation of such approaches is already available. This is true in the forest industry where programs are at present in force which could reduce the establishment costs for a farm woodlot. From this it can be seen that specialty crops may offer one of the important approaches to the solution of the low-income problem.

3. Agricultural Markets and Economic Development

The development of agricultural markets and their effect on economic development are important in approaching the low-income problem. Nicholls believes that the efficiency, adequacy, and competitiveness of marketing services in a local community are probably related to its stage of economic development.[4] He states that in largely rural (underdeveloped) counties,

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[4] William H. Nicholls, unpub. Report of the Subcommittee on Low-Income Rural Areas, S.S.R.C. Committee on Agricultural Economics.

one would expect that the numbers, types, sizes, and varieties of marketing agencies--whether engaged in the purchase of farm products or in the sale of farm production goods--would be less adequate, efficient, and competitive than those in other once similar counties which have enjoyed considerable industrial-urban development. Progress toward higher labor productivity and higher family incomes in low-income rural areas necessarily involves certain concomitant changes in marketing institutions, facilities, services, and practices. If these changes are slow to occur, the resulting effect will probably retard the low-income areas. The local rate of development will probably be faster than it otherwise would have been if the changes on the marketing side accompany or lead production changes in agriculture.

As has been previously stated, this study is directed toward one method of alleviating the low-income problem. The general problem is to discover the nature of the forest market to determine not only what it is but whether it is leading or lagging development in local farming. The next section will view the present status of forest market studies.

B. FOREST MARKET STUDIES

1. General

Studies conducted in other areas on the forest industry have been numerous. The major portion concentrate on the efficiency of the forest market. Many purely descriptive studies have been completed by both public and private institutions. Only portions of the out-of-state research was relevant to this project. The studies related to market efficiency are aimed at improving management and use of forest resources. Only those studies which were helpful in this research will be mentioned.

A study in Massachusetts by Rich and Sisterhenm was made to analyze current marketing practices, attitudes regarding sales, and the effectiveness of such practices and policies.[5] The ultimate objective of this study was to increase the land owner's income. Similar studies were made in Maine by Baker and Beyer, New Hampshire by Swain and Wallace, and Pennsylvania by Carroll, Trotter and Norton.[6] These were made in conjunction with a study of marketing from small woodland areas in the northeast under the supervision of the Northeastern Regional Technical Committee.[7] The objectives of the northeast survey were to obtain information about the forest marketing practices, the pricing processes at the farm level, and some of the factors which affect the practices and prices. This survey dealt only with land owners who had woodlots from 10 to 500 acres in size.

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[5] J. Harry Rich and George H. Sisterhenm, Marketing Forest Products in Massachusetts, Agricultural Experiment Station Bulletin No. 492 (University of Massachusetts, 1955).

[6] Gregory Baker and Frank E. Beyer, Marketing Forest Products from Small Woodland Areas in Maine, Agricultural Experiment Station Bulletin No. 554 (University of Maine, December, 1956).

Lewis C. Swain and Oliver F. Wallace, Marketing Forest Products in New Hampshire, Agricultural Experiment Station Bulletin No. 420 (University of New Hampshire, June, 1955).

W. M. Carrol, C. E. Trotter and N. A. Norton, Marketing Forest Products in Pennsylvania, Pennsylvania Agricultural Experiment Station Progress Report No. 131 (Pennsylvania State College, January, 1955).

[7] Northeastern Regional Technical Committee. Marketing Forest Products from Small Woodland Areas in the Northeast, Northeast Regional Publication No. 25 (Vermont Agricultural Experiment Station Bulletin No. 595, Burlington, Vermont, June, 1956).

2. Local

No marketing research has been performed pertaining to forestry in eastern Oklahoma. A survey of forest industries in Oklahoma by Linn was made in 1948.[8] The survey was developed to obtain accurate knowledge of the extent and location of forests, sawmills, and wood-using industries. Many of the sawmills and other wood-using industries in Linn's survey are no longer in existence. Nevertheless, the information in his study was helpful in locating some of the major wood-using industries which are currently operating in eastern Oklahoma.

A publication, Oklahoma Forest Facts, was compiled by the American Forest Products Industries, Inc. with the aid of the Extension Forester and the Director of the State Division of Forestry.[9] The 1956 edition contains general information about Oklahoma's forest resources and forest industries.

Studies relating to forest resources in Oklahoma have been made by the Southern Forest Experiment Station. The initial survey was made in a five county area (Haskell, Le Flore, Latimer, Pushmataha and McCurtain) of southeastern Oklahoma in 1936.[10] The objective of the study was (1) to make an inventory of the supply of timber and other forest products,

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[8] Ed R. Linn, A Forest Industries Survey of Oklahoma, Experiment Station Bulletin No. B-325, Oklahoma Agricultural Experiment Station (Stillwater, Oklahoma, December, 1948).

[9] Oklahoma Forest Facts, 1956 edition, Published by American Forest Products Industries, Inc., (Washington, D. C.).

[10] I. F. Eldredge, "Forest Resources of Southeast Oklahoma," Forest Survey Release No. 37, United States Department of Agriculture, Southern Forest Experiment Station, (New Orleans, Louisiana, October 18, 1938).

(2) to ascertain the increase in supply of timber through growth, (3) to determine the decrease in supply of timber due to industrial and local use, windfall, fire and disease, and (4) to correlate the findings with existing and anticipated economic conditions. The more recent study included seventeen counties in eastern Oklahoma.[11] This 1955-1956 Forest Survey had as its purpose only the first three items of the 1936 survey. This survey gives the most complete forest resource information for eastern Oklahoma as yet available.

In 1955, the forest service published the Timber Resource Review.[12] The data breakdown is by states and not detailed by counties. However, Oklahoma data is separated for eastern and western Oklahoma. In eastern Oklahoma, it includes the same counties as this study. The purpose of the review was to provide a stock-taking of the current timber situation in the United States and a look at the future with respect to prospective timber supplies and needs.

Since this is only the second forest market study at this institution, selected publications which are related to the forest marketing area are included in the bibliography. All of the publications listed are not specifically related to this thesis. It is felt that listed publications which were not used in the preparation of this thesis will be beneficial to those doing future research on forest markets in Oklahoma.

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[11] Philip A. Wheeler, "Forests of East Oklahoma," Forest Survey Release No. 79, United States Department of Agriculture, Southern Forest Experiment Station (New Orleans, Louisiana, June, 1957).

[12] George F. Burks, Timber Resource Review, Chapter IX, United States Department of Agriculture, Forest Service (Washington, D. C., September, 1955).

C. SPECIFIC OBJECTIVES

1. Detailed Description of the Forest Industry

No recent attempts have been made to take inventory of the forest markets in eastern Oklahoma. Here we are concerned with describing in detail the existing market, and its components. The size, type, location of the various firms operating within the forest industry will be defined.

2. Directory of Forest Industries

The lack of knowledge by sellers of forest products and the buyers of processed wood has been indicated by individuals associated with the forest industry. The directory will provide a three-way classification of the wood industries and will include the information which provide a better informed buyer and seller. Three separate parts of the directory will facilitate immediate access to firm's name, location, and other pertinent information. Through the directory a more adequate, efficient and competitive market can be developed for forest products.

3. Analysis of Sawmill Capacity and Associated Costs

a) Capacity with respect to yearly duration of operation

If the sawmill industry is not presently working at a capacity with respect to time, then the capacity at this level will be estimated. This will aid in determining the current capacity of the sawmill industry as presently constituted and allow for estimating the potential maximum production, assuming forest resources are freely available.

b) Capacity of the firm--

Individual firm capacity will be analyzed for different sawmill types. Cost and output data will be analyzed to determine the optimum sawmill for each type operated. The mills will be classified by the type of equipment.

Cost functions will be fitted to each type of mill to arrive at minimum costs and thereby arriving at the optimum output for each mill type.

c) Capacity of the industry--

By the use of individual firm output and cost data, some estimate of industry capacity will be attempted. This should give some idea of potential output and costs for the industry where firm adjustment has been assumed and all firms are operating at the long-run optimum point of efficiency.

4. Variability of Sawmill Costs

The amount of variability for fixed costs will be estimated between the different firm types. The firms used in estimating the variability will be from all counties surveyed. If a great amount of variability exists, the cause may be explained by analysis of the data.

The variability of variable costs within the firms will also be estimated. Some assessment of the degree to which variation in output explains variability in costs will also be attempted. The major components of this variability will be discussed.

5. Provide Base for Further Efficiency Research

The data from the study will provide needed information for any future study. It will also point to the need for further research especially with respect to the need for a more detailed cost and efficiency analysis. This study did not obtain information for an ideal efficiency study but may provide an idea of the importance of the sawmill industry and an approximate evaluation of costs and efficiency. As would be necessary for any efficiency study, existing conditions in the forest industry must be examined. This study will provide that base.

D. GENERAL PROCEDURE

1. Selection of Area

The area of eastern Oklahoma was selected for two major reasons: (1) the fifteen counties are designated as a low-income area, and (2) this area contains the major forest resources of Oklahoma. These reasons have been illustrated in Chapter I. The counties have been included in previous forest resource studies which will provide a basis for correlating the production and marketing aspects. Some of the fifteen counties have been or are being studied under the rural development program. Previous low income studies have been restricted to a smaller area in Oklahoma, however, to approach the forest marketing angle and its importance to farm income, it was necessary to include a large enough area to adequately describe the forest industry. The counties included in the area were Adair, Atoka, Cherokee, Choctaw, Coal, Delaware, Haskell, Latimer, Le Flore, McCurtain, McIntosh, Muskogee, Pittsburg, Pushmataha, and Sequoyah.

2. Enumeration Methods

The entire population of forest industry firms were contacted to obtain information relevant in satisfying the objectives of this study. One of the major difficulties was to obtain the location of existing firms. Aid in obtaining this information was solicited from the Extension Service, Soil Conservation Service, Forestry Service, and informed individuals in the forest industry. After a complete list of firms was available, schedules to obtain information from individual firms were designed. The Extension Service and the Soil Conservation Service were asked to aid in interviewing the firm's owner or operator.

The schedules were classified into three groups: (1) sawmills and/or planing mills; (2) pulp, post, pole, prop, piling, and tie buyers; and (3) miscellaneous outlets which include wood preserving plants, handle factories, charcoal plants, furniture factories, and crating factories. The data covered the firms' 1956 operations and the enumeration was taken during the summer of 1957. To obtain the highest number of completed firm schedules, the interview method was used.

3. Classification Methods for Directory

The directory provided a three-way classification of the wood industries of fifteen "timbered" counties of eastern Oklahoma. The information listed included the firm's name, operator's name, location, date of establishment, number of workers, wood products made, wood products used, wood type used (hardwood and/or pine) and the number of working days closed during 1956. The first part of the directory contained information classified by county with firms listed alphabetically within three industry groups. The second part provided the sellers of wood products with a list of the wood industries which use these raw materials. Part three was designed for use by the buyer in locating different products made. The directory included all firms which were in operation at the time of the survey regardless of the date of establishment. The Directory of Forest Industries in Eastern Oklahoma was published in 1958.

4. Description of the Industry

Information from the survey was tabulated for the whole industry and for the individual firm types within the industry. Tables were used to give a detailed description of existing conditions and firms were classified by county and firm type.

5. Methods of Capacity Estimation

Economic and statistical models were designed to estimate the capacity of different firm types and for the industry. These estimates were based on minimum costs of the particular firm type and for the whole industry. These were used to estimate the maximum capacity of the industry under the most efficient firm operation by types of firm.

In addition, the capacity of the present market was estimated by increasing the capacity of existing firms to at least 200 day operation per year. This gave an estimate of potential capacity with the existing levels of efficiency.

6. Cost Variability Estimates

The variability existing within firm types was assessed by using the costs from firms of the same type. Both fixed and variable costs will provide data to estimate cost variability. The standard deviation, coefficient of variation and estimate of variance were used in estimating the degree of variability.

CHAPTER III

DESCRIPTION OF THE FOREST INDUSTRY

A. WHOLE INDUSTRY

1. Volume and Value of Industry Production

The fifteen county area of eastern Oklahoma includes most of the forest resources of the State. The ownership of commercial forest land in Oklahoma is shown in Table 1. Since 1945, the commercial forest land in Oklahoma has increased. A large component of this change was the increase in acres of commercial forest land owned by farmers. The 812,000 acres of commercial forest land on farms in 1945 was for eastern Oklahoma. None was reported for western Oklahoma. In 1953, of the 2,240,000 acres of privately owned farm commercial forest land, 1,700,000 acres (68 percent) was in eastern Oklahoma with the remaining 540,000 acres in western Oklahoma. Also in 1953, only 100,000 acres (3 percent) of the private commercial forest land, other than farm, was in western Oklahoma. Of the 6,177,000 acres of commercial forest land, only 12.4 percent is found in western Oklahoma.

The <u>1957 Forest Survey Release</u> for eastern Oklahoma determined the timber trends in five counties (Haskell, Latimer, Le Flore, McCurtain and Pushmataha).[1] A similar survey in these counties was completed in 1938.

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[1] Phillip A. Wheeler, "Forests of East Oklahoma", <u>Forest Survey Release No. 79</u>, United States Department of Agriculture, Southern Forest Experiment Station (New Orleans, Louisiana, June, 1957).

TABLE I

OWNERSHIP OF COMMERCIAL FOREST LAND IN OKLAHOMA, 1945-1953

	1945[a]	1953[b]
	Acres	Acres
Total Commercial Forest Land	4,308,000	6,177,000
Federal Owned and Managed	619,000	270,000
State, County and Municipal Owned	23,000	89,000
Privately Owned	3,666,000	5,548,000
Farm	812,000	2,240,000
Other	2,854,000	3,308,000

[a]Source: Basic Forest Statistics for the United States as of January, 1945. Forest Service, U.S.D.A. (Washington, D. C., September, 1950).

[b]Source: Timber Resource Review, Summary of Basic Statistics, Chapter IX, Forest Service, U.S.D.A., (Washington, D. C., September, 1955).

From 1936 to 1956, there was a decrease of 1.3 percent in commercial forest land. There remained nearly 3 million acres of forested land in these counties, virtually the same as in 1936. Total numbers of hardwood trees (mostly oaks) declined but their total volume remained about the same. Changes in softwoods consisted in the liquidation of old-growth pine and a build-up in second-growth volume. Although there has been a decrease in large-diameter volume and an increase in middle and small diameter volume, the net effect on softwood sawtimber volume is that the five-county area had about the same volume in 1957 as in 1936. It should be emphasized that trends in these five counties are not necessarily indicators of forest resource changes elsewhere in Oklahoma. They are cited because both the prevailing timber types (mainly pine) and pattern of land ownership (mainly non-farm) in this area differ considerably from the rest of the commercial timber belt.

In Table II, the value of forest products by counties is presented including both census and survey data.

A small amount of double counting, due to wood passing from one forest industry to another, occurs in the total gross wood value and the total agri-business value for 1956. This double counting has been eliminated in obtaining the 1956 estimated gross farm value of forest products.

The percent pine columns were calculated by dividing the total value of forest products into the total value of pine for each county. To obtain the pine percentages in the fifteen-county total line, the summation of the fifteen-county forest products value was divided into the summation of the fifteen-county forest products value from pine.

From the census data, variability between census years is present in nearly all counties. These increases and decreases in values of farm forest products may be attributed to variation in the demand for wood products. From the survey results, in 1956 only five of the fifteen counties lie within the 1929-54 average deviation range for these counties. Most other counties lie above the range.

From the survey, data obtained shows that, in all counties except one, value of farm forest products has increased over the 1954 census year. Some of the counties which border Arkansas may be higher in value for 1956 since some of the timber products may have entered from this neighbor state. However, those counties bordering Arkansas contain some of Oklahoma's best timber resources and, therefore, the entire increase in value from farm forest products cannot be attributed to out-of-state timber.

TABLE II

VALUE OF FOREST PRODUCTS WITH PERCENT PINE,
1929-1956

County	1949 Census Farm Value (dollars)[a]	1954 Census Farm Value (dollars)[a]	1929-1954 Average Deviation Range Farm Value[b] (dollars)	1956 Gross Farm Value[c] (dollars)	1956 Gross Farm Percent Pine	1956 Agri-Business Value[d] (dollars)	1956 Agri-Business Percent Pine	1956 Total Gross Value[e] (dollars)	1956 Total Gross Percent Pine
Adair	13,952	13,225	9,000-47,000	74,105	23	204,105	8	204,105	8
Atoka	18,735	14,361	7,000-19,000	67,628	35	67,628	35	67,988	35
Cherokee	23,670	10,985	14,000-40,000	6,816	3	6,816	3	11,552	6
Choctaw	34,919	7,053	8,000-30,000	287,330	98	523,016	54	580,267	58
Coal	11,697	3,609	1,000-13,000	6,959	2	6,959	2	6,959	2
Delaware	24,618	7,869	8,000-52,000	104,448	1	104,448	1	105,730	2
Haskell	7,433	1,377	1,000- 5,000	2,455	36	2,455	36	5,753	64
Latimer	7,073	3,626	2,000- 6,000	5,890	96	5,890	96	63,086	86
Le Flore	45,343	20,140	11,000-33,000	65,409	99	115,535	99	803,798	99
McCurtain	45,988	35,653	26,000-52,000	91,847	87	163,947	49	1,526,454	76
McIntosh	3,336	4,315	2,000- 8,000	7,563	0	7,563	0	7,603	0
Muskogee	5,429	1,501	2,000- 6,000	3,410	0	3,410	0	3,450	0
Pittsburg	9,546	2,935	1,000-15,000	17,305	37	17,305	37	28,215	28
Pushmataha	17,823	26,151	11,000-25,000	36,946	39	36,946	39	200,705	87
Sequoyah	3,688	1,873	1,000-19,000	81,143	95	81,537	95	530,379	97
Total	273,250	154,673	120,000-340,000	859,254	72	1,347,560	46	4,146,044	75

[a]Source: U. S. Department of Commerce, Bureau of Census, U. S. Census of Agriculture, 1949, 1954, (Washington, D. C., 1949, 1954).

[b]For normal or moderately skewed distribution $P(|X - \bar{X}| \leq A.D.) = .575$, where $A\ D = (\Sigma|X|) \div N$.

[c]Excludes value of ties bought by tie yards and creosoting plants to eliminate double-counting.

[d]Includes value of all forest products of farm origin bought by the industries.

[e]Includes value of all forest products of farm and non-farm origin bought by the industries.

The major pine timber is located in southeastern Oklahoma and contributes more to the value of farm forest products than that of hardwood. The percentage of pine diminishes as a movement is made away from the southeastern Oklahoma area. The large farm value of pine in Adair county may be due to the concentration from neighboring counties, however, this county does contain some pine timber resources which are owned mostly by farmers.

In the fifteen-county area, the 1956 estimated gross farm forest products value was $859,254. This amount is 82 percent greater than that reported by the census of 1954. From this, it seems that the wood industry is more important to farm income than had previously been thought. This wood of farm owned origin contributed another half-million dollars of gross value when further processing had been accomplished as the value attributed to agri-business indicates.

According to the survey made by the Southern Forest Experiment Station, the commercial forest land of east Oklahoma supports a growing stock of 1.3 billion cubic feet, an average of 3 cords per acre.[2] The volume of sawtimber in east Oklahoma is 4 billion board feet which is fifty percent pine. In 1955, east Oklahoma net growth was 107 million cubic feet including 245 million board feet of sawtimber. Less than one-half of this net growth, 115 million board feet, was removed in 1955. The Forest Service also states that under the application of minimum forestry practices, the growing stock in east Oklahoma could be doubled.

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[2] Joe F. Christopher and Martha E. Nelson, "1956 Pulpwood Production in the South," Forest Survey Release No. 80, U.S.D.A., Southern Forest Experiment Station, (New Orleans, Louisiana, June, 1957).

This continues to point out the importance of forestry in east Oklahoma which in the past has not been recognized. An increase in production of forest products from the partly untapped forest resources, could bring about considerable improvement in the level of living in eastern Oklahoma especially to the farm owners many of whom are in the low-income group.

2. Volume and Value of Farm and Non-Farm Wood

The volume of forest products was classified by eight industries and by five different units of measure as shown in Table III. The major part of the wood cut in eastern Oklahoma consisted of pine. Charcoal wood buyers and handle stock buyers were the only industries buying hardwood alone. The only other industry with less than 50 percent pine were the tie buyers.

The industries which contributed most to income were the sawmills and creosote plants, each with over one million dollars value of forest products bought. In both cases, over 80 percent of the value of forest products can be attributed to the pine resources. The pine resources are of more value than are the hardwood resources. For instance, timber purchased by sawmills consisted of 72 percent pine by volume while the pine value was 88 percent of the total value of the wood sawn.

The industries contributing most to farm income from wood products are sawmills and creosoting plants. However, most of the income is from non-farm timber resources in these two industries. In only the charcoal wood buyers and handle stock buyers does the major portion of the income go to farmers who own these resources. It may also be noted that no pine is used in these two industries.

TABLE III

VOLUME AND VALUE OF NON-FARM AND FARM WOOD, WITH PERCENT PINE BY TYPES AND NUMBERS OF INDUSTRIES

Industry		Volume			Industry Value			Farm Value	
Class	Number[a]		Unit	Percent Pine	Total (dollars)	Percent Pine	Percent of Total Value	Estimated Total (dollars)	Percent of Industry Value
Sawmills	124	78,865,000	Bd.Ft.	72	1,387,219	88	33	235,692	17
Pulp Buyers	12	37,540	units	81	411,750	88	10	96,998	24
Pole Buyers	3	56,000	pieces	100	71,150	100	2	375	1
Props and Posts Buyers	29	2,384,000	pieces	76	310,640	63	7	79,905	26
Tie Buyers	4	425,000	pieces	24	496,200	20	12	---	--
Charcoal Wood Buyers	4	2,550	cords	0	22,800	0	1	21,000	92
Handle Stock Buyers	3	1,850	cords	0	36,750	0	1	36,750	100
Creosoting Plants	5	3,699,620	Cu.Ft.	82	1,409,535	82	34	388,534	28
Totals	169				4,146,044		100	859,254	21

[a]Numbers in this column do not sum to the total since some establishments buy more than one form of wood.

Of the total income from forest products, 75 percent is attributable to the pine resources. One-fifth of this total value goes to the farm owners of timber resources. About 72 percent of the farm income from wood products is derived from pine. It can be seen that pine is the most important wood with respect to farm income in eastern Oklahoma.

3. Volumes and Values of Secondary Wood-Users

The additional information contained in Table IV gives an indication of the amount of wood bought in a semi-finished form by specified industries. Although some secondary wood-users may have been omitted, those interviewed on the survey indicate the importance of this group as indirect outlets for wood produced on farm and non-farm woodlots. All industries associated with the use of wood are either directly or indirectly contributors to the amount of income received by persons in these counties. The adequacy of secondary wood-using industries directly affects the volume of wood products processed by the primary industries.

TABLE IV

VOLUME AND VALUE OF SECONDARY WOOD-USERS[a]

Industry	Number	Volume (M Bd. Ft.)	Value (dollars)
Planing Mills	12	21,949	554,730[b]
Furniture Factories	4	1,664	68,800
Handle and Gunstock Mills	2	100[c]	4,000[c]
Total	18	23,713	627,530

[a]Secondary wood-users are defined as those industries who buy semi-finished wood.

[b]Value not available for four mills.

[c]Incomplete information.

4. Industry Work Force

The total work force in eastern Oklahoma decreased during the period 1929-1949. Work force comparisons are shown in Table V. The percentage of the total work force employed in agriculture was maintained during the period 1929-39, however, it decreased by over 31 percent from 1939 to 1949. While the total work force has declined, the forestry work force has maintained its percentage as agriculture was losing its work force to other industries. This is illustrated graphically in Figure IV. The cross-hatched area represents the forestry work force percentage of the total work force. The area below forestry is the agriculture work force percentage and the area above forestry is the percentage of the total work force in other industries. The figures at the top of the graph are the total work force numbers for their respective years.

TABLE V[a]

WORK FORCE COMPARISONS IN FIFTEEN COUNTIES OF EASTERN OKLAHOMA, BY SOURCE, 1929-1949

Item	1929	1939	1949
Total work force	124,200	95,821	95,137
Agricultural work force	64,766	48,792	33,464
Percent of total	52.15	50.92	35.17
Forest work force	4,974	5,211	4,398
Percent of total	4.00	5.44	4.62

[a]Summary of Appendix Tables I, II, and III.

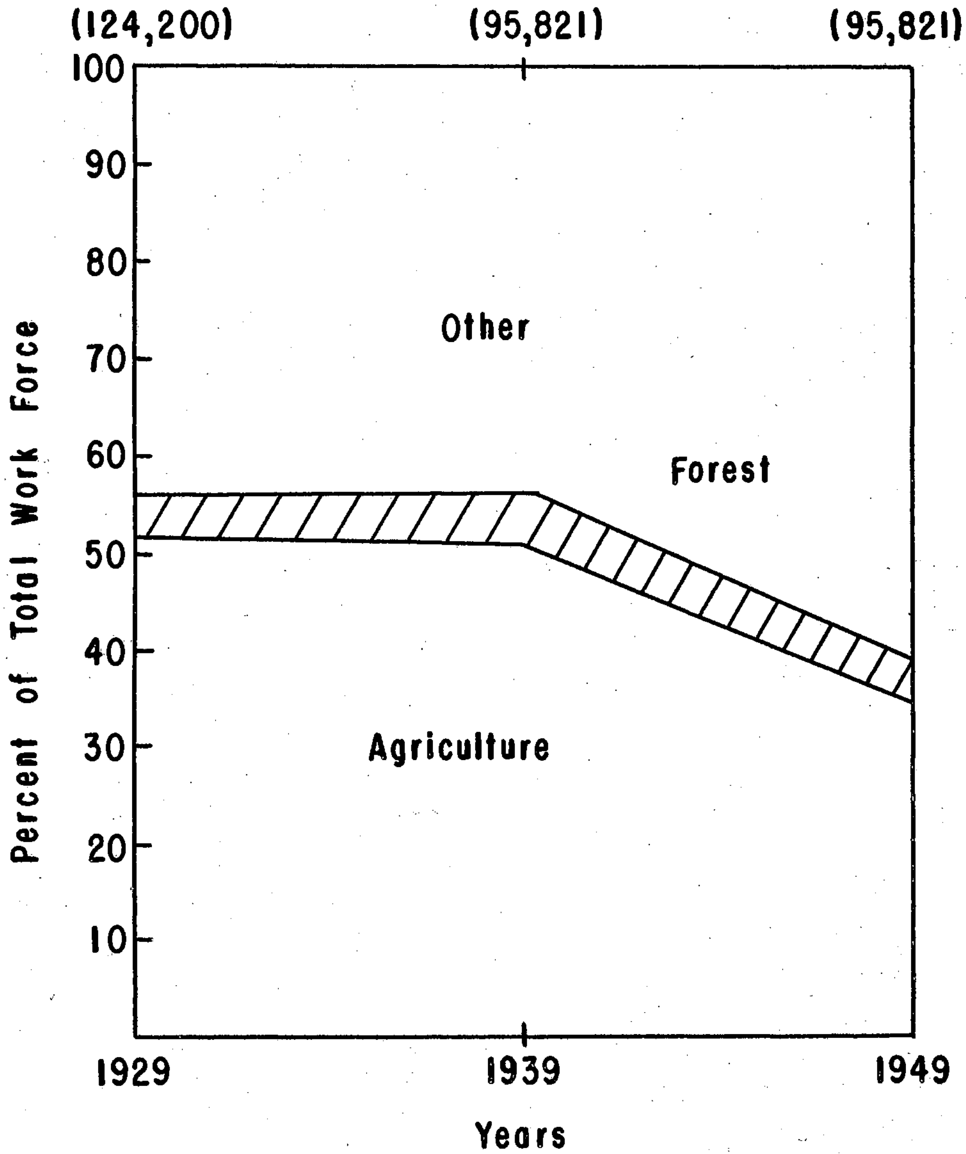

Figure IV. Percentage Change in Distribution of the Total Work Force in Fifteen Counties of Eastern Oklahoma, 1929-1949

Table VI gives a breakdown of the work force by industry type. The largest employment (69.2 percent) occurs in the sawmill industry which also has the greatest number of man days (65.7 percent). The amount of income from this source is therefore of importance to some families in these counties. Sawmills not only provide a market for farm and non-farm woodlot products which increases the incomes of the resource owners but also supplies an additional source of income for those employed by this industry. However, the wages received by employees of industries such as the creosoting plants may be expected to be larger than those obtained in the sawmill industry. No method of assessing the incomes of employees in the various industries is available in this study but a wide variation may be expected to occur between these industries. The number of workers for the industries which are involved in the preliminary operations, i.e. loggers, was not ascertained by this study. Therefore, the total number of forest industry workers, if available, would reveal a much better picture of the income derived from the forest industry.

B. SAWMILLS

1. Duration of Establishment

By the use of a bar graph in Figure V, the distribution of sawmills by the duration of establishment is illustrated.

One-hundred and thirty-two of the total 133 sawmills reported their date of establishment. Over half (57 percent) have been established since 1950. Twenty-nine percent of the mills were established in the 1940's. Nearly three-fourths (73 percent) of the sawmills have been put into operation during past ten years. The mills which have been established for more than ten years are generally permanent and have more nearly

TABLE VI

INDUSTRY WORK FORCE

Industries	Man Days: Numbers	Man Days: Percent of Total	Number of Workers: Usual	Percent	High	Percent
Sawmills	168,740	65.7	871	69.2	983	63.0
Pulp, Pole, Prop, Post and Tie Buyers	40,850	15.9	173	13.7	280	18.0
Charcoal Wood Buyers	1,650	.6	28	2.2	54	3.5
Handle Stock Buyers	5,740	2.2	24	1.9	31	2.0
Creosoting Plants	39,760	15.6	163	13.0	211	13.5
Total	256,740	100.0	1,259	100.0	1,559	100.0

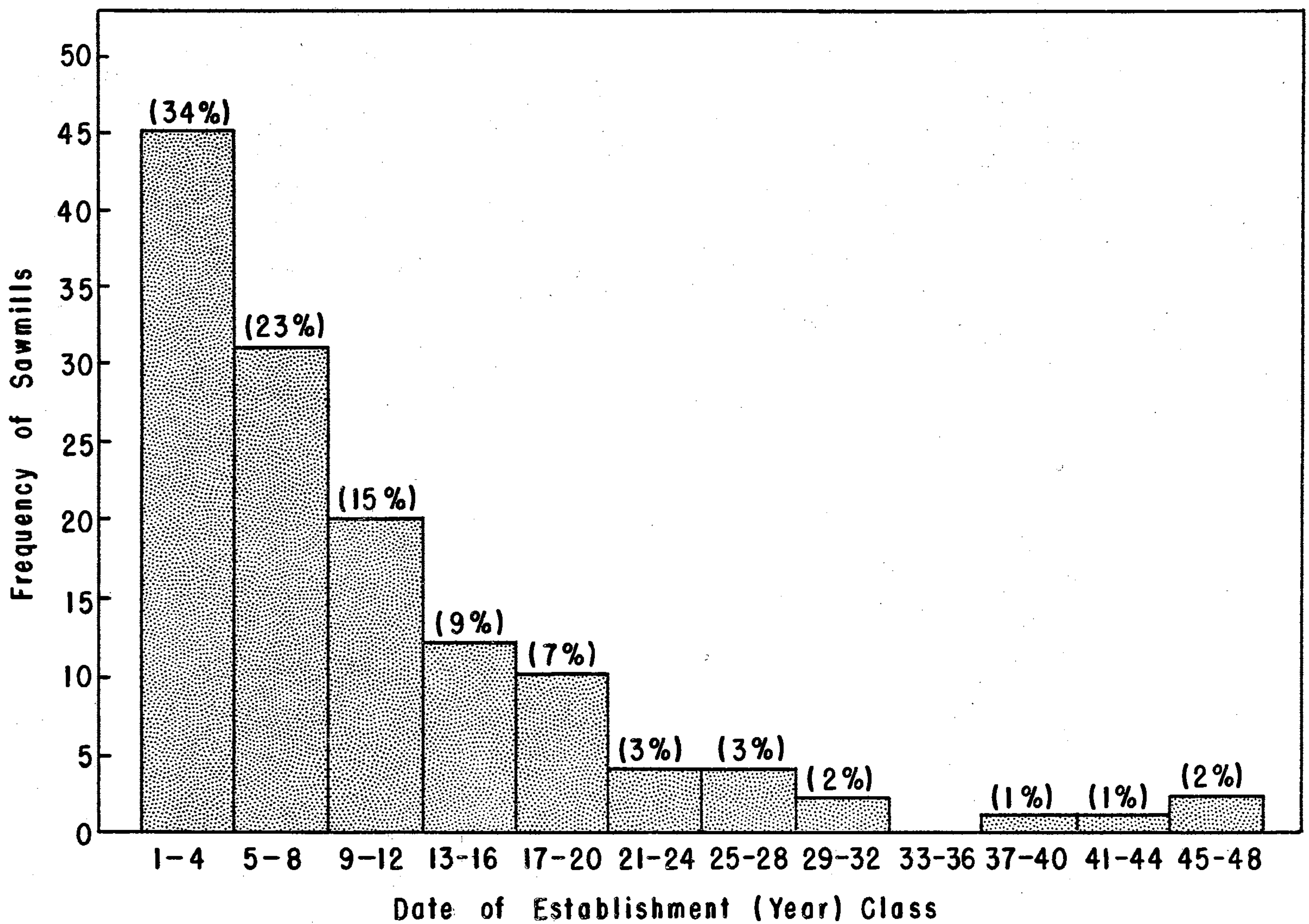

Figure V. Distribution of Sawmills by Duration of Establishment from 1957 maximum output for the type of equipment used.[3] Some of the more recently established mills have been in operation previous to their present location but have been either in other counties or adjoining states. Also, many of the mills established during the past few years are portable and their duration in one location may not be over one to two years. The mills which have been in one location for several years may usually be found in the pine area. Of the total number of mills for which complete data are available, forty-one percent were established during the period 1953-1957 with about half of these (fifty-one percent) classed as permanent. During the period 1948-1952, twenty-one percent of the total number of mills were established, nearly three-fourths of these were considered permanent. Thirty-eight percent of all mills had an establishment date of before 1947. Eighty-one percent of those established before 1943 are permanent mills. Naturally permanent mills are more likely to have been in existence longer than the temporary type. Sixty-five percent of all mills are classed as permanent.

2. Size of Work Force

Figure VI shows the distribution of the work force in the sawmill industry. Only those mills reporting the usual number of workers were used for this distribution.

The usual number of workers was reported by 129 sawmills. The major number (74 percent) of the sawmills employed 1-3 men. Eighteen

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[3] A "permanent" sawmill is defined as being permanent with respect to location not duration. Most of the "temporary" mills in this sense are also portable by nature of the equipment.

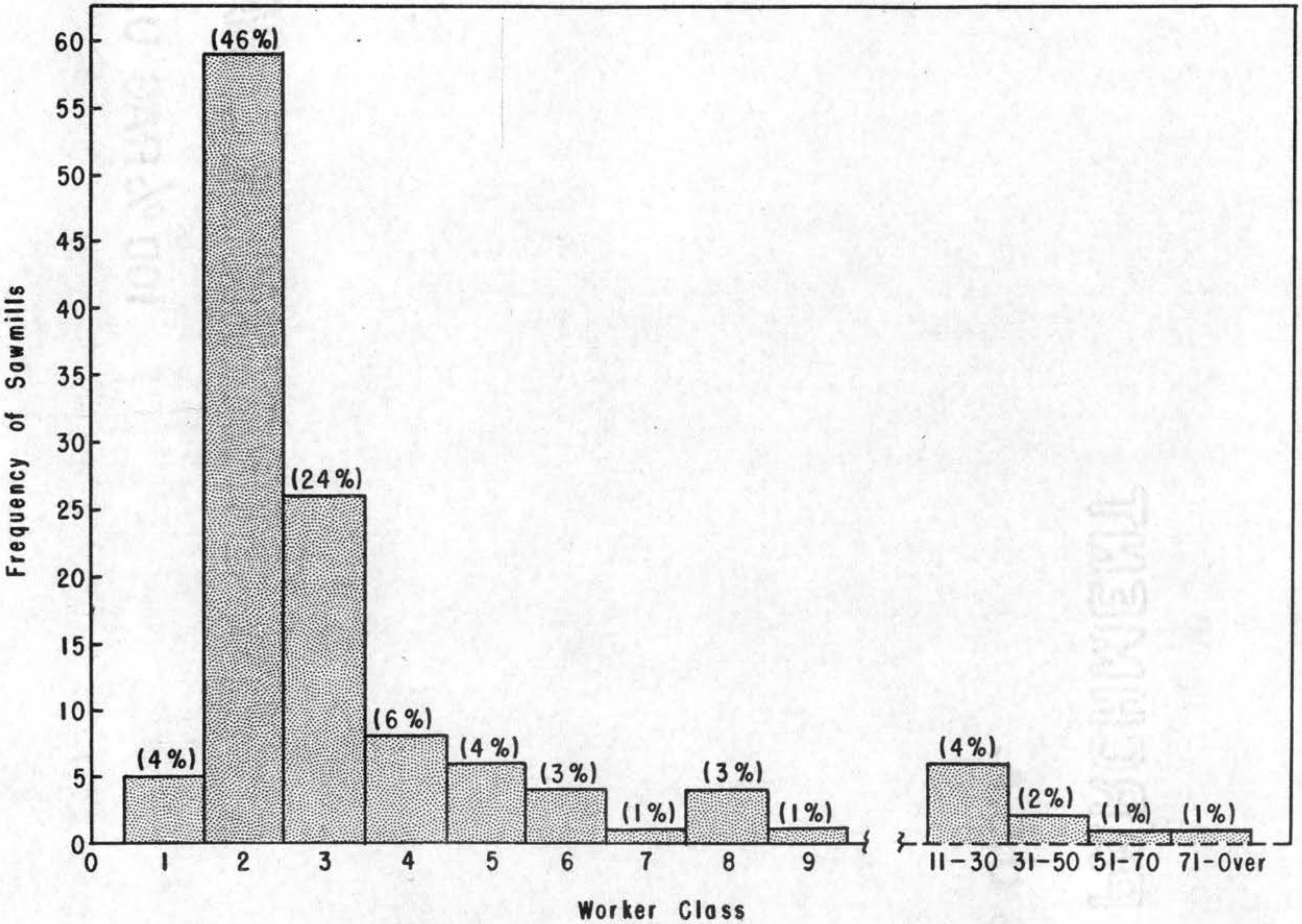

Figure VI. Distribution of Sawmills by Usual Workers Class sawmills (14 percent) operated with 4-6 men with sixteen sawmills (12 percent) using seven or more men.

The number of workers used by mills with the same type of equipment varies. The small mills (i.e., those with only one head saw) may be employing from one to five men when actually three men would be sufficient for the mill operation itself. Some mills indicated the excess number of workers was, in part, to provide some sort of employment for their neighbors. Others using only one or two men are not striving for an efficient sawmill operation but rather for a means of supplementing their income from other sources. These mills, which are undermanned, usually operate on a seasonal basis. However, some mills indicated they would be willing to increase output if timber resources were more readily available. This would indicate a need for improving the productivity of woodlots. The Forest Service has stated that the productivity of woodlots could be doubled through the use of minimum forestry practices.

3. Types of Products

The three major classes of products sawn are ties, bridging, and construction lumber. All but 5 percent of the 132 mills reporting produced these products. The distribution among the major products is as follows--construction lumber (58 percent), ties (24 percent), and bridging (13 percent). The production of ties and bridging uses mainly hardwood resources. Thus, these products are produced predominantly outside the pine counties. Although furniture stock is of minor importance, the value of this specialty product is greater than that of any other product. However, the limited quantity of specialty wood in eastern Oklahoma restricts the processing of these products.

Ninety-one of the firms reporting indicated they produced at least two commodities with thirty-one of the firms producing three or more products. The diversification of products by mills is usually dependent on the species of wood and available secondary wood-using markets in the area.

4. Sawlog Sizes

The distribution of sawmills by average low diameter is illustrated graphically in Figure VII.

Nearly half of the 55 mills sawing pine are sawing pine logs with an average diameter of 8-9 inches and one-third are sawing 10-11 inch logs. Pine logs with the small average diameters are usually being sawn by mills outside of the predominantly pine counties. Since most mills are sawing pine logs of less than eleven inches in diameter, this means that many small trees are being cut which obviously reduces the efficiency of these mills.

The 107 mills sawing hardwood are sawing larger logs than those sawing pine. Sixty-four percent of the mills are sawing logs with average small end diameters between 12-15 inches. The difference in size of logs between pine and hardwood may be attributed to the difference in value of these products. At the stump, the price per M bd. ft. for pine is about ten dollars higher than that of hardwood. The price of pine as the end product is higher than hardwood products. With better prices received for pine, the mills have been inclined to ignore any type of marked timber program which would in the long run improve both size and quality of the timber. Many mills, however, particularly in the pine region, are moving toward selective cutting of timber and this should lead to more income for both the processor and the resource owner.

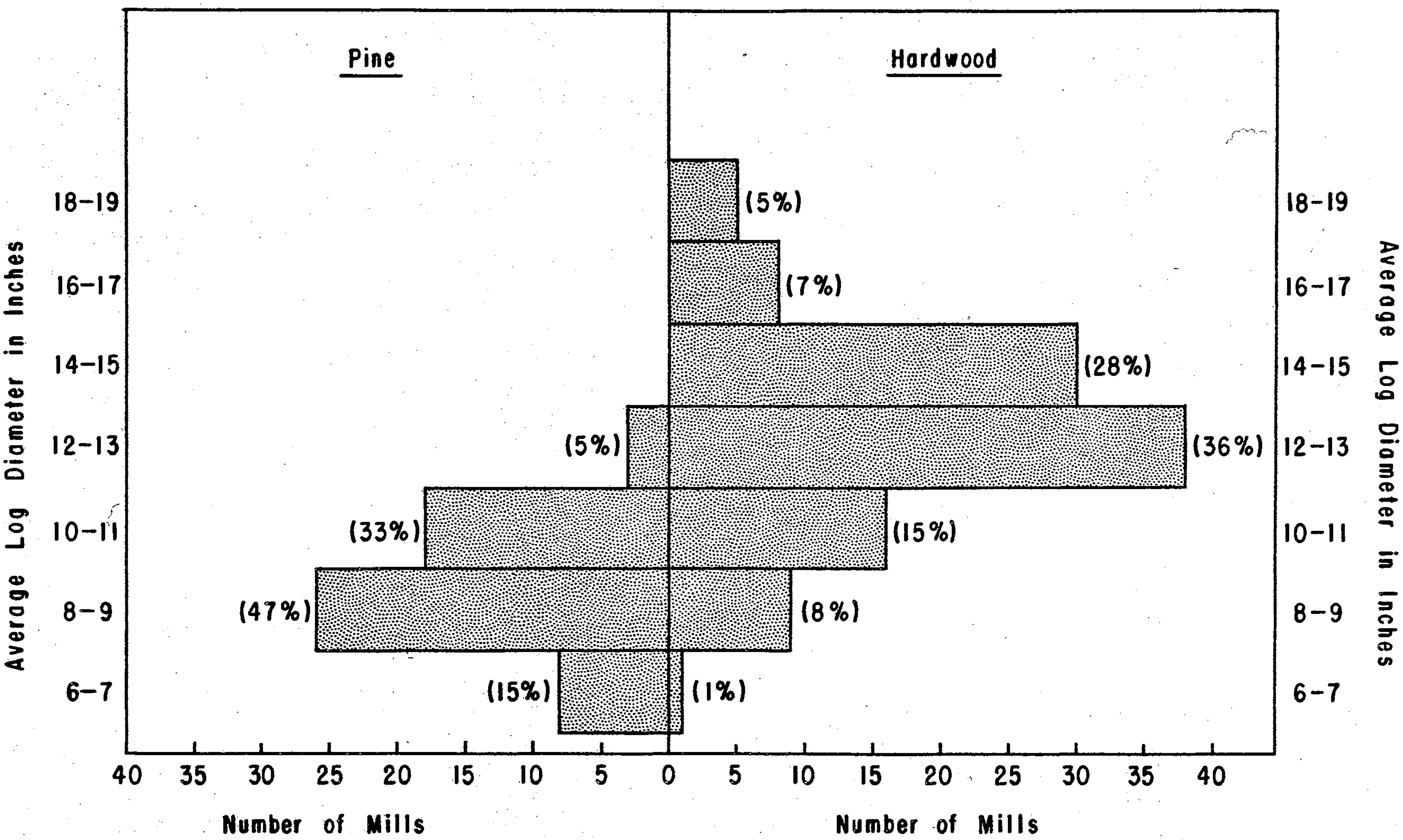

Figure VII. Distribution of Sawmills by Average Log Diameter[a]

[a]Refers to the average small end diameter.

5. Length of Haul

The distance which logs must be hauled from the stump to the saw can become a major cost in some instances. A distribution of the length of haul is shown in Figure VIII.

The average length of haul was reported by 127 of the 133 sawmills. Eighty-three percent hauled an average of fifteen miles (one way) with less than 3 percent of the mills traveling more than twenty-five miles to obtain timber. It is apparent that most of the mills are located near the timber resources. Some of the temporary mills are situated on the tract of timber purchased and will move to a new site when these resources are exhausted. Those mills with large output may in some instances travel over fifty miles to obtain sawlogs which are of desirable size and quantity. The permanent mills are not able to relocate without incurring high costs and therefore are prone to haul timber greater distances.

The length of haul is of importance to the costs of producing wood products. This would be of concern in determining the efficiency of the overall mill operation which would include all costs from stump to the final mill product.

The lack of information concerning transportation costs points to the need for an efficiency study to determine the optimum distance which various size mills should haul timber. This may indirectly affect the incomes of the resource owners by reducing the firm's processing costs.

6. Location of Purchase

Table VII indicates the percent of wood which is purchased at different locations.

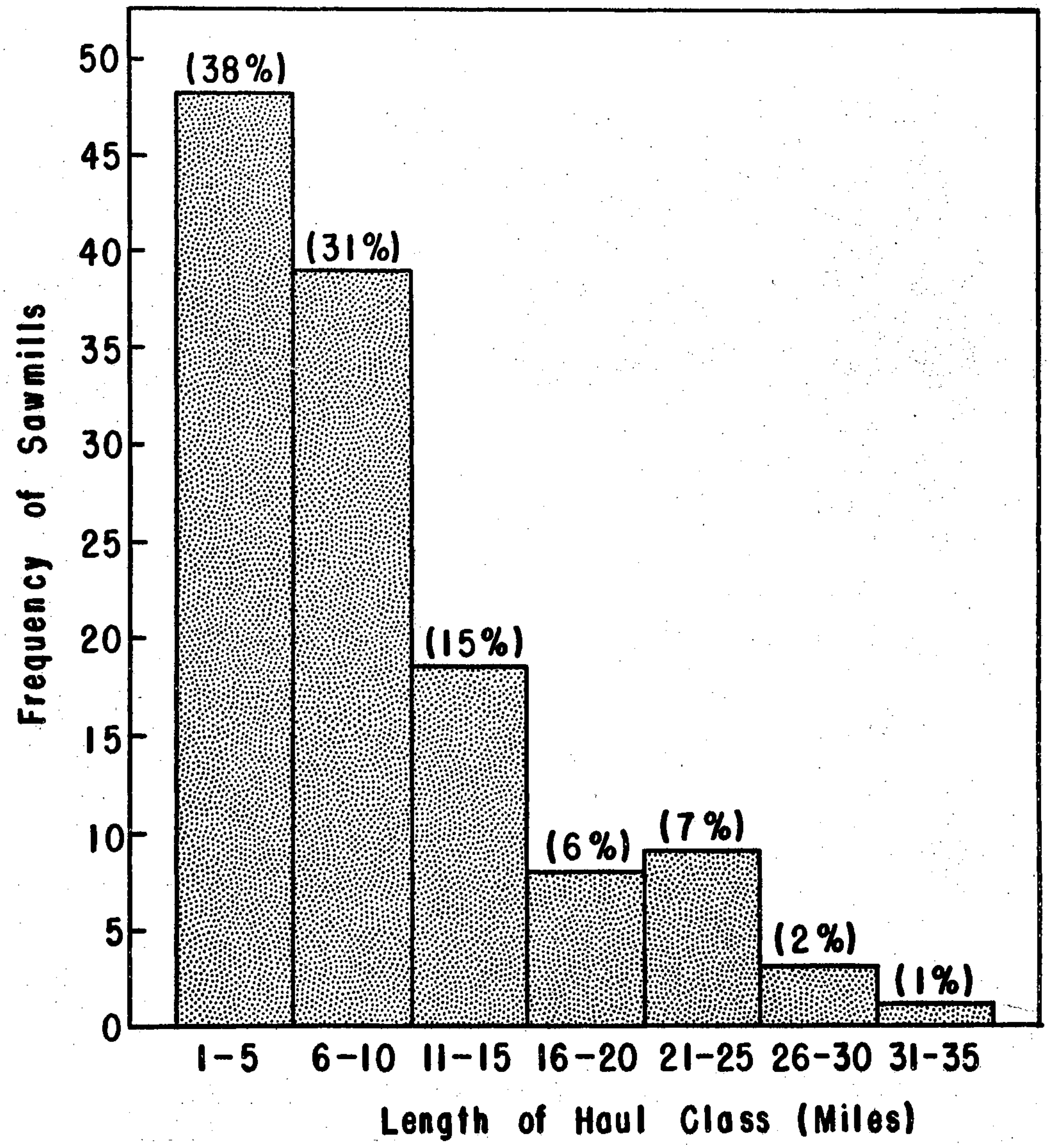

Figure VIII. Distribution of Sawmills by Average Length of Haul Class

TABLE VII

VOLUME SAWN BY PURCHASE LOCATION, 1956

County	County Volume (M Bd. Ft.)	Percent Industry Volume	Percent Bought at Stump	Percent Bought at Mill	Percent Bought at Roadside
Adair	2,378	3	77	23	--
Atoka	2,861	4	47	53	--
Cherokee	1,055	1	78	22	--
Choctaw	4,947	6	67	27	6
Coal	350	a	100	--	--
Delaware	2,147	3	92	8	--
Haskell	560	1	94	6	--
Latimer	2,025	3	--	100	--
Le Flore	5,810	7	91	9	--
McCurtain	43,181	55	89	11	--
McIntosh	1,263	2	100	--	--
Muskogee	575	1	100	--	--
Pittsburg	3,395	4	62	38	--
Pushmataha	7,970	10	41	58	1
Sequoyah	348	a	69	31	--
Total	78,865	100	78	22	a

[a] Less than .5 percent.

The sawmills in twelve of the fifteen counties purchase the major portion of their wood at the stump. Only one county reports no wood purchased at the stump, with three counties purchasing all wood at the stump. Over three-fourths of the fifteen-county wood sawn is bought at the stump. Two counties only report a negligible amount of wood purchased at the roadside. The various mills who purchase wood at the mill indicate some lack of vertical integration since much of this wood is contracted by intermediate woodcutters. The determination of whether improved efficiency would occur through vertical integration is an area for additional study.

One county has over half of the total wood sawn. This wood is mainly from non-farm woodlots and may include some wood from adjoining counties or Arkansas. However, the amount of wood taken across county lines is assumed to balance for any given county. Those counties with major pine or hardwood concentrations account for the major portion of the fifteen-county wood sawn. Of course, the larger sawmills in terms of output per year are located in the counties with the large quantities of wood sawn.

7. Price Variation

Seventeen percent of the sawmills reported price variation for wood bought at the stump, ten percent reported price variation for wood bought at the mill. Considering the fact that most wood is bought at the stump (78 percent) this implies that of all wood bought fifteen percent involves price variation.

The quoted variations are likely to be under-estimated since the respondents were the buyers. The amount of variation was not available. Differences in accessibility of the timber stand and the length of road haul make a study in price variation for woodlot products extremely cumbersome. A study of this phase by surveying the wood sellers would add greatly to improving the market for forest products.

8. Operating Horsepower

Graphically in Figure IX is shown the distribution of sawmills by the total amount of horsepower used.

Of the 133 sawmills contacted on the forest survey, 128 reported total horsepower of their mill. Most mills (77 percent) operated with motors rated at less than 150 horsepower. Sixteen percent of the mills

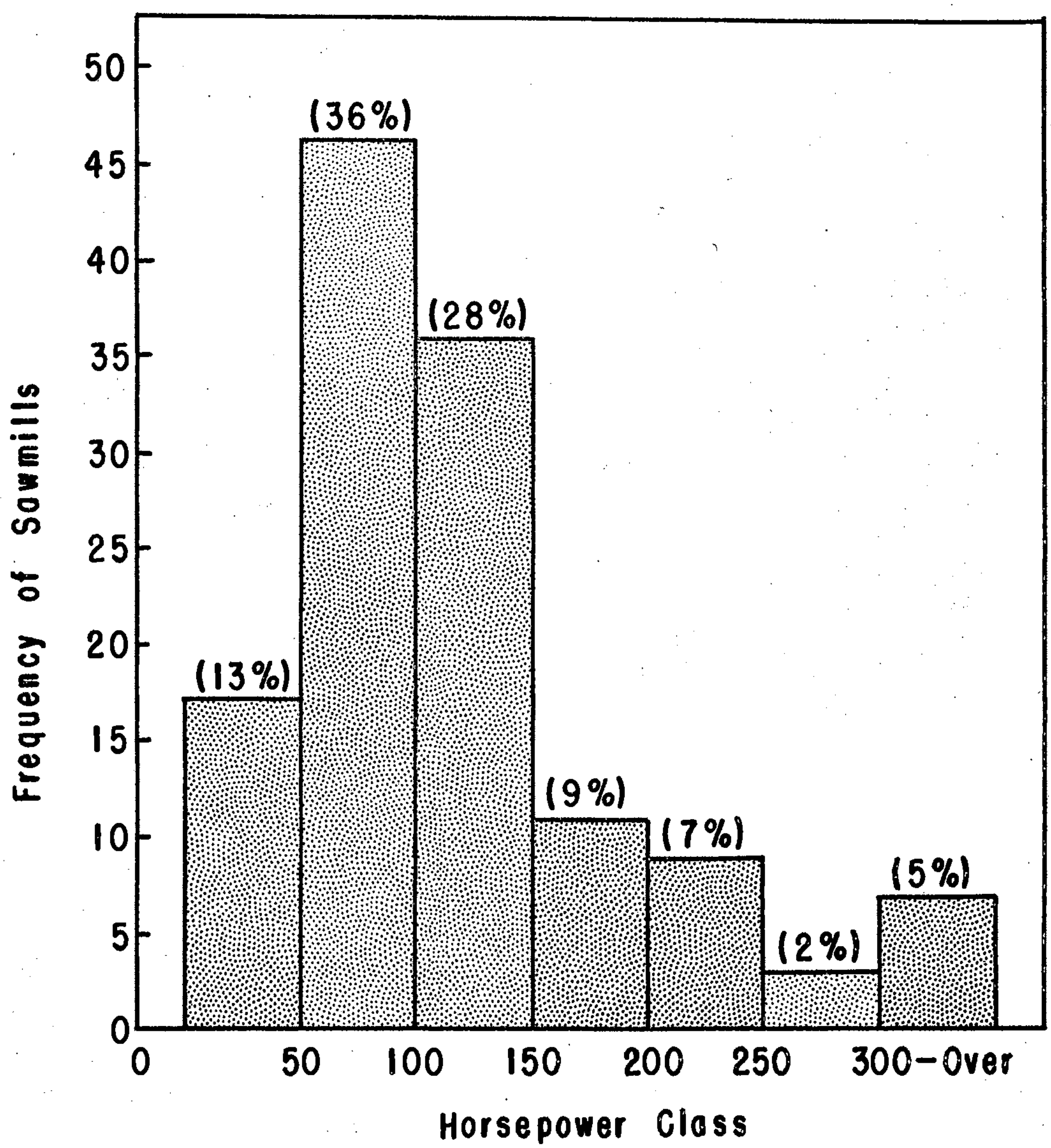

Figure IX. Distribution of Sawmills by Horsepower Class had motors between 150-249 horsepower and seven percent had motors with horsepower rating of over 250.

Some sawmills were obviously overpowered or underpowered. Many firms using car motors were not geared for maximum efficiency. This lack of power in many instances caused delays particularly if large timber was being sawed. Most mills which are located at or near the major pine and hardwood resources generally have ample horsepower for their operations. The greatly differing horsepower ratings for motors in similar mill types indicates a need for determining the optimum power unit for the different size of each mill.

9. Combinations of Saw and Motor Equipment

One of the major differences in equipment is in the number of head saws, edgers, trimmers, and gang saws which are utilized by a firm. Table VIII illustrates the different combinations which occur in eastern Oklahoma.

TABLE VIII

DISTRIBUTION OF SAWMILLS BY TYPE OF EQUIPMENT

Frequency of Mills		Type of Equipment			
Number	Percent	Head Saws	Edgers	Trimmers	Gang Saws
54	45	1	-	-	-
15	13	1	1	-	-
18	15	1	-	1	-
24	20	1	1	1	-
1	a	1	2	-	-
1	a	1	1	2	-
1	a	2	1	-	-
1	a	2	2	1	-
2	2	1	1	1	1
1	a	2	2	2	1
1	a	3	-	-	1
119	100	124	49	49	4
Totals for 130 Mills		137	53	51	4

[a]Less than one percent.

Nearly half of the sawmills for which complete information is available report as having one head saw and no edgers or trimmers. Ninety-five percent of the mills have only one head saw and no gang saw. The remaining five percent are large mills mainly operating in the pine counties of eastern Oklahoma. The installation of gang saws by mills is a recent effort to improve their efficiency. Mills using the gang saw have in some cases doubled their output. Those who have recently installed a gang saw expect an improved efficiency in mill operation. The change from the use of the head saw to a gang saw has been gradual and in some instances the head saw is still being used in conjunction with the gang saw. A later chapter of this thesis will give an indication of the efficiency of mills with various types of equipment.

The number of motors by the different types is shown in Table IX. Most sawmills are powered by gas motors. The type of gas motors varies from those obtained from old cars to the large stationary motors. The duration of service obtained from these gas motors also varies. Some motors are replaced every year while the stationary types are expected to be in operation for several years, depending on the hours used per year. The sawmills with more than one motor usually have larger output per year than the single motor mills. The additional motors generally power auxiliary equipment such as edgers and trimmers. The motor used to power the head saw have greater horsepower ratings than the auxiliary motors.

The use of diesel motors, which are stationary, is limited to eighteen sawmills. These motors have higher horsepower ratings than most gas motors. The initial cost for this type of motor is usually greater than for gas motors due mainly to differences in horsepower ratings.

TABLE IX

SAWMILLS CLASSIFIED BY NUMBER OF MOTORS

Number of Motors	Frequency of Motors			Total Mills
	Gas	Diesel[a]	Electric	
1	90	15	1	106
2	23	3	1	27
3	1	--	3	4
10-15	--	--	2	2
20-25	--	--	2	2
over 25	--	--	1	1
Total Mills Reporting	114	18	10	142
Total Motors Reported	139	21	586	746

[a]Also includes steam and kerosene motors.

Electric motors in most instances are used to power edgers and trimmers. Only ten sawmills reported the use of electric motors. The location of some sawmills prevents the use of electric motors. However, the feasibility of using electric motors was not determined by this study.

Several types of power are used by sawmills. Which type is best can only be determined by studying their efficiency under similar conditions. Variables such as mill size and location would be of major importance. The knowledge of firm efficiency in eastern Oklahoma is lacking, and a latter part of this study will show that a future efficiency study would be desirable. The objective of such a study would be to improve the incomes of sawmill operators, woodlot owners, and the consumers of wood products through more efficient plants.

C. PULP, PROP, POLE, POST, AND TIE BUYERS

1. Duration of Establishment

A distribution of the duration of establishment is illustrated in Figure X. The total number of buyers surveyed (37) reported the length of establishment. Fifty-seven percent of these have been established in the 1950's with 35 percent put into operation during the 1940's. The buyers who have been established for twenty or more years are large-volume operators. The new outlets for these various products have led to new firms entering the industry. Many of the firms in the northern counties are post buyers who handle only a few posts as a sideline to their main enterprise. For these latter firms, being in operation for several years does not indicate that large volumes are handled. The large buyers which have been recently established began their operation because of secondary markets for wood products. Also, lower grades of wood are being used by some buyers who have recently established. One buyer in the hardwood area of eastern Oklahoma purchases low grade hardwood to process into absorbent structural paper. More study is needed to determine industries which could use the inferior trees on woodlots.

2. Size of Work Force

Figure XI shows the distribution of workers in this segment of the forest industry. Sixty percent of the buyers have only one person handling the products at the yard. Twenty-four percent have 2 to 3 employees with six buyers having four or more workers. One firm, operating in six different locations, employs one hundred workers.

Seventy-seven percent of the firms with only one worker are exclusively post buyers. Seventy percent of these are located in the northern counties, and all except two firms handle only hardwood posts. The firms handling pine posts are naturally located in the southern counties primarily.

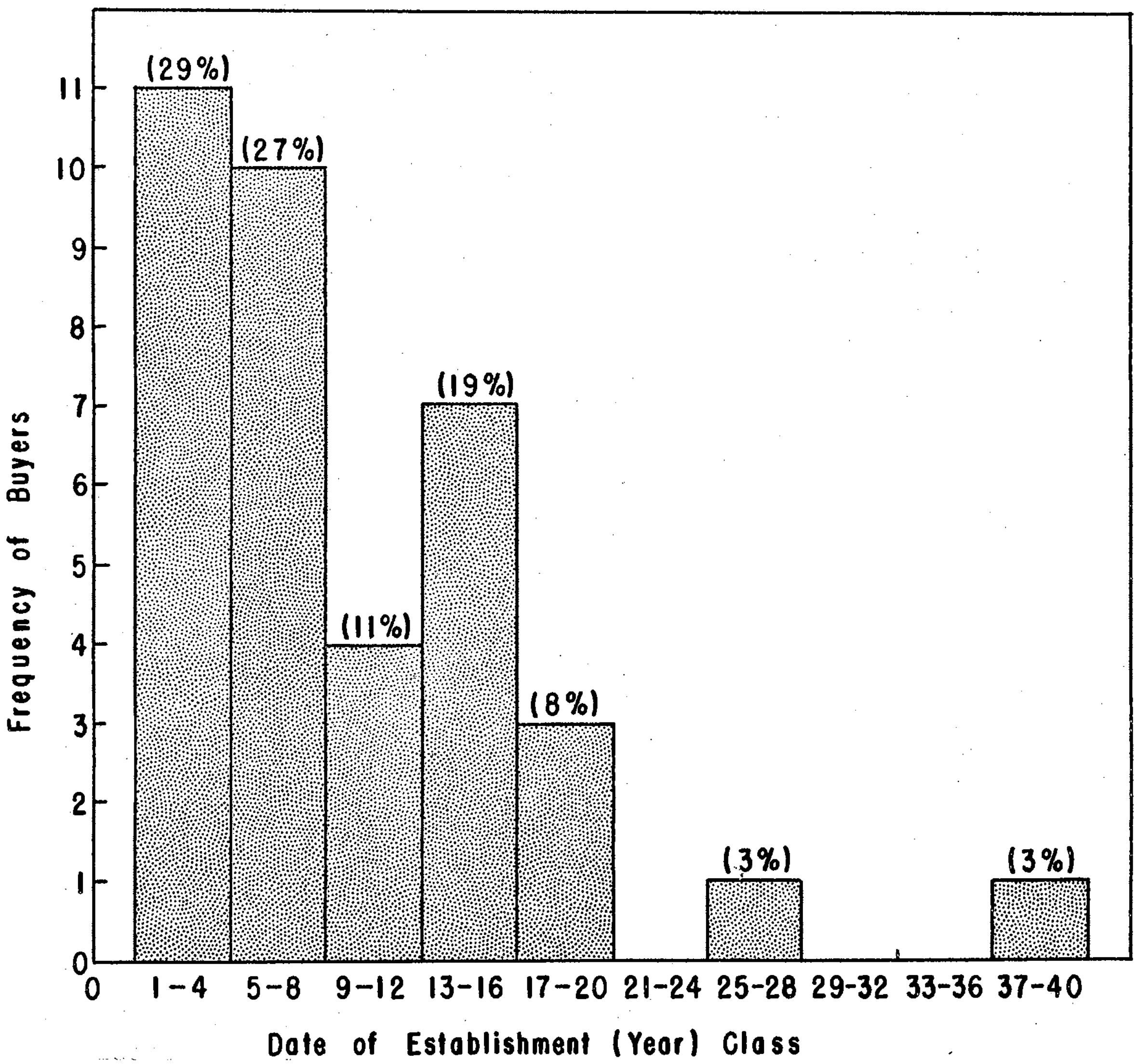

Figure X. Distribution of Pulp, Prop, Pole, Post, and Tie Buyers by Duration of Establishment from 1957

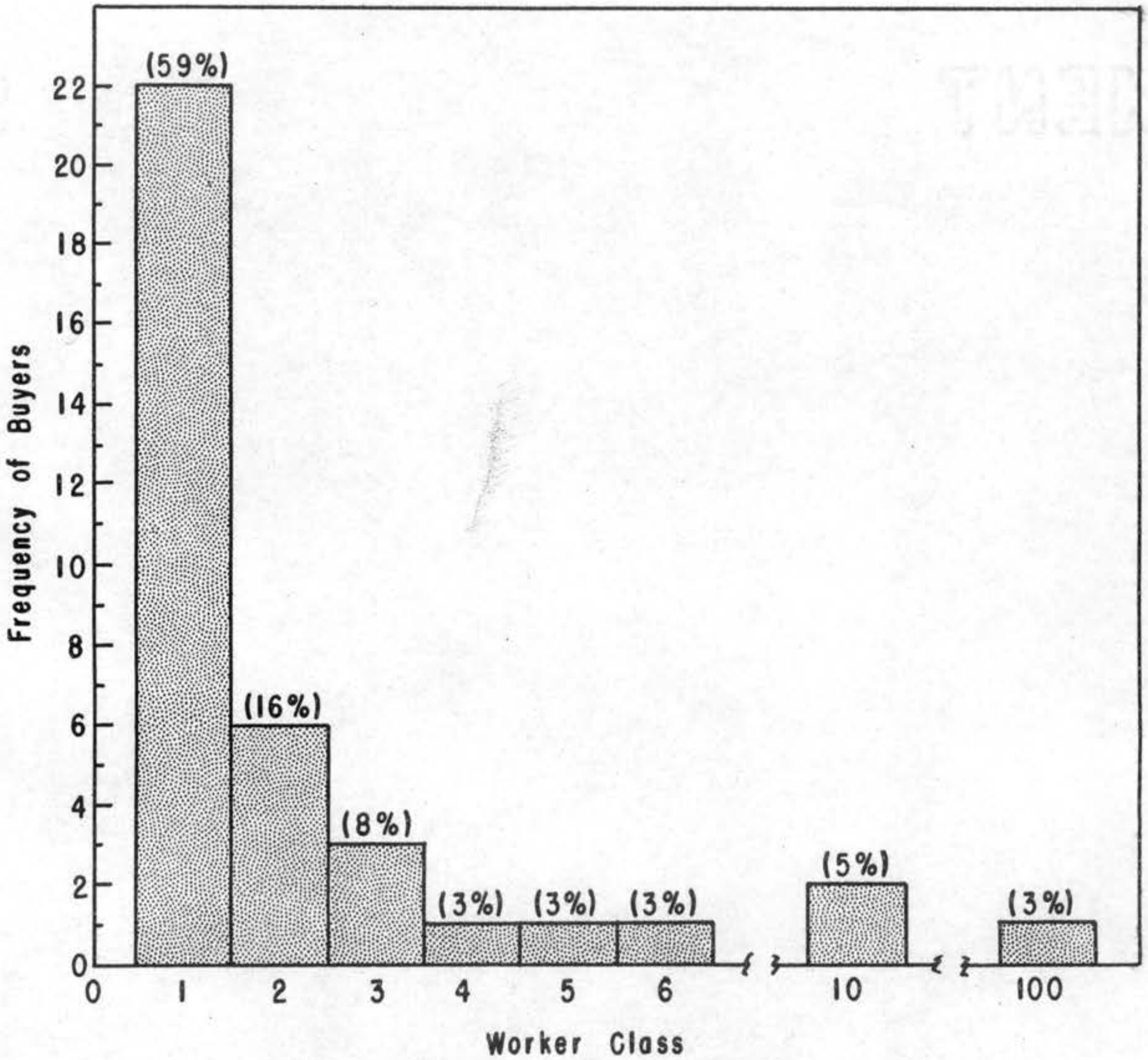

Figure XI. Distribution of Pulp, Post, Pole, Prop, and Tie Buyers by Usual Workers Class

The number of workers cutting the wood sold to buyers was not ascertained. There would be no way of determining how many cutters were involved as buyers in many instances had no record of persons from whom they had purchased wood. Therefore, the actual employment in this industry would be difficult to ascertain. Much seasonality in wood cutting was found, particularly for those cutting hardwood posts.

3. Types of Product and Price Variation

Included in Table X are the buyers classified by wood type. The amount of price variation is shown by the last column of the table. Thirty-seven buyers are located in nine of the fifteen eastern Oklahoma counties. The largest number of firms (62 percent) are post and prop buyers. Twelve firms (32 percent) are buying pulpwood. The post buyers are mainly located in the northern counties with the pulpwood buyers operating in the southern pine counties.

TABLE X

PRODUCT DESCRIPTION BY TYPE OF BUYERS

	Buyers Reporting		
Wood Type	Number of Buyers	Most Important Products	Price Variation
Pulp	12	11	3
Poles	3	-	-
Posts and Props	23	24	1
Ties	4	2	3

Twenty-four buyers (65 percent) have post and props as their major product. Pulpwood is the next most important product bought by these buyers. Two of the four firms buying ties list this product as being the most important. Eight of the buyers handle two or more products with five buyers purchasing three or more different products.

Only a small amount of price variation was reported by the buyers. Three of the firms buying pulpwood indicated that their prices varied during 1956 and three tie buyers reported price variation. The large buyers, particularly the post handlers, have price lists for the various products. There is some difference in prices between counties, however, the price of the products within a county are usually the same. The difference in prices between counties can be partially explained by the difference in species and quality of the wood. The difference in pulpwood prices may be attributed to the location of the outlet. Some pulpwood buyers are able to set lower prices because no other firm is near enough for the woodlot owners to attain higher prices for their products. It is the judgment of the writer that the present pulpwood production potential would not warrant the establishment of more buyers.

4. Length of Haul

Figure XII shows graphically the distribution of buyers by the length of their haul. This shows only the average distance the wood is hauled to the buyer's yard.

Thirty-six buyers reported an average distance of haul for timber. Seventy-eight percent of the timber was hauled a distance of twenty miles or less. The longest of the average distance was seventy-five miles by one buyers. The hauls which were over twenty miles involved all types of buyers. The hauling in northern counties which are predominantly hardwood is done mostly by farmers who cut these wood products for an

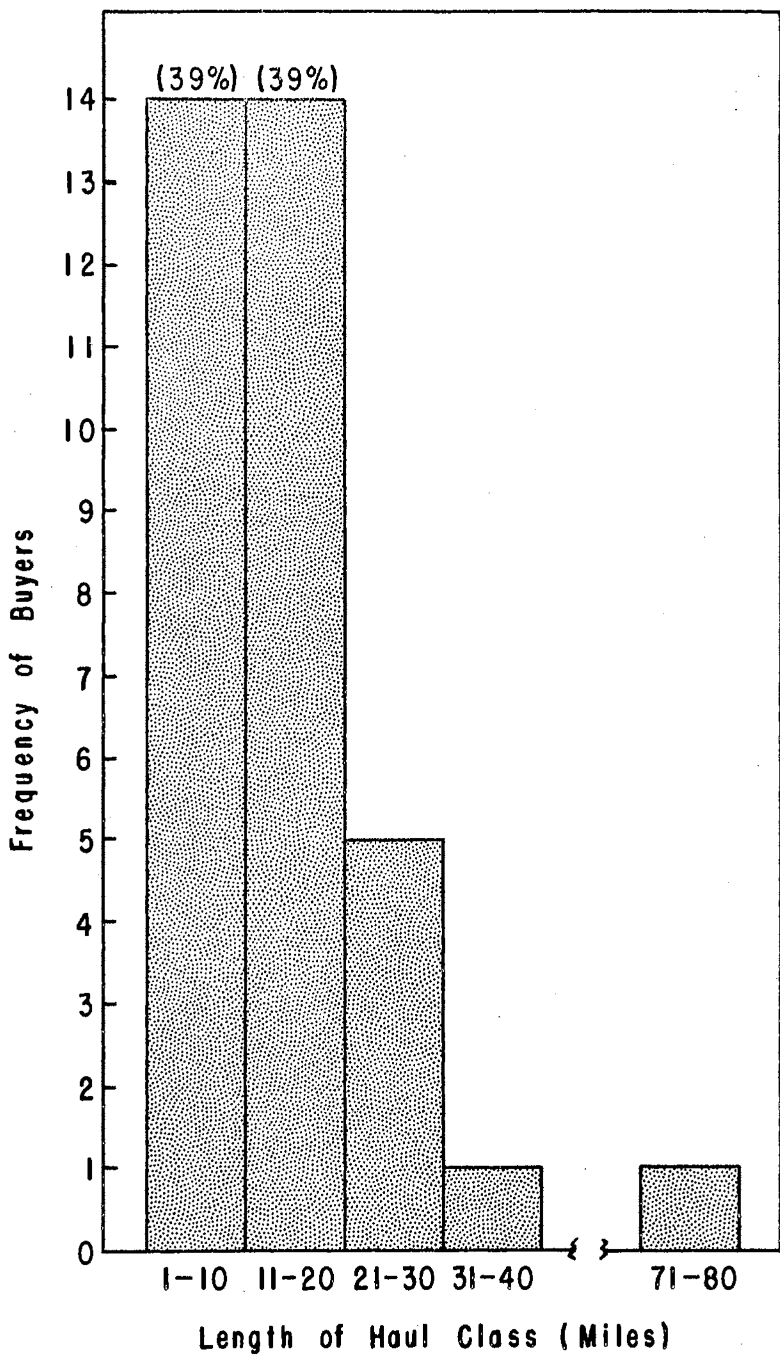

Figure XII. Distribution of Pulp, Prop, Pole, Post, and Tie Buyers by Average Length of Haul Class additional income. The hauling in the pine counties is in most instances done by the buyer or by a contract hauler. The timber is usually hauled to points of concentration located at railroad terminals. This is especially true of pine pulpwood buyers as it is all shipped out of state for processing.

D. MISCELLANEOUS WOOD PROCESSORS

1. Charcoal Makers

There are four charcoal wood buyers in eastern Oklahoma. These are located where an adequate supply of hardwood is present. Hickory and oak are the most common types of wood used in making charcoal.

One firm has been in operation forty-one years with the other three being established in the years 1956-57. The increased use of charcoal has brought about the establishment of firms in the counties where adequate low grade hardwood is present. A large amount of charcoal is processed into charcoal briquettes.

The usual number of workers employed ranges from four to twelve men. The firm which has been established for the longest period indicated the operations runs on a seasonal basis. This means that the firm is not operating at capacity and allowing the workers and kilns to be idle during a portion of the year. The reason for this seasonality was not determined. The more recently established firms indicated they would operate the entire year, thereby giving full-time employment for their workers.

The volume of wood processed by the charcoal plants for a period of one year cannot be ascertained since three of the firms were established during 1956 or later. Some of the recently established plants have intentions of building additional kilns which would increase their volume. The price paid per cord of wood varies between counties but not within counties. The wood resource owners in the southern counties receive a lower price per cord than of those resource owners in the northern counties. The lower price in the southern counties may be explained by a low volume of wood being processed relative to a large volume of wood available for processing. According to A. C. Pakula, a large charcoal industry could be supported by those Oklahoma forest resources which have no higher use value.[4]

All of the wood used is obtained from farm woodlots except in one instance where the wood was being cleared from a ranch. The wood is usually hauled to the charcoal plant by the resource owners. One charcoal maker handles the entire operation with his workers from the stump to the finished products. The distance of the haul from the woodlot ranges from one to forty miles. Most of the wood is hauled from ten to twenty miles. The transportation costs would be a limiting factor in the distance wood could be economically hauled to a plant.

This study indicates a need for additional investigation of the charcoal plants. With the possibility of increasing farm incomes through the use of low-grade hardwoods, the feasibility of increasing charcoal output could be determined by studying plant efficiency and market demand for the product.

2. Handle Makers

Four handle mills are using wood from farm woodlots in eastern Oklahoma. Three mills have been established since 1940 with the other

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[4]A. C. Pakula, _The Domestic Charcoal Market in Oklahoma_, Bulletin No. B-495, Oklahoma Agricultural Experiment Station, August, 1957, p. 18.

mill beginning its operation in 1920. These mills are located in a three-county area (Adair, Cherokee, and Delaware) in eastern Oklahoma.

All firms worked 200 or more days during 1956. The number of men working ranged from one to ten per mill. These mills are somewhat seasonal in their operations as they decrease the number of men used during the summer months. The reason for the decline in output during the summer months is due to the decrease in demand for handles. A large number of axe, mattock, hoe, pick, hammer, and maul handles are manufactured by these mills. The firms indicated the best sales occurred the fall, winter, and spring months, with most of their products being sold in the southern and southwestern states.

The major types of wood used for making handles are hickory and ash. Except for one firm, the wood is cut and hauled to the mill by the farmers in the area. The price paid by the mills varies from eighteen to twenty-three dollars per cord. This difference in price may be partially attributed to the types and quality of wood bought by the mills. The income received by the farm woodlot owners in these counties contributes substantially to their family income.

The distance of the haul by farmers averages between ten and twenty miles with some large truck loads being hauled up to sixty miles. Most of the wood is hauled from nearby farms.

Some of the plants appeared to be in good mechanical condition while others had machines that were in need of repair or replacement. The plant efficiency seemed to vary greatly because the antiquated equipment being used by some firms. The determination of the most efficient type of plant with the use of the available wood resources may be very beneficial to increasing the returns to both the firm and the farm woodlot owner. Although this wood outlet may be small compared to other types of outlets, any means of increasing farm income should be investigated.

3. Creosoting Plants

Creosoting plants have been in operation in eastern Oklahoma since 1907. The five firms reporting use the pressure method of treating wood. A dipping method was used in the early days by some firms, but this did not impregnate the wood fibers except near the surface. Most firms have converted to the pressure system, and through an educational program, most consumers are now specifying only pressure-treated wood.

Only one firm operated less than 200 days during 1956. The reason for this firm operating less than 200 days was due to the conversion of the plant to the pressure treating system. Most firms are operating at or near capacity as the demand for creosoted wood products was good during 1956.

The average daily number of men used by a plant is up to seventy-five. The variation in the number of workers employed during the year were only slight. The time of year is a factor affecting the number employed as adverse weather conditions tend to restrain full operation.

Almost 3.7 million cubic feet of wood was processed during 1956 by the five creosoting plants in this study. The prices ranged from 35 to 42 cents per cubic foot. This difference in price may be mainly attributed to the different types and sizes of wood processed. The major products creosoted are pine posts and poles. One firm creosotes only hardwood ties while other firms creosote only a negligible amount of hardwood.

Three of the five firms buy their wood from farm-owned woodlots. Forty-five percent of the wood processed was bought from farm-owned timber. Most of this wood was hauled by contract haulers with only one firm reporting fifty percent being hauled by farmers. The average haul varies from ten to seventy-five miles. The longest hauls occur for those firms which are located outside of the pine region.

The increase in volume of wood being creosoted has provided an incentive for woodlot owners to sell the timber to these processors. Much timber which was undesirable for other uses in the past can now be used by the creosoting plants. Additional investigation of the creosoting plants may prove fruitful as these products have become important to the forest industry during the recent years.

CHAPTER IV

THE MODEL FOR POTENTIAL CAPACITY OF THE SAWMILL INDUSTRY

A. INTRODUCTION

1. Type of Firm Studied

Sawmills were selected for this study for several reasons. Secondary industries using dimension stock are dependent on the production of sawmills. These secondary wood users provide markets for wood products which influence,both directly and indirectly, the per capita income of families in eastern Oklahoma. These other industries seem to be working near capacity. The buyers, creosoting plants and handle factories are working at or near the maximum number of working days. It is assumed that these industries' efficiency is at or near optimum, certainly it is more near optimum efficiency than the sawmill industry.

In the sawmill industry there are a sufficient number of firms to make a statistical study of cost, efficiency, and capacity. This number is large enough that a breakdown into different types of firms leaves sufficient members in each group to make statistical fitting of cost functions possible. The sawmills in addition, all produce one type of product regardless of the type of firm.

The last reason is, perhaps, the most important. There are obvious indications that many sawmills operate less than capacity especially with respect to duration of yearly operation. Only a small number of mills (seventeen) are operating over 200 days per year. The remaining firms operating at less than 200 days indicate excess capacity in this industry.

This means that with sufficient wood resources, the industry output could be increased with existing equipment and with possible reduction of unit costs. Since sawmills are processors of logs into lumber, an understanding of potential log supply and lumber demand is needed.

2. Log Production Potential

The production of woodlot products in eastern Oklahoma is now below its potential. The non-farm production under present management is assumed to be at or near full capacity. If the farm production is brought up to the level per acre of non-farm production, output would be nearly doubled for pine sawlogs. Also with the application of minimum forestry practices the output of all woodlot products could be nearly doubled, to bring production near the net growth potential.

Several factors must be considered in developing a program for better production of wood products. First, the time required for growing merchantable sawlogs in eastern Oklahoma would be, in most areas, a minimum of twenty years for pine and even longer for the hardwood species. Therefore any investment in pine seedling planting would involve a lengthy period before any monetary return was realized. Secondly, the land ownership, outside of that owned by non-farm residents, is generally restricted to small tracts, 50 to 100 acres. For forest production to be economical, it is estimated that forest land must return more than 2 to 3 dollars per acre annually which is currently the case in many instances. Also, confronting the land owner is the progressive land tax which is being adopted by some states along with a maximum land area ownership by an individual. These are only a few of the problems facing the woodlot owners in eastern Oklahoma.

Forestry workers in Oklahoma estimate that production can be increased by about thirty percent by 1975 and an increase of fifty percent by the year 2000. The current production could be increased by insect, disease and fire prevention along with planting seedlings and removing the undesirable species. This would indicate that the potential capacity of forest production is encouraging. Only through better forestry programs can this potential production be achieved.

3. Lumber Demand Potential

The potential demand for wood products by 1975 may possibly call for a greater amount of imports into this state than is expected. With the possibility of a rapid industrial development, it could also be expected to increase the use of wood by a similar proportion in Oklahoma.

The estimated demand for industrial wood for the U.S. in 1975 may be 25 to 40 percent above 1952.[1] The demand for fuelwood would decrease by about 25 percent during the same period. It is reasonable to assume that certain species of wood will be imported regardless of the production in Oklahoma. However, imports can be balanced with exports of the existing species in Oklahoma to meet the nation's demand. Under existing conditions, the potential demand for wood products in Oklahoma would exceed the expected 1975 production by an even greater percentage than at the present. Increasing production through better management could by 1975 at least meet the current ratio of production to demand. By increasing managerial practices, it could be expected that by 1975 the output of

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[1]Edward C. Crafts, "Timber Resources for America's Future", Timber Resource Review, Forest Service, United States Department of Agriculture (Washington, D. C., September, 1955) p. 28.

sawlogs in eastern Oklahoma could be as high as 150 million board feet. In 1955, the output of sawlogs was 115 million board feet. If this is the amount which eastern Oklahoma currently is required to supply to meet the nation's demand then it is reasonable to assume that by 1975 the demand for forest products could be met with Oklahoma's increased output and a similar increase in output by other areas of the nation. However, applying the estimated demand increase for the United States in 1975 would project a large increase in wood consumption in Oklahoma. No data are available for estimating the potential demand for wood products in Oklahoma specifically. The consumption of wood in Oklahoma during the past has not been recorded. This restricts any estimation of potential demand in Oklahoma to a mere guess--an indication that further study of the demand for wood by the Oklahoma market and of the total demand for Oklahoma wood would be useful. There is at present no study reporting any estimates of the parameters of wood demand either by areas or by the nation.

4. General Statement of the Model

In the absence of demand relationships, firm and industry efficiency and capacity must be examined only in a cost sense divorced from revenue and profit considerations. Such an analysis implies that unit revenue is independent of output, an assumption that may nearly hold up only under small variations in output. The capacity of sawmills will be compared with three supply conditions - 1956 actual, 1975 net growth potential, 1975 demand potential. These figures are 86.7, 115.0, and 152.2 million board feet respectively. There are three major ways in which the capacity of the sawmill industry may be increased; (1) raising the days operated by existing firms to some reasonable maximum such as 200 days, (2) increasing individual firm efficiency, for a given type of firm, and (3) optimizing the efficiency of the industry by maximizing the efficiency of the optimum type of firm.

The objectives of the above methods are to determine the effect of efficiency increase on the wood industry. It will allow the estimation of changes in the value of forest production from both farm and non-farm woodlots, especially the determination of the increase in value of farm wood production as a percent of the present. The effect these methods have on the capital costs of the forest industry will be reflected. Another important factor is determining what these methods will do to the man days of employment and payroll in the industry. More efficient production of wood products in Oklahoma may increase the demand if more favorable pricing is made possible by reduced costs.

Improving the efficiency of the firms and improving the structure of the industry is only on a pilot study basis and will be useful in determining the need for further study. If a large degree of variability exists within a firm type, then improving the efficiency of firms by another more detailed study would seem useful. This also applies to improving the industry structure by obtaining the optimum efficient firm operation in the industry. An example of increasing the efficiency of an operation has occurred since the data for this study was obtained. One firm recently indicated that, after the addition of a gang saw, it has nearly doubled its output in the second year of its operation after learning how better to employ the new equipment. Whether this has lowered its average cost curve could only be determined by an efficiency study, however, this firm's owner believes a more efficient operation has resulted from the addition of this equipment.

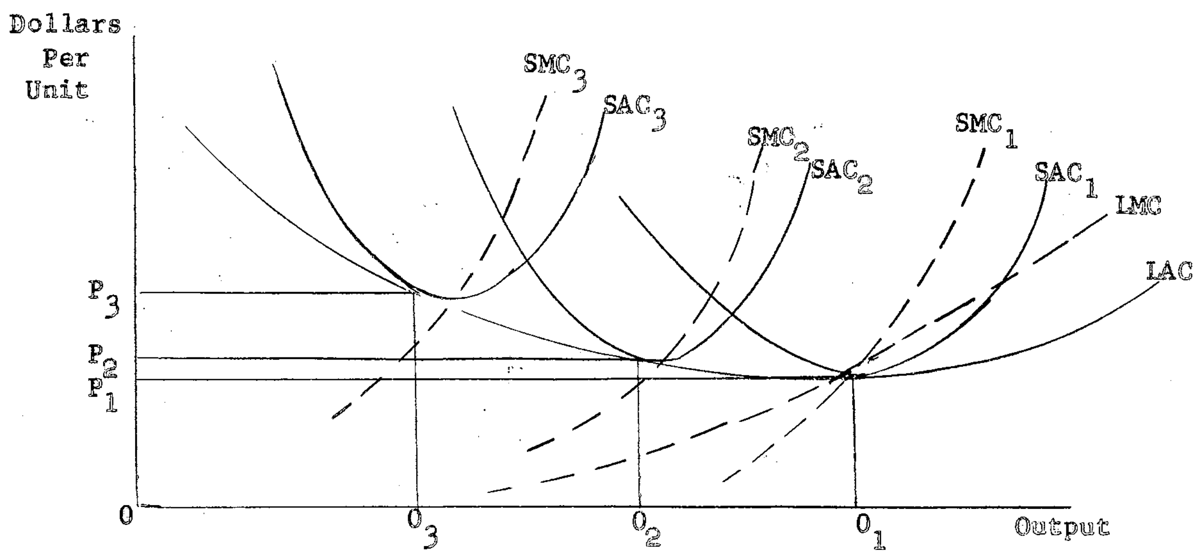
B. CAPACITY AT 200 DAYS OPERATION

The existing types of firms could be brought to full capacity in terms of the number of days operated. Of the mills for which complete data are available, fifty-eight percent operated less than half of the year. Only fourteen percent of the mills operated 200 days or more during 1956. The sawmill industry in eastern Oklahoma is thus below its potential capacity with respect to days operated. The method for obtaining an estimate of "time" capacity is as follows: All firms which work 200 days or more are allotted their actual production. Those which work less than 200 days are increased to 200 days at calculated daily outputs. This assumes that up to 200 days there are constant returns to time as a variable factor. 200 days was chosen as capacity with respect to time since many sawmills are hindered by days when bad weather makes dirt road transport and outside operation impracticable if not impossible using existing techniques and fixed plant. Covered mills, log inventories, and favored location makes operation up to 300 days possible for some mills. It is assumed that below 200 days, on the average, lack of full "time" capacity is capable of being remedied without changing the fixed plant, always assuming the product is saleable at profit. The firm and industry capacity models will be standardized at 200 days operation for all firms.

C. FIRM AND INDUSTRY CAPACITY THEORY

1. Economic Capacity Theory

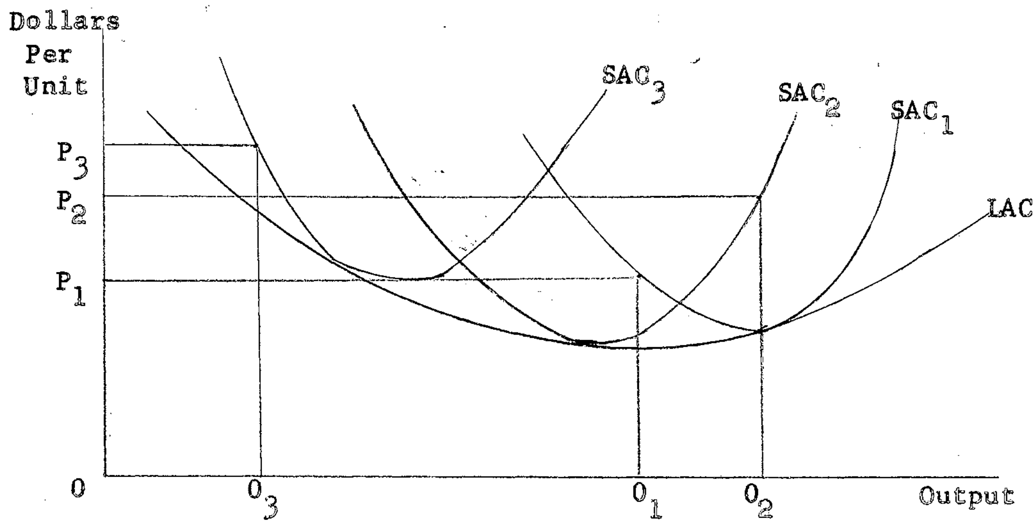
To view theoretically the cost curves for an industry, the following diagram is presented.



For the industry, optimum economic capacity is defined as the point where total output is at $O_1 \times N_1$, (N_1 equals number of firms), and each firm is operating at SAC_1 plant type. At this point, $SAC_1 = SMC_1 = LMC = LAC$ for each firm and average costs are at a minimum in both the short and the long run.

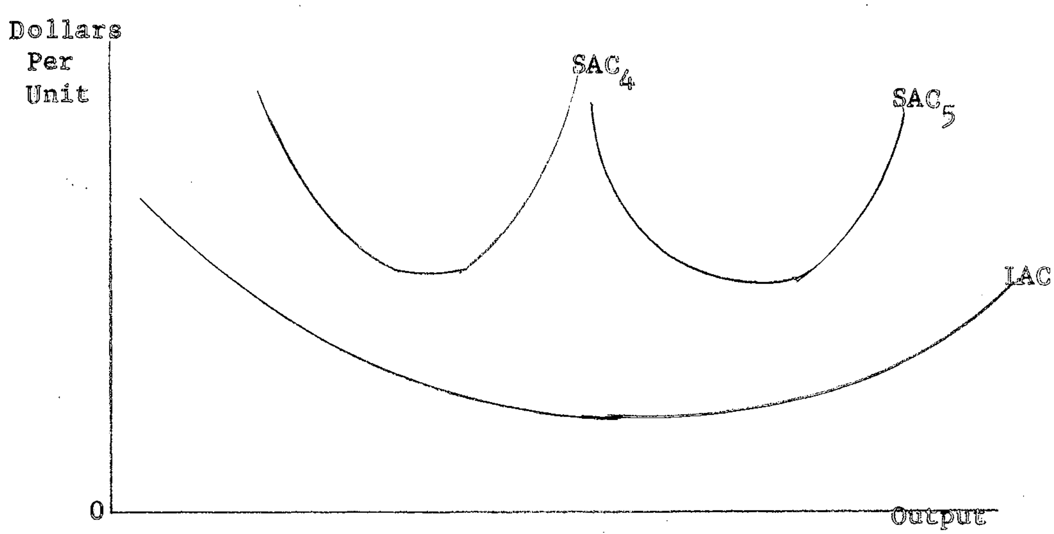
Optimum economic capacity of the firm is when some firms are operating on SAC_1, SAC_2, and SAC_3, but all are operating at minimum SAC_i. Total demand in the short run is equal to $(O_3 \times N_3) + (O_2 \times N_2) + (O_1 \times N_1)$. This assumes that firms cannot immediately change their scale of plant.

Even in the short run some firms may be operating on SAC_1, SAC_2, and SAC_3 but at outputs where short run average costs are above the minimum. This may be illustrated as follows:

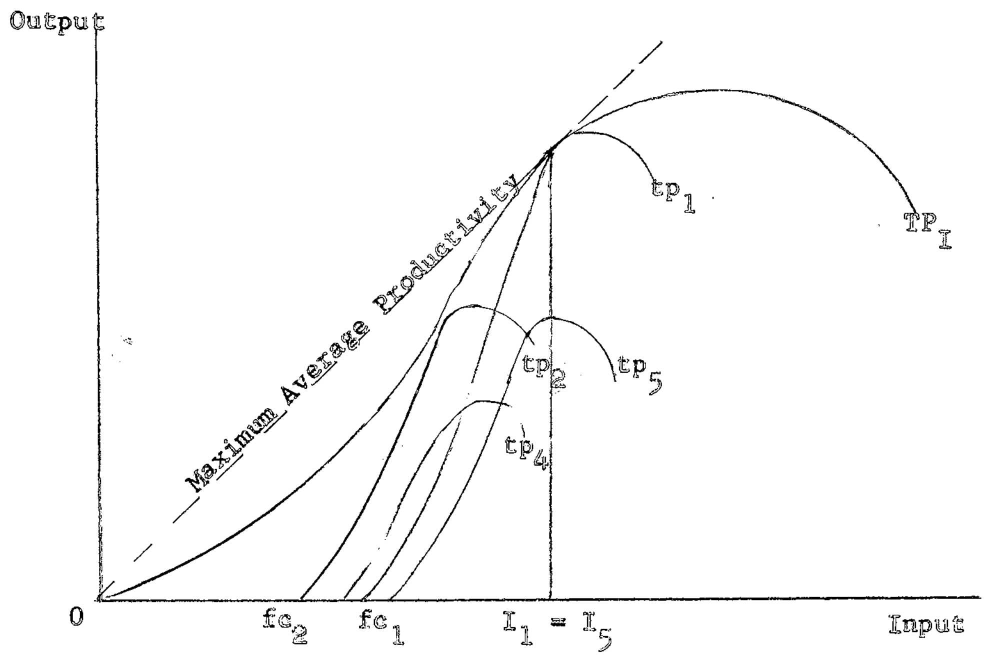


These firms could make adjustment within their scale of plant to decrease costs by increasing or decreasing output.

It is also possible that some firms are operating on different SAC curves due to not using the best available techniques at given outputs. These firms not using the optimum technique for a given output would have average cost curves that lie completely above the LAC curve. This can be shown as follows:



The long run average cost curve is an envelope curve to those short run average cost curves that use the best techniques for any given input-output combination. The difference between SAC_1 and SAC_2 is not a lack of optimizing techniques but a lack of optimizing the long run technology available. A higher degree of technology used implies higher fixed costs. The following production curves illustrate the input-output combinations underlying this argument. f_c represents fixed costs in terms of inputs. TP, total industry production implies maximum technology. Firm number 5 for example, has not optimized techniques for the given inputs $I_1 = I_5$.



The total product curves, tp_4 and tp_5 correspond respectively to the firm's SAC_4 and SAC_5 curves. tp_1 and tp_2 are tangent to TP_1 and correspond to SAC_1 and SAC_2 respectively.

Locational disturbances may affect economic firm and industry structure efficiency. For economic firm efficiency the plant is operating at minimum SAC for a given plant type or capital expenditure using the best techniques for given inputs. Also for optimum industry structure efficiency, all firms are operating on the same SAC curve which is tangent at its minimum to the minimum point on the LAC curve. That is, each firm would have the same plant type for industry efficiency. The production or output by the industry would be based on the long run or planning product curve. Each firm would operate where $tp_1 = TP_I$, illustrated in the foregoing diagram. But within any given area, demand for output may be so small with transport cost isolation that maximum structural efficiency cannot be achieved. For the same reasons, even single firms may be operating at a profit using inefficient techniques for an output that is above the minimum average cost for the industry and above the minimum average cost for the firm. Such isolation may allow firms to operate under monopolistic competition and restrict output to maximize profit. The sawmill industry particularly has the characteristic of this type of locational disturbance to "spaceless" economic equilibrium.

2. Assumptions

a) Firms are operating in pure competition with respect to output and factor demand, i.e., the price of wood products is very little affected by firm output and the prices of factors (logs, equipment, power, and labor), are unaffected by firm input levels.

b) Due to lack of estimates of demand elasticities, assume that the elasticity is unity and thus revenue unaffected by output. (This assumption is reasonable since Oklahoma's production is only a small percent of national production and if national demand elasticity is unitary. However, transport costs do tend to isolate Oklahoma's demand).

c) Firms are not isolated spatially with respect to output. (The maximum length of haul by mills in all counties of eastern Oklahoma overlaps considerably. They not only overlap within counties but between counties.)

d) Capital and labor markets are perfectly liquid and thus changes in plant type and industry structure are feasible even though not necessarily profitable. Certainly labor in eastern Oklahoma is physically available since it is a labor surplus area with grossly underemployed labor in agriculture. The capital liquidity assumption is much less likely to be valid. The decision to expand a plant is based on the returns to capital and labor and the unit cost of capital may very well be increasing with increasing use. But in addition, it may just not be available at any price which is most likely locally.

3. The Sources of Data

Data for this study was obtained by the survey and from secondary sources.

a) Survey data:

Data available from the survey includes production in board feet of wood by sawmills for 1956, the number of days individual firms operated, the total horsepower of the power units, the numbers and kinds of power units, the numbers and kinds of saws operated and the usual number of men in the sawmill operation.

From this information, the output for each mill was calculated at a level of a full-year's operations. Those firms operating at less than 200 days were brought up to the full-year level to obtain the estimated sawmill industry capacity at standardized durations of operation. The remainder of the physical information then needed prices and depreciation rates to be transformed into fixed and variable cost series.

b) Secondary data:

Price information on gas and diesel motors and their operating costs was furnished by the Allis-Chalmers Company, Sand Springs, Oklahoma. Electric motor prices and operating costs were furnished by Elmer Daniels, Agricultural Engineering Department, Oklahoma State University. These operating costs were of a schedule nature allowing the survey information on horsepower and type of motor to be translated into estimated operating costs.

Prices of other equipment and their rate of depreciation was furnished by L. J. Clymer, State Extension Forester. Mr. Clymer also gave estimates of motor depreciation in the sawmill industry which were sufficiently different from the makers' estimates to warrant their use. The faster rate of depreciation is probably due to the conditions of operation in the sawmill industry where uneven loads, dust and moisture tend to wear out power equipment faster than the average given by the makers.

Wages are reasonably standardized throughout the industry with two wage rates; one for a sawyer and one for his helpers. Variation in total labor costs is due largely to variation in the number of helpers which in turn is partly dependent on the number of small saws. Some more efficient and higher output mills pay higher rates but all were standardized at the average. Mr. Clymer furnished these rates which were checked by a small telephone sample to representative firm types. This data is listed in the appendix.

c) Reliability of the data:

There are several obvious lacks in data. No within-firm variability is available since yearly average figures for each firm were used. Within-firm variability due to differences in labor inputs or inefficient use of similar equipment, will be assessed by comparing firms of similar equipment types. This introduces the assumption that within broad types of firms there is no necessary difference in managerial skill.

The data used in this analysis is not that needed for the ideal efficiency and capacity study. There are several improvements needed for such a study. Data to obtain within firm variability from various levels of labor inputs are needed. Also, the different levels of firm management for similar types of equipment and the engineering data on optimum types of equipment and power needs would be required for analyzing the industry's individual firm efficiency and capacity. Individual firm labor costs and other individual firm costs would be required. Time and motion studies of different types and arrangements of this optimum equipment could be analyzed with respect to these individual costs. Nevertheless, it is hoped that this study will detect gross differences in firm efficiency and point to the places where detailed efficiency studies might be warranted. The results will also lend valuable help to such a study in illustrating the major firm types and the major sources of variability within these types.

D. FIRM AND INDUSTRY CAPACITY MODEL

1. The Model Problem

The model problem in the case of empirical cost curves is composed of at least three important facets; the economic, the statistical, and the empirical. The model must first conform to the underlying assumptions of economic theory. Then it must be susceptible to statistical fitting processes. The difficulty of solving this problem is compounded by the joint dependence of these two parts of the problem. The third facet is the nature of the empirical observations which are commonly attained by surveys or cost accounting studies of an industry. This data problem will be examined first.

a) The data problem:

Nearly all empirical observations of average costs lie around a hyperbolic type of function. This is true of this study, as Figure XIII illustrates.

In other words, we seldom have observations in the real world where diminishing returns occur: the average cost curves, assuming as we do that factor prices are independent of output, never seem to turn up, although the example in Figure XIII does have one final observation that would lie above a hyperbolic function. This predisposes the investigator to fit a hyperbolic average cost function through fitting a linear total cost function or to fit directly a logarithmic function to the observations of average cost.

b) The statistical problem:

The types of curves that may be fitted statistically are numerous but nevertheless limited. Linear in real numbers of their logarithms is the common choice. Polynomials of any degree with or without product terms can also be fitted but involve more difficulty in computation and considerable likelihood that one or more coefficients of degree higher than unity do not differ significantly from zero.

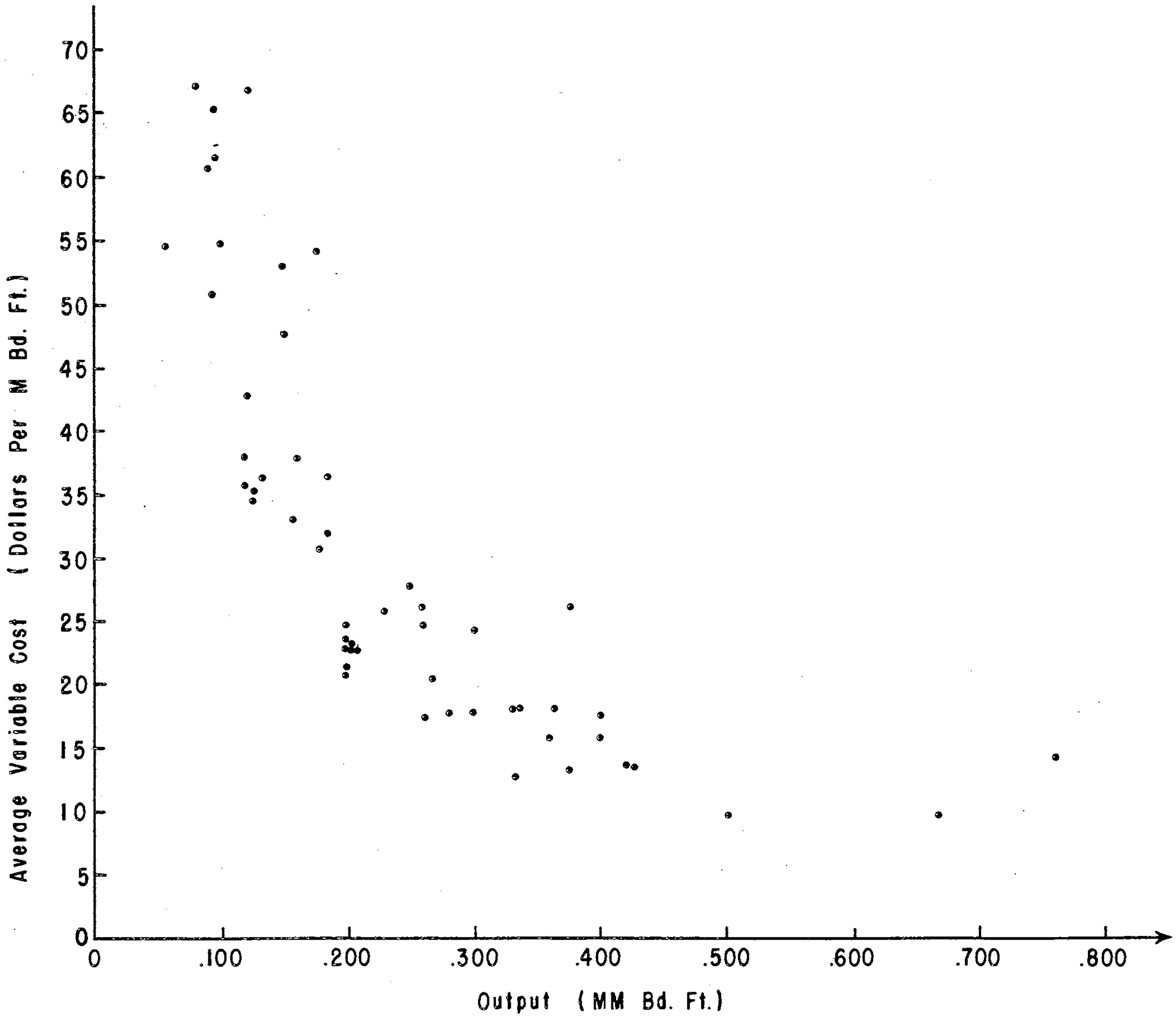


Figure XIII. Empirical Relationship of Average Variable Cost and Output for Sawmills with One Headsaw

c) The economic problem:

The economic problem involves finding forms of equations that do not violate the implications of the assumptions made by economic theory. Industry or long-run total cost curves may indeed be linear, implying constant returns to the factors. But firm or short-run total cost curves must at least be convex to the output axis so that long-run industry average cost does not lie above average total firm costs. The following section on the models investigated will demonstrate these difficulties. A further difficulty involves the use of the model. We are looking for firm and industry maximum cost efficiency without regard to demand relationships. In the absence of empirical studies in the forest industry, price is assumed independent of output and thus cost efficiency is examined outside of revenue considerations. Cost efficiency can be thought of as minimizing average total cost for the firms and average (variable) cost for the industry. To do this, these curves will have to attain a minimum at finite outputs. Put in a different way, the form of the equations estimated will have to be such that would allow firm average total cost and industry average cost to reach a minimum as will be seen in the following section, this will necessitate the use of polynomial form.

2. The Linear Model[2]

a) Statistical assumptions:

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[2]The symbols used in this model will be standard in all models. TC = long-run total cost in dollars per thousand board feet, AC = long-run average cost, FC = long-run fixed cost, c = short-run fixed cost, atc = average total cost, avc = average variable cost, mc = marginal cost, e = error. Small letters denote short-run and capital letters denote long-run. Output in million board feet is denoted by x. Any additional letters will be explained at time of use.

The equation to be fitted is:

$$tc_{ij} = c_i + b_i\, x_{ij} + e_{ij},$$

where, x_{ij} are measured without error,

$$E\ (e_j) = 0,\ E\ (e_j^{\,2}) = \sigma^2, \qquad \left[\hat{\sigma}^2 = SSE \div (n - 1)\right]$$

and $\quad E\ (e_j\ e_k)$, the covariances, $= 0$.

Fitting this model by least squares will give us the best linear unbiased estimates of the unknown parameters for the sample observed over $j = 1, 2, \ldots, n_i$ firms of the i^{th} type.

b) Economic assumptions:

Assume

$$TC = Bx,\ AC = B \text{ and } FC = 0.$$

$$tc_i = c_i + b_i\ x;$$

$$atc_i = b_i + c_i\ x^{-1};$$

$$avc_i = b_i = mc$$

$$tc,\ x,\ c,\ b,\ \geq 0, \text{ and}$$

$$i = 1, 2, \ldots, 7, \text{ the type of firm.}$$

c) Implications:

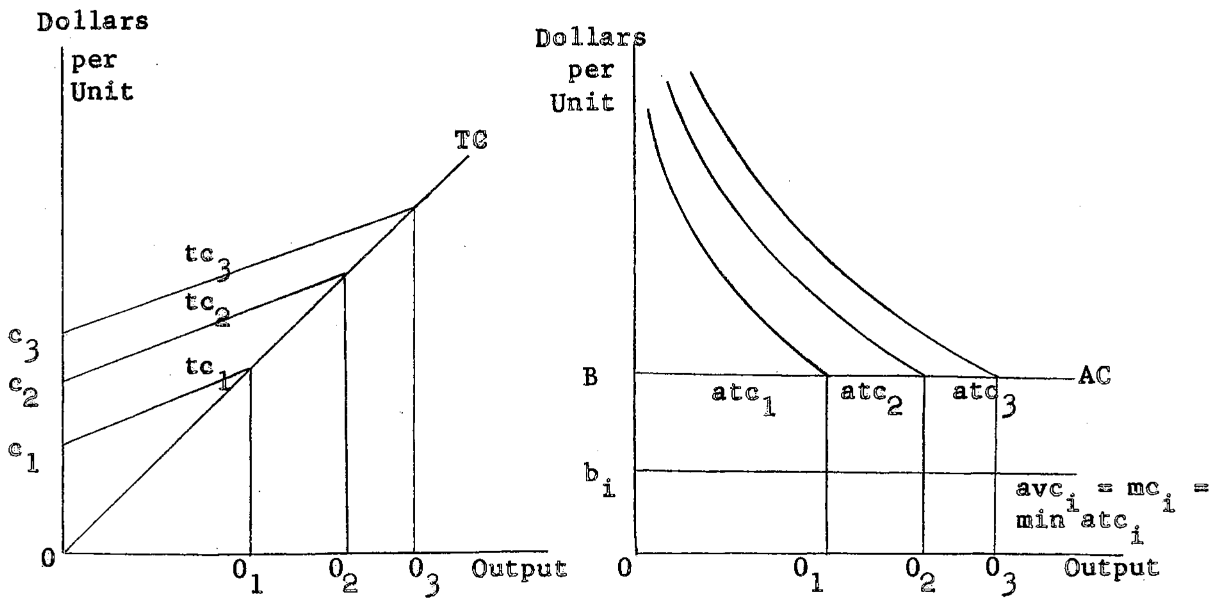
The curves are not useful for this analysis for when $b_i = b_j < B$, the following figure demonstrates that atc_i does not reach a minimum for finite outputs and this minimum equals $b_i < B$. When $b_i > B$, similar conclusions apply.

3. The Logarithmic Model

a) Statistical assumptions:

The equation is

$$\text{Log } avc_{ij} = \log a_i + b_i \log x_{ij} + \log e_{ij}.$$



b) Economic assumptions:

The equations for the long-run are

$$TC = Ax^{1+B},\ AC = Ax^{B},\ \text{and } MC = (1 + B)\ Ax^{B}.$$

The short-run equations are

$$tc_i = c_i + a_i\, x_i^{1+b_i}, \text{ where } tc_{ij},\ x_i,\ c_i,\ a_i,\ \geqq 0 \text{ and } b_i \leqq 0,$$

$$atc_i = c_i\, x_i^{-1} + a_i\, x_i^{b_i},$$

$$tfc_i = c_i,$$

$$tvc_i = a_i\, x_i^{1+b_i},$$

$$avc_i = a_i\, x_i^{b_i} \text{ and}$$

$$mc_i = (1 + b_i)\ a_i\, x_i^{b_i}.$$

c) Implications:

For a fit of the usual average cost observation; b_i, $B < 0$. Two of the many possibilities will be examined.

For $-1 < b_i, < 0$, $B \leqq 0$ and as $x \geqq 0$ increases:

$$0 \leqq TC = Ax^{1+B} \leqq \infty$$

$$\infty \geqq MC = (1 + B)\ Ax^{B} \geqq 0$$

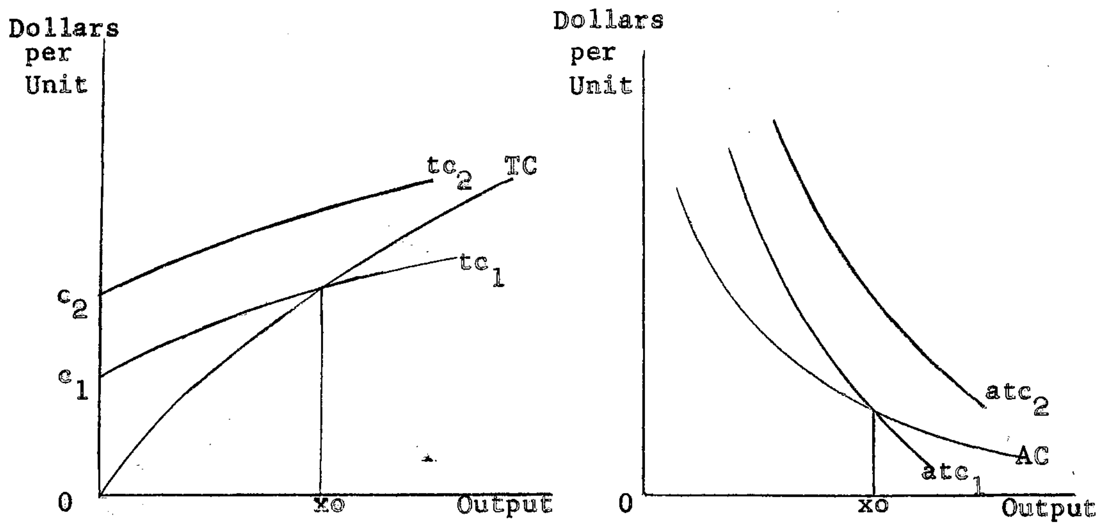
$$\infty \geqq AC = Ax^{B} \qquad \geqq 0$$

$$0 < tc_i = c_i + a_i\ x_i^{1+b_i} \leqq \infty$$

$$\infty \geqq mc_i = (1 + b_i)\ a_i\ x_i^{b_i} \geqq 0$$

$$\infty \geqq atc_i = c_i\ x^{-1} + a_i\ x_i^{b_i} \geqq 0$$

This would imply curves as follows:



Unless the A, B, coefficients are restricted with respect to the a_i, b_i, c_i, these curves can intersect. Even with such restrictions, the average curves reach a minimum of zero at infinite output. This model, then, can only be used as a fitting model over limited outputs and not to determine maximum firm or industry efficiency.

For $b_i \leqq -1$, $-1 < B \leqq 0$ and as x increases:

$$0 \leqq TC = Ax^{1+B} \leqq \infty$$

$$\infty \geqq MC = (1 + B)\ Ax^{B} > 0$$

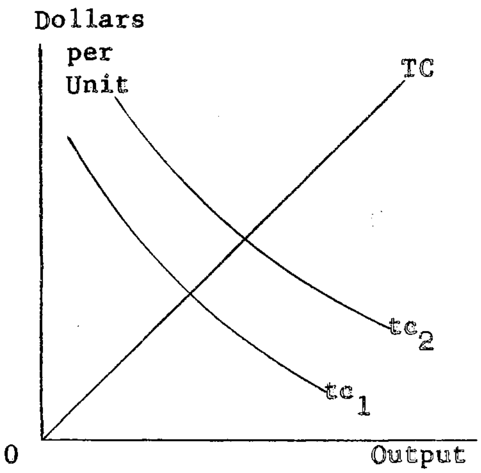
$$\infty \geqq AC = Ax^{B} \geqq 0$$

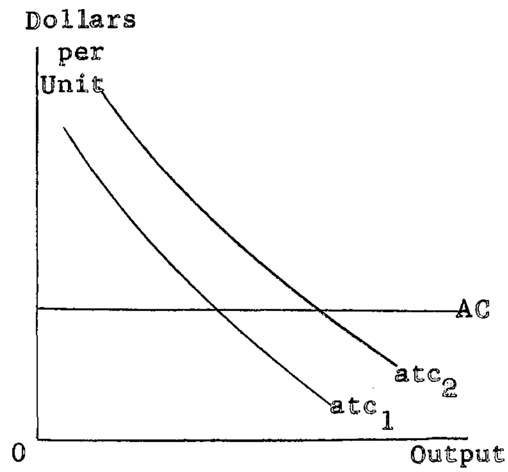
$$\infty \geqq tc_i = c_i + a_i x_i^{1+b_i} \leqq c$$

$$\infty \geqq atc_i = c_i x_i^{-1} + a_i x_i^{b_i} \geqq 0$$

$$\infty \geqq mc_i = (1 + b_i) a_i x_i^{b_i} \geqq 0$$

This would imply curves as follows when $B = 0$.





Once again, this model is not applicable for a capacity study.

4. The Polynomial Model

a) Statistical assumptions:

The equation is

$$avc_{ij} = a_i + b_i x_{ij} + d_i x_{ij}^2 + e_{ij}.$$

b) Economic assumptions:

The relevant equations as before are for the firm:

$$avc_i = a_i + b_i x_i + d_i x_i^2,$$

$$tvc_i = a_i x_i + b_i x_i^2 + d_i x_i^3,$$

$$tfc = c_i,$$

$$tc_i = c_i + a_i x_i + b_i x_i^2 + d_i x_i^3, \text{ and}$$

$$atc_i = a_i + c_i x_i^{-1} + b_i x_i + d_i x_i^2,$$

where tc_i, x_i, a_i, $d_i \gtreqless 0$, $b_i \lesseqgtr 0$.

and for the industry:

$$AC_k = a + Bx_k + Dx_k + E_k,$$
$$TC_k = Ax_k + Bx_k^2 + Dx_k^3$$

where k are the observations described below.

c) Implications:

For b_i, $B < 0$, a_i, c_i, d_i, A, C, D > 0, as $x \gtreqless 0$ increases:

$$0 \lesseqgtr TC = Ax + Bx^2 + Dx^3 \lesseqgtr \infty$$
$$A \lesseqgtr MC = A + 2Bx + 3Dx^2 \lesseqgtr \infty$$
$$A \lesseqgtr AC = A + Bx + Dx^2 \lesseqgtr \infty$$
$$\infty \gtreqless atc_i = c_i\ x_i^{-1} + a_i + b_i\ x_i + d_i\ x_i^2 \lesseqgtr \infty$$
$$c_i \lesseqgtr tc_i = c_i + a_i\ x_i + b_i\ x_i^2 + d_i\ x_i^3 \lesseqgtr \infty$$
$$a_i \lesseqgtr mc_i = a_i - 2b_i\ x_i + 3d_i\ x_i^2 \lesseqgtr \infty$$

The curves illustrated in Figure XIV would apply. One added restriction would be that TC and AC are envelope curves of tc_i and atc_i. This would mean that

$$mc_i = a_i + 2b_i\ x_i + 3d_i\ x_i^2 = A + 2Bx + 3Dx^2 = MC \text{ for some } x_i > 0.$$

But this restriction only applies to the fitting of TC, <u>not</u> to the short run firm curves. This model itself violates no implications of firm theory and may be used for discovering maximum efficiency of the firms and industry. The only further trouble with the function is the possibility that minimum average costs be negative.

Maximum efficiency of the firm--atc_i:

$$atc_i' = 2d_i\ x + b_i - c_i\ x^{-2},$$
$$\text{at } atc_i' = 0,\ (2d_i\ x + b_i)\ x^2 = c_i$$

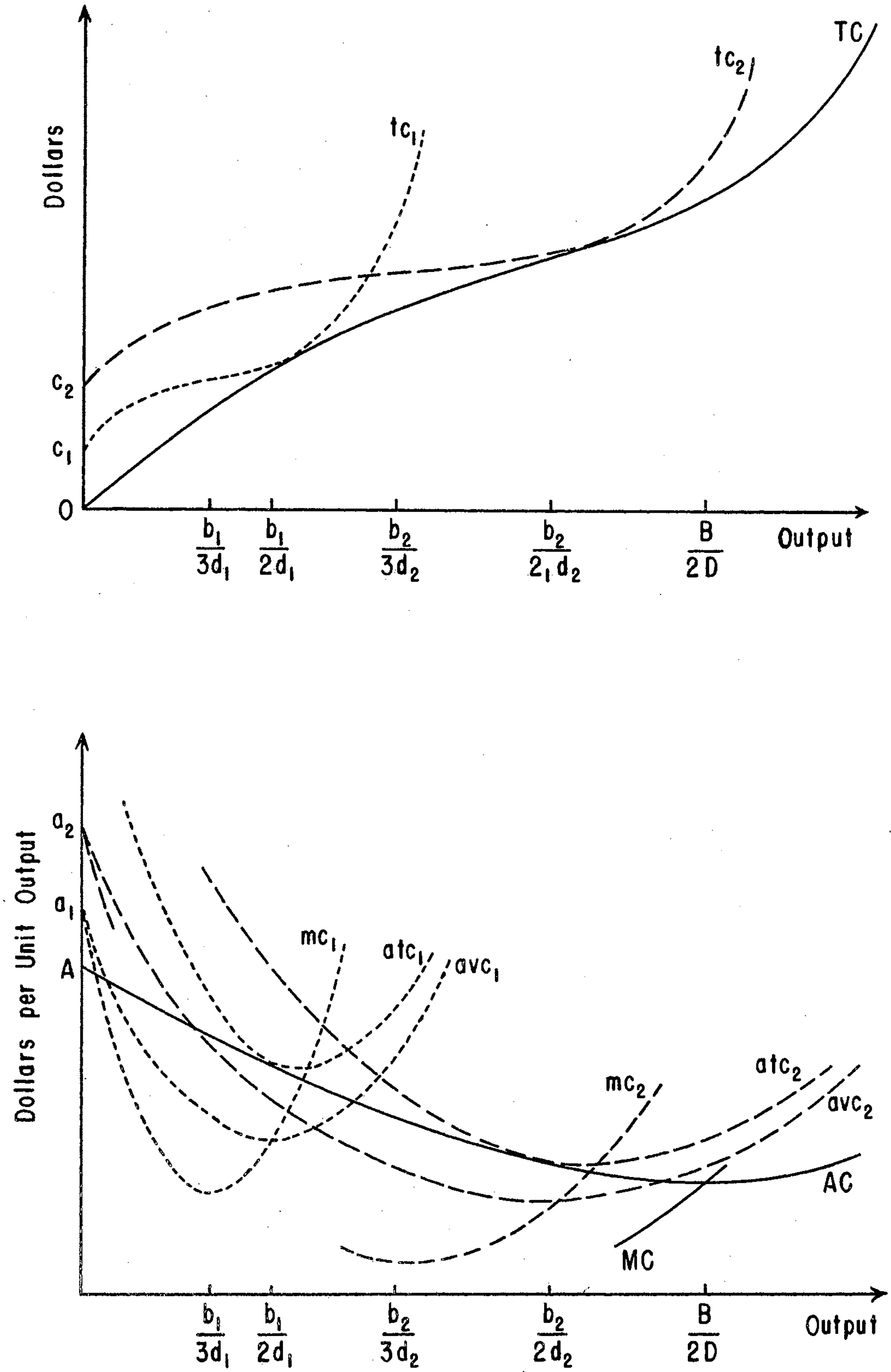


Figure XIV. The Polynomial Model

This can be solved by iteration for x. It will be seen, by Descartes' rule, that this cubic equation in x has one real positive root for $x \geq 0$.

Fitting the envelope curve involves difficulties beyond the range of this study when considered jointly with the relatively small importance of the results for industry efficiency. Instead an approximation will be fitted by finding the equation for a curve drawn free-hand and envelope to the firm cost curves.

The model fit will be $AC = A + Bx + Dx^2 + e$ and industry efficiency would be at output x where $AC' = 0$, at $x = \frac{B}{2D}$.

5. The Lowest Quintile Model

Finally, estimates of maximum efficiency will be made by taking, for each firm type, the lowest quintile of firms as distributed by average total costs and calculating the average of their unit costs and outputs. This method will allow examination of the power and labor used by the more efficient firms whereas the other models abstract from these factors. The other models will be used mainly to assess the variability of costs and the output flexibility of the different types of firms. Most important they will be used to compare the averaged results with results from a more theoretical model.

CHAPTER V

EMPIRICAL RESULTS OF POTENTIAL CAPACITY MODELS

A. CAPACITY RESULTS AT 200 DAYS OPERATION

By increasing the firm's operation to at least 200 days per year, the sawmill industry's capacity would increase by nearly twenty percent.[1] This is an increase from the current 78,342,000 board feet capacity to a 200-day capacity of 96,216,750 board feet. The increase is due primarily to increased operations of small mills. Many of the firms working less than half of the year are small with respect to capital investment and men employed. In the counties outside of the pine area, the industry capacity could be increased by forty percent if the number of days operated by sawmills were increased to 200 or more.

B. ESTIMATED FIRM COST FUNCTIONS

The polynomial equation was fitted to the four types of firms analyzed. In addition, the linear and logarithmic functions were fitted to all except Firm Type I.

1. Results

The results of fitting the different equation types to the different firm types are summarized in Table XI. The y-intercept, the regression coefficients, the tests of significance of the coefficients and the correlation coefficients are presented.

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[1]These do not include about twenty mills which did not have complete data for 1956.

TABLE XI

ESTIMATED COST EQUATIONS

Firm Type	Equation Form[a]	a	b	d	t_b	t_d	R^2	Minimum R^2*
1. Headsaw	Polynomial	89.621	-348.074	351.892	-6.298**	4.567**	.540**	.112
2. Headsaw	Linear	5.342	3.270		1.198		.082	.219
Trimmer	Logarithmic	1.828	- .00145		-6.236**		.708**	.219
	Polynomial	103.427	-447.763	504.712	-6.037**	4.701**	.813**	.329
3. Headsaw	Linear	6.936	2.767		3.250**		.452**	.264
Edger	Logarithmic	1.639	- .000483		-4.143**		.551**	.264
	Polynomial	93.964	-207.580	71.711	-3.909**	3.462**	.596**	.393
4. Headsaw Edger	Linear	11.343	1.292		1.304		.082	.187
Trimmer	Logarithmic	1.487	- .000261		-6.719**		.704**	.187
	Polynomial	45.119	- 34.751	5.483	-3.551**	2.756*	.476**	.283

[a]See Text.

*95 percent level of confidence, the null hypothesis is in all cases that the population parameter is zero.

**99 percent level of confidence, the null hypothesis is in all cases that the population parameter is zero.

2. Comparisons

For the linear model, the b and R^2 values are only significant in the case of Firm Type III.[2] In Firm Type I, both the b and d values are significant at the one percent level and the R^2 is significant at the one percent level for the polynomial fitted. In this case the regression accounts for fifty-four percent of the variation.

In Firm Type II, the b value for the logarithmic and the b and d estimates for the polynomial equation are significant at the one percent level and the R^2 is significant at the one percent level for these two equation types. By the use of the polynomial equation a greater amount of variation is explained, 81 percent, by the regression than by either the linear or the logarithmic. None of the variation is statistically explained by the use of the linear function.

All of the b, d and R^2 values in Firm Type III are significant at the one percent level. The R^2 of the polynomial is greater than either the linear or the logarithmic. Almost sixty percent is explained by the regression in the polynomial model. Firm Type III presented the greatest difficulty in obtaining reasonable results for fitting the equations. A possible reason for the poor fit may become more apparent later in this chapter.

Only the b values of the logarithmic and polynomial equations are significant for Firm Type IV. These b values are significant at the one

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[2]The question of significance is only relevant if the east Oklahoma population is thought of as a sample of U.S. sawmills. Otherwise, the fitting of equations is a purely mathematical process.

percent level. The d value for the polynomial is significant at the five percent level. The R^2 for the logarithmic and polynomial equations are significant at the one percent level. The R^2's for the linear equation is not significant. For this firm type, the logarithmic regression explains seventy percent of the cost variation. As in Firm Type II, the linear equation for Firm Type IV has a very low R^2 and none of the variation is statistically accounted for by the regression.

A reasonably good fit of the polynomial equation was obtained for all four firm types. Only in the case of Firm Type IV was the logarithmic equation a better fit than the polynomial. In nearly all of the firms a poor fit of the linear equation resulted. Only one significant R^2 was obtained for any of the linear equations.

3. Economic and Statistical Conclusions

a) The linear model which was previously shown to be a "non-economic fit" also provides a poor statistical fit. This is true for all firm types except Type III.

The logarithmic equation provides a good statistical fit in all firm types but this equation gives a non-economic fit. Only in the case of Firm Type IV is the R^2 numerically the largest.

The polynomial gives both a good economic and statistical fit. Although the logarithmic equation may give the better statistical fit, the economic fit of the equation must be given consideration. In all but one firm type, the polynomial has the highest R^2 value. It is vital for the economic fit that the model does well in all cases, so that the polynomial overall was the best model from both economic and statistical considerations.

b) The above results justify statistically the use of more sophisticated models than the linear, although only for economic theory reasons the use of the polynomial rather than the logarithmic.

c) The results also justify the data used and way it was modified in the sense that the economic model was not rejected by the data.

4. Results from the Lowest Quintile Model

In using the lowest quintile of the firms in each type the average output and the average of average total costs were obtained for each type. As the fixed equipment of the firm increased the output increased and average total cost decreased. Five other single examples of firm types averaged out at higher output but higher cost also. The figures for the industry minimum long-run average cost co-ordinates were obtained as a weighted average of the firm estimates. The average output and average total cost of Firm Type IV and the other firms were used in obtaining a more realistic estimate of the optimum industry efficiency co-ordinates from a more efficient group of firms. The results are summarized in Table XII.

TABLE XII

LOWEST QUINTILE MODEL AVERAGE TOTAL COST AND AVERAGE OUTPUT

Firm Type	Number	Average Output	Average Total Cost Per M Bd. Ft.
		(M M Bd. Ft)	(dollars)
I	11	.445	13.97
II	4	.506	11.10
III	3	1.233	10.75
IV	4	2.410	7.41
Other firms	5	3.236	11.67
Industry	27	1.350	11.79
Industry of IV and Others	9	2.869	9.78

C. ESTIMATES OF INDUSTRY COST FUNCTIONS

At first it was thought that an approximation to an envelope curve could be fitted by using a restricted number of observations from the different firm types. The results from these attempts were unsatisfactory. The resulting industry cost function was nowhere near an envelope curve.

Fitting a free hand curve brought to light the fact that although the firm cost curves went to a minimum at outputs similar to the average outputs of the lower quintile firms the unit cost of these outputs as estimated from the functions were in two cases of four negative.

For these reasons, a new set of cost functions were estimated from a reduced number of observations. The reduction of observations from the original was made on the basis of eliminating the few extremely high cost and low output firms of each type. The results are summarized in Table XIII.

TABLE XIII

AVERAGE COST FUNCTIONS - ESTIMATES FROM RESTRICTED OBSERVATIONS, POLYNOMIAL MODEL, y in $ atc/MBF, x in MMBF

Function				Estimated Parameters					
Type	Restriction	n	c	a	b	d	t_b	t_d	R^2
I	$x \geq .2$	31	124.20	36.40	-72.64	53.40	-3.387**	2.197**	.574**
II	$x \geq .2$	9	131.20	29.57	-48.51	28.27	- .639	.307	.579**
III	$x > .2$	10	142.20	30.15	-31.01	8.69	-3.382**	2.566*	.834**
IV	$x > .2$	18	227.61	27.93	-14.25	1.87	-3.047**	2.060	.569**
AC	1/	24	---	15.21	- 3.06	0.24	-1.687	.691	.474

*, ** Levels of significance of 95 percent and 99 percent. The null hypothesis in all cases is that the population parameter is zero.

[1] Observations taken from Type I: 11, y < 18.00; Type II, III and IV: 8, first quintile of y; plus the 5 other single firm types.

It will be seen from Table XIV that the statistical fit was not as good as in the unrestricted model. But the firm cost curves in three cases did conform to theoretical expectations. In the case of Firm Type II the cost function was highly inflexible and came to a negative minimum average total cost.

TABLE XIV

COMPARISON OF MINIMUM AVERAGE TOTAL COST VALUES BY DIFFERENT METHODS OF ESTIMATION

Firm Type	First Quintile of Average Total Cost		Statistical Estimates			
			All Observations		Restricted Observations	
	min. y	x	min. y	x	min. y	x
	$/MBF	MBF	$/MBF	MBF	$/MBF	MBF
I	13.97	445	3.86	495	11.87	683
II	11.10	506	4.37	444	- 2.44	861
III	10.75	1233	-56.16	1448	2.56	1787
IV	7.41	2410	- 9.87	3171	0.90	3817
Industry AC	11.79	1350	4.84	3627	5.55	6306

The envelope curve was drawn tangent to the three other firm types as illustrated in Figure XV. Its output for a minimum average cost of \$1.00 was 3000 MBF. Its equation, mathematically fitted since its minimum was known was

$$AC = 25.0 - 1.9\ x + 2.7\ x^2$$

It will be seen from Figure XV that Firms I, III and IV are in ascending order of output flexibility and in descending order of minimum firm unit cost. The curves, however, tend to over-estimate economies

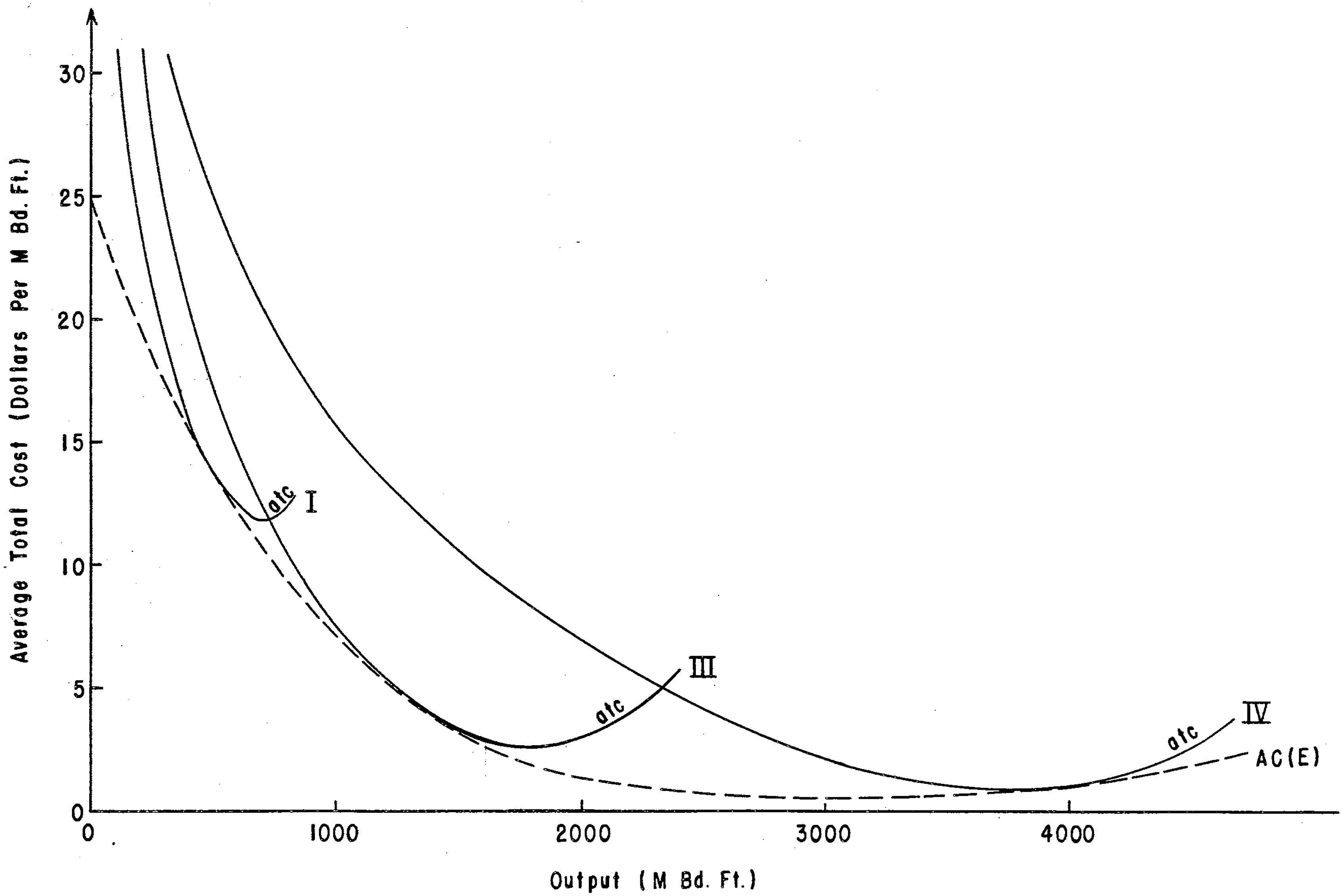

Figure XV. Statistically Derived Average Total Cost Functions for Three Types of Firms from Restricted Observations possible in that the minimum costs are much lower than most observations. For these reasons it was decided to use the "First Quintile" estimates in assessing the firm capacity potential of the industry. In the case of industry efficiency, 3000 MBF seems a reasonable output but the unit costs involved will likely be closer to $10.00 per MBF when compared to the actual data. These figures will be used for the industry capacity coordinates. Table XIV illustrates the comparison of results from these varied methods.

D. MAXIMUM EFFICIENCY FOR THE INDUSTRY

1. Potential Outputs at Maximum Firm Efficiency

A comparison of the existing and potential output of the industry is shown in Table XV. The existing conditions show that 112 firms are used in processing 56,700,000 board feet of wood. At maximum efficiency the number of firms could be reduced to fifty-five. This is less than half of the number now required for the current output. The number of workers required would also be reduced by more than half.

The net growth in eastern Oklahoma as cited in a previous chapter is 115,000,000 board feet. To attain this amount of output minus the one firm's output which is held constant, 79 firms would be required when operating at maximum efficiency. The number of workers for processing the 85,000,000 board feet is only 73 percent of the existing number of men employed.

The maximum potential output for the existing firms working at maximum efficiency would be 122,248,000 board feet. This figure excludes the 30,000,000 board feet of one firm. The estimated potential wood

TABLE XV

MAXIMUM FIRM EFFICIENCY FOR PRESENT FIRM-TYPE DISTRIBUTION

Firm Type	Existing at 200 Days			Present[a]			Net Growth Production[a]			Potential[a]		
	Output (MBF)	Men	No. Firms	Output (MBF)	Men[b]	No. Firms	Output (MBF)	Men[b]	No. Firms	Output (MBF)	Men[b]	No. Firms
I	12,929	137	54	12,929	58	29	16,711	76	38	24,030	108	54
II	4,875	45	18	4,875	30	10	6,333	39	13	9,108	54	18
III	6,703	54	15	6,703	25	5	12,860	50	10	18,500	75	15
IV	20,373	113	21	20,373	54	9	35,190	90	15	50,610	126	21
Other	11,820	44	4	11,820	22	2	13,906	33	3	20,000	44	4
Total	56,700	393	112	56,700	189	55	85,000	288	79	122,248	407	112
Firms Held Constant	30,000	300	1	30,000	300	1	30,000	300	1	30,000	300	1
Total	86,700[c]	693	113	86,700	489	56	115,000	588	80	152,248	707	113

[a] Capacity of firms operating at efficiency of lower 20 percent of firms in each type.

[b] Number of men equals number of firms times median number of workers.

[c] Excludes seven firms because of poor data.

production from woodlots in 1975 is 150,000,000 board feet. By subtracting one large firm's output, it can be seen that the current number of mills, operating at maximum efficiency, can process the 1975 potential production.

To obtain the maximum efficiency by firm type, the average output, average total cost, total costs, power type, horsepower, and work force are given in Table XVI. In the data are shown that as output increases by firm type, the total cost increases but average total cost decreases. Also the average horsepower except for Type II and IV, and median number of workers increase as output increases. The data in this table were computed by using the lower 20 percent of the firms in each type, i.e., the lowest quintile model.

2. Potential Value of Output at Maximum Firm Efficiency

The estimated potential value for the existing firms at maximum efficiency in the firm types is given in Table XVII. For the same firm types at 200 days capacity the current total output is 44,880,000 board feet of which 28,723,000 board feet (64 percent) is pine and 16,157,000 board feet (36 percent) is hardwood. By using the average costs per thousand board feet of pine ($18.65) and of hardwood ($8.63) the total value is 675,119 dollars. Of the present total value, the farm value of wood is 114,770 dollars (17 percent).

The potential total output at maximum firm efficiency is 102,248,000 board feet with 26,607,000 board feet (26 percent) of the total amount attributed to farm woodlots. The potential total value is 1,538,090 dollars with 261,475 dollars going to farm woodlot owners. For the same firms at maximum efficiency the current output would more than

TABLE XVI

FIRM COST DATA AT MAXIMUM EFFICIENCY WITH HORSEPOWER AND WORK FORCE

Type	Average Output MMBF	Average Total Cost per MBF	Total Costs (dollars)	Power Type Class	Power Type Frequency	Horsepower Average per Mill	Horsepower Weighted Average	Workers Class	Workers Frequency	Workers Median
I	.445	13.97	6,216.65	1 gas	8	88	97	1	1	2
				2 gas	2	150		2	7	
				1 diesel	1	65		3	2	
								4	1	
II	.506	11.10	5,616.60	1 gas	4	70	70	1	1	3
								2	1	
								3	2	
III	1.233	10.75	13,254.75	1 gas	1	100	145	2	1	5
				2 diesel	1	210		5	1	
				1 diesel	1	125		8	1	
IV	2.410	7.41	17,858.10	1 gas	4	124	124	4	1	6
								5	1	
								7	1	
								8	1	

TABLE XVII

ESTIMATED VOLUME AND VALUE AT MAXIMUM FIRM EFFICIENCY

	Potential				Value at Stump			
Type	Total Volume[a] (MMBF)	Pine (MMBF)	Hwd. (MMBF)	Farm Volume[b] (MMBF)	Hwd. (Dollars)	Pine (Dollars)	Total (Dollars)	Farm[b] (Dollars)
I	24.030	15.379	8.651		74,658	286,818	361,476	
II	9.108	5.829	3.279		28,298	108,711	137,009	
III	18.500	11.840	6.660		57,476	220,816	278,292	
IV	50.610	32.390	18.220		157,239	604,074	761,313	
Total	102.248	65.438	36.810	26.607	317,671	1,220,419	1,538,090	261,475

[a]Total output is computed by the average output at maximum firm type efficiency (Average output times number of firms in type).

[b]Computed by use of existing volume and value, farm to total ratios.

double as would the value of the wood. This indicates that with firm efficiency and adequate wood resources available the sawmill industry would be even more important than at the present.

3. Potential Output and Values at Maximum Industry Efficiency

Using the coordinates of 3000 M board feet with average total cost at 10 dollars per M board feet, the industry capacity would depend on the number of firms. With 100 firms, the output would be 300 MM board feet giving a total value of 4,512,840 dollars. Of the total volume and value, the farm output would be 78 MM board feet with a value of 767,183 dollars. This indicates the magnitude of the sawmill industry operation when at maximum industry efficiency. The capital costs of attaining such efficiency are perhaps not as large as might be thought. Firm Type IV can be a very efficient firm as the results show producing around 2500 MBF per year at an average total cost of $7.50 per MBF. Yet the fixed equipment difference between this type and the others is relatively small as the yearly depreciation fixed costs show. The yearly fixed costs are $227.61 versus $124.20, $131.20, and $142.20 for Types I, II and III. So at the worst the yearly fixed costs do not double between Type I and Type II. However, the total expenditure to buy the extra equipment is quite large and capital may well be rationed. Also the figures overestimate the actual market values of the equipment of the smaller firms who often operate with very much depreciated equipment.

E. VARIABILITY RESULTS

There exists a large amount of variability as is illustrated by the estimates of variation in Table XVIII. The estimated standard deviation was computed for each firm type. Type III has the largest standard

TABLE XVIII

FIRM VARIABILITY USING AVERAGE VARIABLE COSTS

Type	$\bar{y}$	$\hat{\sigma}y^2$	$\hat{\sigma}\ y$	$\frac{\hat{\sigma}\ y}{\bar{Y}}$	R	Range of Y	$\bar{Y} \pm 1.96\ \hat{\sigma}\ y$	Percent above $\bar{Y}$
I	33.57	689.051	26.250	.782	.734641**	9.64-183.15	$-17.88 < \bar{Y} < 85.20$	37.04
II	34.88	711.165	26.668	.765	.901644**	10.08-104.66	$-17.39 < \bar{Y} < 87.15$	33.33
III	37.31	1,375.419	37.087	.994	.771714**	5.61-133.25	$-35.38 < \bar{Y} < 110.00$	33.33
IV	21.83	333.707	18.268	.837	.689698**	5.57- 90.06	$-13.98 < \bar{Y} < 57.64$	28.57

**$P(R = 0) < .01$, $P(|Y - \bar{Y}| < 1.96\ \sigma\ y) = .95$.

deviation while Type IV has the smallest. The larger the standard deviation, the wider the scatter about the mean. This is shown by using $\bar{Y} \pm 1.96\ \hat{\sigma}y$ where for normal distribution one would expect 95 percent of the distribution to be within this range. Again, Type III has the greatest amount of dispersion, $-35.38 < \bar{Y} < 110.00$. Another measure of dispersion used is the coefficient of variation, $\frac{\hat{\sigma}y}{\bar{Y}}$. This gives the relative amount of variability in comparing the firm types. Relative to the other firm types, Firm Type III has the greatest amount of variability with Type I and II having about equal variability.

The range of Y is large for all firm types. This gives another demonstration of the large amount of variability. The percent above the mean column also indicates the skewness in the distribution as does the difference between the two sigma range and the actual range. All of the firms are skewn below the mean with Firm Type IV showing the largest percentage of firms below the mean.

The ideal analysis in variability would be to compare the variability within each type of firm between each types of firms after allowing for variations in output. But this is impossible since we have to make the assumption that the regression form was the best fit in all cases which is obviously not necessarily valid. The same model for each type is not necessarily the best model. Nevertheless, output variability does remove a somewhat similar amount of variability from average total costs in all cases, so that a comparison between the variabilities of each type may be justified.

The F-test was used in Table XIX to test H_o: $\hat{\sigma}_i^2 = \hat{\sigma}_j^2$. The hypothesis that $\hat{\sigma}\ y_1^2 = \hat{\sigma}\ y_4^2$ was rejected at the 10 percent level of significance and the hypotheses that $\hat{\sigma}\ y_3^{\ 2} = \hat{\sigma}\ y_4^{\ 2}$ was rejected at the 1 percent level of significance.

TABLE XIX

F-TEST OF VARIANCES, H_o: $\hat{\sigma}_i^{\ 2} = \hat{\sigma}_j^{\ 2}$

	y_2	y_3	y_4
y_1	.969	.501	2.065*
y_2		.517	2.131
y_3			4.122***

*= 90 level of confidence.

***= 99 percent level of confidence.

The conclusions to be drawn are somewhat subjectively based but may be summarized as follows. Type IV has much less variability in average costs than any other type of firm. It is also more flexible with respect to output and is capable of handling large outputs in several instances of individual firms. In fact four firms in this type averaged about 2.400 MBF of output but only $7.50 of average total costs. When the smaller variability in average costs and the large variability in output is added to the similar explanation of cost variability by output variability (48 percent) the conclusion seems reasonable that Firm Type IV is the most economically efficient of the firm types investigated. The fixed costs of this firm are, of course, almost double those of the other types.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Fifteen counties of eastern Oklahoma which are in the low-income area were included in this study. The major objective of this thesis was to describe the current and estimate the potential capabilities of the processing industries for forest products, especially as they might restrict the possibility of improving incomes to the low-income farmers of eastern Oklahoma by greater use of their forest resources.

In this study, farm income, forest resources and forest markets were the three major factors examined. Five objectives were presented and analyzed each of which directly or indirectly influences farm forest resource use and farm income: (1) to provide a detailed description of the forest industry, (2) to establish a directory of forest industries to improve market knowledge of the buyers and sellers of wood, (3) to analyze sawmill capacity and associated costs, (4) to determine the variability of sawmill costs, and (5) to provide base for further research in the general area of forest product processing.

Conclusions:

(1) The size of the forest industry of eastern Oklahoma as measured by numbers of firms (133 sawmills) and their output (78 MMBF) is larger than previous estimates which were available.

(2) The market for forest products should be made more perfect with respect to buyer and seller knowledge by "The Forest Market Directory",

Oklahoma State University Extension Bulletin, 1958.

(3) Existing sawmills could process 85 percent of the eastern Oklahoma net-growth potential (115 MMBF) merely by increasing their days of operation to at least 200 days per year.

(4) With the present capital equipment of the various types of firms, by operating near economic capacity with respect to the variable inputs, labor and power, the sawmills could process 102 percent of the 1975 estimated output needs of the industry (120 MMBF for eastern Oklahoma).

(5) With this same economic capacity, the present output could be handled by about one-half of the existing firms but difficulties of location and transport costs may well interfere with this result.

(6) One hundred sawmills, operated at somewhere near the industry optimum, would be able to process 300 MMBF of logs at less than ten dollars per MBF of total unit costs.

(7) Thus, by all measures used, the sawmill industry is working at far less than capacity. A more useful way of putting this conclusion is to say that the industry, even as now constituted, but especially if operation were more efficient, could handle considerably greater volume of timber from eastern Oklahoma. Other things being equal, the opportunity for increased income to low-income farmers in this area is not, therefore, restricted by the structure of the forest processing market.

(8) A large amount of cost variability exists in the sawmill industry that is not entirely explained by differences in output of various firm types.

(9) The description of the industry with its high variability in sawmill costs and the pilot investigation of the efficiency of the

various sawmill firm types will aid further investigation to improve the industry.

Recommendations:

(1) Information for the buyers and sellers should be kept up-to-date through periodic revisions of The Forest Market Directory.

(2) Research needs which were unearthed by this study could be listed as follows:

a) Economic efficiency studies of the engineering and cost aspects of representative sawmills, and secondary wood users such as charcoal makers.

b) The economics of location of forest product processing industries with respect to the situation and accessibility of timber stands and lumber markets.

c) Demand relations for forest products in Oklahoma and the region.

d) Price and pricing practices of farm-owned timber.

e) New wood use potential especially for inferior grade timber.

(3) An extension of the programs to increase farm wood growth and production should be initiated to make better use of the existing capacity of the processing industry for forest products in order to aid farm income improvement in the low income area of eastern Oklahoma.

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APPENDIX TABLE I

DISTRIBUTION OF WORK FORCE FOR EASTERN OKLAHOMA, BY COUNTY AND SOURCE, 1929[a]

County	Total Work Force[b]	Agricultural Work Force[b]					Forest Work Force	Total Estimated Forest Work Force
		Total Work Force	Agricultural Work Force	Percent of Total	Forest Work Force	Percent of Total		
Adair	4,566	2,865	2,625	91.63	240	8.37	106	346
Atoka	4,659	2,997	2,956	98.62	41	1.38	250	291
Cherokee	5,452	3,816	3,590	94.09	226	5.91	86	312
Choctaw	8,218	5,116	5,069	99.09	47	.91	105	152
Coal	3,606	2,294	2,255	98.29	39	1.71	8	47
Delaware	4,688	3,580	3,385	94.54	195	5.46	124	319
Haskell	4,559	3,322	3,308	99.57	14	.43	42	56
Latimer	3,464	1,787	1,763	98.64	24	1.36	144	168
Le Flore	13,035	7,149	7,071	98.91	78	1.09	721	799
McCurtain	11,374	6,939	6,783	97.75	156	2.25	1,016	1,172
McIntosh	7,522	5,564	5,541	99.58	23	.42	24	47
Muskogee	23,490	7,519	7,504	99.80	15	.20	76	91
Pittsburg	18,649	5,862	5,797	98.89	65	1.11	241	306
Pushmataha	4,757	2,800	2,685	95.91	115	4.09	511	626
Sequoyah	6,161	4,546	4,434	97.54	112	2.46	130	242
Totals	124,200	66,156	64,766		1,390		3,584	4,974
Percent of Total Work Force			52.15					4.00

[a]Source: United States Department of Commerce, Bureau of Census, Characteristics of the Population, 1929, (Washington, D. C. 1929).

[b]Work Force is defined as all civilians 10 years old and over who were at work, or with job but not at work.

APPENDIX TABLE II

DISTRIBUTION OF WORK FORCE FOR EASTERN OKLAHOMA, BY COUNTY AND SOURCE, 1939[a]

County	Total Work Force[b]	Agricultural Work Force[b]: Total Work Force	Agricultural Work Force[b]: Agricultural Work Force	Agricultural Work Force[b]: Percent of Total	Agricultural Work Force[b]: Forest Work Force	Agricultural Work Force[b]: Percent of Total	Forest Work Force	Total Estimated Forest Work Force
Adair	3,461	2,159	2,104	97.44	55	2.56	231	286
Atoka	4,547	2,914	2,904	99.66	10	.34	246	256
Cherokee	4,599	2,849	2,791	97.95	58	2.05	242	300
Choctaw	6,633	3,922	3,905	99.57	17	.43	163	180
Coal	3,141	2,099	2,095	99.79	4	.21	15	19
Delaware	4,598	2,808	2,754	98.07	54	1.93	258	312
Haskell	3,548	2,447	2,444	99.88	3	.12	36	39
Latimer	2,496	1,199	1,195	99.63	4	.37	195	199
Le Flore	9,528	4,595	4,578	99.63	17	.37	766	783
McCurtain	10,207	5,465	5,417	99.13	48	.87	1,778	1,826
McIntosh	5,558	3,831	3,828	99.91	3	.09	29	32
Muskogee	18,284	5,305	5,301	99.92	4	.08	103	107
Pittsburg	9,966	4,010	4,007	99.93	3	.07	117	120
Pushmataha	4,339	2,377	2,357	99.15	20	.85	486	506
Sequoyah	4,916	3,124	3,112	99.63	12	.37	234	246
Wtd. 15 County Total	95,821	49,104	48,792		312		4,899	5,211
Percent of Total Work Force			50.92					5.44

[a]Source: United States Department of Commerce, Bureau of Census, Characteristics of the Population, 1939 (Washington, D. C., 1939).

[b]Work Force is defined as all civilians 14 years old and over who were at work, or with job but not at work.

APPENDIX TABLE III

DISTRIBUTION OF WORK FORCE FOR EASTERN OKLAHOMA BY COUNTY AND SOURCE, 1949[a]

County	Total Work Force[b]	Agricultural Work Force[b]					Forest Work Force	Total Estimated Forest Work Force
		Total Work Force	Agricultural Work Force	Percent of Total	Forest Work Force	Percent of Total		
Adair	3,830	2,114	2,099	99.31	15	.69	148	163
Atoka	3,942	1,957	1,944	99.32	13	.68	189	202
Cherokee	4,648	2,126	2,096	98.59	30	1.41	83	113
Choctaw	5,719	2,396	2,356	98.32	40	1.68	218	258
Coal	2,437	1,357	1,350	99.47	7	.53	40	47
Delaware	4,182	2,325	2,305	99.13	20	.87	147	167
Haskell	3,719	2,025	2,018	99.67	7	.33	43	50
Latimer	2,493	904	898	99.37	6	.63	135	141
Le Flore	9,047	2,866	2,820	98.38	46	1.62	620	666
McCurtain	8,366	3,275	3,220	98.32	55	1.68	1,526	1,581
McIntosh	4,714	2,545	2,542	99.90	3	.10	21	24
Muskogee	21,535	3,417	3,414	99.90	3	.10	144	147
Pittsburg	12,121	2,743	2,736	99.74	7	.26	113	120
Pushmataha	3,481	1,611	1,593	98.86	18	1.14	312	330
Sequoyah	4,903	2,078	2,073	99.75	5	.25	384	389
Wtd. 15 County Total	95,137	33,739	33,464		275		4,123	4,398
Percent of Total Work Force			35.17					4.62

[a]Source: United States Department of Commerce, Bureau of Census, Characteristics of the Population, 1949, (Washington, D. C., 1949).

[b]Work Force is defined as all civilians 14 years old and over who were at work, or with job but not at work.

APPENDIX TABLE IV

FARM FOREST AREA BY SPECIES AND COUNTY, 1956

County	Thousand of Acres		
	Hardwood	Pine	Total
Adair	115.2	10.0	125.2
Atoka	100.3	66.8	167.1
Cherokee	132.4	11.5	143.9
Choctaw	86.5	15.3	101.8
Coal	81.2	4.3	85.5
Delaware	152.4	13.3	165.7
Haskell	58.9	5.1	64.0
Latimer	8.0	65.1	73.1
Le Flore	19.2	155.8	175.0
McCurtain	1.2	9.8	11.0
McIntosh	12.2	3.1	15.3
Mayes	11.9	3.0	14.9
Muskogee	26.3	6.6	32.9
Ottawa	23.8	6.0	29.8
Pittsburg	186.1	16.2	202.3
Pushmataha	15.1	122.5	137.6
Sequoyah	96.3	8.4	104.7
TOTAL	1,127.0	522.8	1,649.8

This table was obtained by the use of unpublished data from the Oklahoma Division of Forestry. The total acres of farm forest acres in each county was multiplied by the estimated percent of the total acres in pine and estimated percent of the total acres in hardwood. This gave estimates of the acres of pine and hardwood by counties.

APPENDIX TABLE V

CALCULATION OF FARM VERSUS NON-FARM OUTPUT OF PINE AND HARDWOOD OF SAWLOGS

A. Comparison of Survey Results

	Acres	Bd.Ft.	Bd.Ft./Acre
1955-56			
Forest Service Survey[1]			
Pine	1,578,700	60,390,000	38.25
Hardwood	4,053,300	19,510,000	4.81
1956			
Forest Markets Survey[2]			
Pine	1,574,100	57,132,000	36.30
Hardwood	3,821,700	21,733,000	5.69

[1]Forest of East Oklahoma, 1955-56, Forest Survey Release 79, Forest Services, U.S.D.A., June, 1957. Includes seventeen counties in eastern Oklahoma.

[2]Includes fifteen of the seventeen counties included in the Forest Service Survey.

B. Calculation of Farm Versus Non-Farm Breakdown of Sawlog Output

1.	Farm-Owned Production in Fifteen Counties 1956 (MBF)	Pine	5,376
		Hardwood	15,893
		Total	21,269

Date were obtained from 1956 Forest Survey by this station. Timber bought by sawmills from farmers is the only volume indicated.

2.	Total Acres Commercial Forest Land in Fifteen Counties	Pine	1,574,100
		Hardwood	3,821,700
		Total	5,395,800

Data were obtained from Table 6, page 22 of Forest Survey Release 79. Mayes and Ottawa were taken out of the seventeen-county total by using the proportions of growing stock of pine and hardwood in Table 15 of Release 79 and applying to the commercial forest area in B4.

Appendix Table V (continued)

3. Farm Acres of Commercial and Non-Commercial Forest Land in Seventeen Counties	Pine	522,800
	Hardwood	1,127,000
	Total	1,649,800

Data obtained from the Oklahoma Division of Forestry (unpub.) information for counties in eastern Oklahoma. The farm forest acres and the estimated percent hardwood and percent pine were obtained for each county from this source. See Table of Farm Forest Area by Species for Seventeen Counties of Eastern Oklahoma.

4. Farm Acres of Commercial and Non-Commercial Forest Land in Fifteen Counties	Pine	513,800
	Hardwood	1,091,300
	Total	1,605,100

The data for Mayes and Ottawa Counties were subtracted from the information of the seventeen counties. See Farm Forest Area Table for complete county data.

5. Farm Acres of Commercial Forest Land in Fifteen Counties	Pine	509,504
	Hardwood	1,082,696
	Total	1,592,200

This table was calculated by subtracting from the acres of farm commercial forest land (1636.9 acres) the amount of farm forest land in Mayes and Ottawa counties (44.7 acres). This gave the total farm-owned commercial forest land in the fifteen counties. To obtain the area of commercial forest land by species, the proportions of pine (32 percent) and hardwood (68 percent) were multiplied by the total area (1,592,200 acres).

6. Non-Farm-Owned Production (MBF) in Fifteen Counties, 1956	Pine	51,756
	Hardwood	5,840
	Total	57,596

Source of data is from 1956 Forest Survey at this station. Includes only volume of non-farm timber bought by sawmills.

7. Non-Farm Acres of Commercial Forest Land in Fifteen Counties	Pine	1,064,596
	Hardwood	2,739,004
	Total	3,803,600

Data obtained by subtracting B5 from B2.

8. Total Acres Commercial Forest Land in Fifteen Counties Classified by Farm and Non-Farm	Farm	1,592,200
	Non-Farm	3,803,600
	Total	5,395,800

Data obtained from the totals in B5 and B7.

Appendix Table V (continued)

9.	Sawmill Output of Farm-Owned Commercial Forest Per Acre, 1956	Pine Hardwood	10.55 bd.ft/acre 14.68 bd.ft/acre

Data obtained by $\frac{\text{Farm Pine Board Feet (B1)}}{\text{Farm Pine Land Acres (B5)}}$ = Bd.Ft./acre of Pine

$\frac{\text{Farm Hwd. Board Feet (B1)}}{\text{Farm Hwd. Land Acres (B5)}}$ = Bd.Ft./acre of Hwd.

10.	Sawmill Output of Non-Farm-Owned Commercial Forest Per Acre, 1956	Pine Hardwood	58.62 bd.ft/acre 2.13 bd.ft/acre

Data obtained by:

$\frac{\text{Non-farm Pine Board Feet (B6)}}{\text{Non-farm Pine Land Acres (B7)}}$ = Bd.Ft./acre of Pine

$\frac{\text{Non-Farm Hwd. Board Feet (B6)}}{\text{Non-Farm Hwd. Land Acres (B7)}}$ = Bd.Ft./acre of Hwd.

APPENDIX A

Schedules Used in Obtaining the Primary Data

1957 FOREST MARKETS SURVEY:
A - (MILLS)

(1,2)	(3,4)	(5)

____
(Firm) (Manager) (Location)

1. (check one) Sawmill________ Planing Mill________ Saw and Planing Mill________ ________ (6)

2. (check one) Is your location permanent _____ temporary _____ ________ (7)

3. Products: (check all applicable and circle most important) Ties ____, Bridging ____, Construction Lumber ____, Furniture Stock ____, Crating ____, Other ____ ________ (8) ________ (9) ________ (10)

4. (enter year) What date was this business established?______________ (11, 12)

5. How many working days were you closed in 1956? ______________ (13, 14) days.

6. How many workers do you employ? Usual _______ (15,16) High _______ (17,18) Low _______ (19,20)

---

7. What was your total BOARD SCALE (mill tally) volume in 1956? ________ Board feet ________ (21-23)

8. What percent of the logs you sawed was bought from resident farm owners? ________ (24, 25) percent.

9. What percent of your total 1956 volume was pine? __________ (26, 27) percent.

10. What was the average (small end) diameter of the logs you sawed in 1956: Pine_______ (28,29) in., hardwood _______ (30,31) in.

Appendix A (continued)

11. For timber you bought in 1956 at the:

	Stump	Roadside	Mill
a. What proportion did you buy at each location?	____% (32,33)	____%	____% (34,35)
b. What average price did you pay? ($ per thousand bd. ft. log scale)	$____ (36-38)	$____ (39-41)	$____ (42-44)
c. Did these prices vary much in 1956? (Yes or No)	____ (45)	____ (46)	____ (47)

12. What proportion of the timber you bought in 1956 was hauled to the mill by: Self______ (48,49) percent; Farmer______ (50,51) percent; Other ______ percent.

13. What distance is the usual haul? Average______ (52,53) mi., longest______ (54-56) mi., shortest______ (57,58) mi.

14. How many power units do you operate? Electric______ (59) Diesel______ (60) Gas______ (61)

15. What is the total horsepower from all power units? ________ (62-65) H.P.

16. How many Head Saws______ (66) Edgers______ (67) Trimmers______ (68)

17. How much wood do you normally keep on hand in logs ________ (69,70) Bd. ft., (Doyle Rule) in lumber________ (71, 72) Bd. ft.(mill tally).

18. What would be your first estimate of the market value of your equipment?

$________________ (73-77)

Appendix A (continued)

(1,2)	(3,4)	(5)

1957 FOREST MARKETS SURVEY:

B: (PULP, POST, POLE, PROP, PILING, AND TIE)

____
(Firm) (Manager) (Location)

1. Products: (check all applicable and circle most important): Pulp_____

   Post_____ Prop_____ Pole_____ Piling_____ Ties_____ Other_____

   (6) (7) (8) (9) (10)

2. (enter year) What date was this business established?__________ (11, 12)

3. How many working days were you closed in 1956? __________ days (13, 14)

4. How many workers do you employ? Usual ______ (15,16) High ______ (17,18) Low______ (19,20)

5. What percent of the total amount of wood bought in 1956 did you buy from resident farmer owners? __________ percent (21, 22)

6. What percent of the total wood bought was pine?__________ percent (23, 24)

Appendix A (continued)

7. What was your total 1956 volume (if information cannot be obtained in units given, please specify the unit of measure used)?

Product	1956 Volume	Unit of Volume	1956 Yard Price Approximate Average*
Pulp (25-27)		units(4'x5'x8')	(49,50) per unit
Poles(28-30)			
Classed		lineal feet and/or	per pole
(31-33)		Number	(51,52)
Utility		lineal feet and/or	per pole
(34-36)		Number	(53,54)
Posts (37-39)			
Barky			
(40-42)		Number	(55,56) per post
Peeled (43-45)		Number	(57-58) per post
Ties (46-48)		Number	(59-60) per tie

* We are looking for the total dollar payments for each wood product. When available this could be entered instead of this unrealistic "average price". Price lists for the different classes and sizes are already available.

8. Did the price range much in 1956 for these products? (check those varying) Pulp_____ Poles_____ Posts_____ Piling_____ Ties_____ (65)

9. What was your average 1956 inventory in: Pulp_____ (66) (units), Poles _____ (67) (number), Posts_____ (68) (number), Ties_____ (69) (number), Piling _____ (70) (number).

Appendix A (continued)

10. What proportion of the wood you bought in 1956 was hauled to your yard by: Self_____ (71,72) percent; Farmer_______ (73,74) percent; Other_______ percent.

11. What distance is the usual haul: Average_______ (75,76) mi., Long_______ (77,78) mi., Short_______ (78,80) mi.

(1,2)	(3,4)	(5)

1957 FOREST MARKETS SURVEY:
C: MISCELLANEOUS OUTLETS

____

(Firm) (Manager) (Location)

1. Products: (check all applicable and circle most important): Wood Preserving_____ Handle Bolt_____ Charcoal_____ Furniture_____ Crating_____ Other (specify)__________________ _____ (6) _____ (7) _____ (8) _____ (9) _____ (10)

2. (enter year) What date was this business established?_______________ (11, 12)

3. (enter days) If you do not operate year round, how many working days were you closed in 1956?_______________ (13, 14)

4. (enter number) How many workers do you employ? Usual_______ (15,16) High_______ (17,18) Low_______ (19,20)

Appendix A (continued)

5. (check one) What unit of wood measure do you use primarily in purchasing your wood? Cord_____ Unit (specify cu.ft.) _____ Cubic feet_____ Board feet_____ Number (specify dimensions)_________ Other (specify) ____________________ _______
(21)

6. (enter number using units of measure checked above) 1956 total amount of wood used__________________
(22-27)

7. What was the average 1956 price you paid per unit as above for this wood at the mill? (enter number) $________________
(28-31)

8. (enter yes or no) Did this price vary much in 1956?_________________
(32)

9. What was your average wood inventory in units as above?______________
(33-37)

10. What percent of all wood bought did you buy direct from resident farmer owners? _______________ percent.
(38,39)

11. What percent of all wood bought was pine?____________ percent.
(40,41)

12. What percent of the wood you bought in 1956 was hauled to your yard by: Own transport _____ percent; Farmer_____ percent; Other_____ percent.
(42,43) (44,45)

13. What distance are these hauls? Average________ mi., Longest________ mi., Shortest________ mi.
(46,47) (48-50) (50,51)

APPENDIX B

DETAILED DATA ON FIRM COSTS

TABLE 1

FIRM TYPE I -- ONE HEADSAW

Total Costs	Total Fixed Costs	Total Variable Costs	Output in MM Bd. Ft.	Average Cost Per M Bd. Ft.	Average Variable Cost per M Bd. Ft.
(dollars)	(dollars)	(dollars)	(per 200 days)	(dollars)	(dollars)
5595.54	124.20	5471.34	.178	31.44	30.74
4832.17	124.20	4707.97	.200	24.16	23.54
4647.26	124.20	4523.06	.120	38.73	37.69
5595.54	124.20	5471.34	.267	20.96	20.49
5263.74	124.20	5139.54	.120	43.86	42.83
5595.54	124.20	5471.34	.100	55.96	54.71
4289.36	124.20	4165.16	.200	21.45	20.82
6175.52	124.20	6051.32	.333	18.55	18.17
4398.06	124.20	4273.86	.200	21.99	21.37
6175.52	124.20	6051.32	.160	38.60	37.82
5891.96	124.20	5767.76	.420	14.03	13.73
10917.23	124.20	10793.03	.758	14.40	14.23
8145.77	124.20	8021.57	.120	67.88	66.85
4944.17	124.20	4819.97	.500	9.89	9.64
7137.60	124.20	7013.40	.400	17.84	17.53
6508.07	124.20	6383.87	.260	25.03	24.55
5595.54	124.20	5471.34	.090	62.17	60.79
4398.06	124.20	4273.86	.333	13.21	12.83
5701.71	124.20	5577.51	.360	15.84	15.49
6032.17	124.20	5907.97	.230	26.23	25.69
6032.17	124.20	5907.97	.096	62.84	61.54
9636.79	124.20	9512.59	.175	55.07	54.36
3198.06	124.20	3073.86	.056	57.11	54.89
7256.32	124.20	7132.12	.150	48.38	47.55
4944.17	124.20	4819.97	.133	37.17	36.24
9281.75	124.20	9157.55	.050	185.64	183.15
6706.04	124.20	6581.84	.364	18.42	18.08
4746.50	124.20	4622.30	.200	23.73	23.11
8081.75	124.20	7957.55	.150	53.88	53.05
6394.94	124.20	6270.74	.096	66.61	65.32
5891.96	124.20	5767.76	.425	13.86	13.57
4528.79	124.20	4404.59	.125	36.23	35.24
7047.26	124.20	6923.06	.250	28.19	27.69
4469.21	124.20	4345.01	.125	35.75	34.76
4647.26	124.20	4523.06	.200	23.24	22.62
4398.06	124.20	4273.86	.120	36.65	35.62

Table 1 (Continued)

Total Costs	Total Fixed Costs	Total Variable Costs	Output in MM Bd. Ft.	Average Cost Per M Bd. Ft.	Average Variable Cost Per M Bd. Ft.
(dollars)	(dollars)	(dollars)	(per 200 days)	(dollars)	(dollars)
5135.70	124.20	5011.50	.282	18.21	17.77
4647.19	124.20	4522.99	.089	52.22	50.82
5506.04	124.20	5381.84	.080	68.82	67.27
5595.54	124.20	5471.34	.167	33.51	32.76
7375.52	124.20	7251.32	.300	24.58	24.17
6508.07	124.20	6383.87	.400	16.27	15.96
6036.79	124.20	5912.59	.185	32.63	31.96
6175.52	124.20	6051.32	.333	18.54	18.17
4691.96	124.20	4567.76	.261	17.98	17.50
5135.70	124.20	5011.50	.375	13.70	13.36
4832.17	124.20	4707.97	.208	23.23	22.63
5489.36	124.20	5365.16	.300	18.30	17.88
4647.26	124.20	4523.06	.200	23.24	22.62
10037.85	124.20	9913.65	.375	26.76	26.44
6795.54	124.20	6671.34	.183	37.13	36.46
5047.14	124.20	4922.94	.200	25.24	24.61
6901.71	124.20	6777.51	.260	26.54	26.07
6706.04	124.20	6581.84	.667	10.05	9.87

TABLE 2

FIRM TYPE II -- ONE HEAD SAW, ONE TRIMMER

Total Costs	Total Fixed Costs	Total Variable Costs	Output in MM Bd. Ft.	Average Cost Per M Bd. Ft.	Average Variable Cost Per M Bd. Ft.
(dollars)	(dollars)	(dollars)	(per 200 days)	(dollars)	(dollars)
5050.23	131.20	4919.03	.047	107.45	104.66
4654.26	131.20	4523.06	.300	15.51	15.08
5602.54	131.20	5471.34	.200	28.01	27.36
4054.14	131.20	3922.94	.200	20.27	19.61
6182.52	131.20	6051.32	.600	10.30	10.08
6978.81	131.20	6847.61	.600	11.63	11.41
6182.52	131.20	6051.32	.072	85.87	84.05
6856.38	131.20	6725.18	.114	60.14	58.99
3205.06	131.20	3073.86	.240	13.35	12.81
5496.36	131.20	5365.16	.125	43.97	42.92
6802.54	131.20	6671.34	.333	20.43	20.03
5708.71	131.20	5577.51	.192	29.73	29.05
6039.17	131.20	5907.97	.585	10.32	10.10
7293.89	131.20	7162.69	.167	43.68	42.89
13377.80	131.20	13246.60	.420	31.85	31.54
6528.12	131.20	6396.92	.400	16.32	15.99
5898.96	131.20	5767.76	.100	58.99	57.68
6177.80	131.20	6046.60	.180	34.32	33.59

TABLE 3

FIRM TYPE III -- ONE HEAD SAW, ONE EDGER

Total Costs	Total Fixed Costs	Total Variable Costs	Output in MM Bd. Ft.	Average Cost Per M Bd. Ft.	Average Variable Cost Per M Bd. Ft.
(dollars)	(dollars)	(dollars)	(per 200 days)	(dollars)	(dollars)
7109.96	142.20	6967.76	.400	17.77	17.42
6412.94	142.20	6270.74	.300	21.38	20.90
5909.96	142.20	5767.76	.500	11.82	11.54
5613.54	142.20	5471.34	.225	24.95	24.32
7808.61	142.20	7666.41	.190	41.10	40.35
11808.84	142.20	11666.64	.800	14.76	14.58
7678.83	142.20	7536.63	.400	19.20	18.84
6633.55	142.20	6491.35	.250	26.53	25.96
7561.14	142.20	7418.94	.400	18.90	18.54
10481.05	142.20	10338.85	.200	52.40	51.69
10402.54	142.20	10260.34	.077	135.10	133.25
6146.17	142.20	6003.97	.053	115.97	113.28
7155.60	142.20	7013.40	.308	23.23	22.77
8265.26	142.20	8123.06	.200	41.33	40.62
13599.55	142.20	13457.35	2.400	5.67	5.61

TABLE 4

FIRM TYPE IV -- ONE HEADSAW, ONE EDGER, ONE TRIMMER

Total Costs	Total Fixed Costs	Total Variable Costs	Output in MM Bd. Ft.	Average Cost Per M Bd. Ft.	Average Variable Cost Per M Bd. Ft.
(dollars)	(dollars)	(dollars)	(per 200 days)	(dollars)	(dollars)
5946.56	227.61	5718.95	.400	14.87	14.30
8893.22	227.61	8665.61	.400	22.23	21.66
16542.71	227.61	16315.10	.450	36.76	36.26
20067.96	227.61	19840.35	1.342	14.95	14.78
12074.76	227.61	11847.15	.577	20.93	20.53
13391.45	227.61	13163.84	1.000	13.39	13.16
10585.16	227.61	10357.55	.115	92.04	90.06
11860.24	227.61	11632.63	.554	21.41	21.00
9116.22	227.61	8888.61	.600	15.19	14.81
12959.73	227.61	12732.12	4.800	2.70	2.65
13826.92	227.61	13599.31	1.043	13.26	13.04
7767.15	227.61	7539.54	.200	38.84	37.70
11359.73	227.61	11132.12	2.000	5.68	5.57
23671.29	227.61	23443.68	1.042	22.72	22.50
5950.55	227.61	5722.94	.154	38.64	37.16
10244.24	227.61	10016.63	.400	25.61	25.04
15992.77	227.61	15765.16	1.364	11.72	11.56
18660.00	227.61	18432.39	1.067	17.49	17.27
11231.71	227.61	11004.10	.788	14.25	13.96
14795.37	227.61	14567.76	1.477	10.02	9.86
9592.77	227.61	9365.16	.600	15.99	15.61

APPENDIX C

TABLE 1

YEARLY COSTS ASSOCIATED WITH FIXED EQUIPMENT

Firm Type	Headsaw[a]	Carriage[b]	Trimmer[b]	Edger[b]	Other Equipment[b]	Total Yearly Fixed Costs[c]
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
I	178.00	297.00	--	--	500.00	124.20
II	178.00	297.00	70.00	--	500.00	131.20
III	178.00	297.00	--	180.00	500.00	142.20
IV	207.40	472.60	96.00	189.00	1000.00	227.61

[a]Depreciated at the rate of 25 percent per year.

[b]Depreciated at the rate of 10 percent per year.

[c]Summation of depreciated costs of fixed equipment.

Appendix C (continued)

TABLE 2

COSTS ASSOCIATED WITH VARIABLE INPUTS

Firm Type	Labor Costs per Hour		Power Costs					
	Sawyer	Helper	Gasoline, Propane and Butane Engines		Diesel Engines		Electric Motors	
			Cost per Horsepower Hour	Depreciation Rate per Year	Cost per Horsepower Hour	Depreciation Rate per Year	Cost per Horsepower Hour	Depreciation Rate per Year
	(dollars)	(dollars)		(percent)	(cents)	(percent)	(cents)	(percent)
I	1.50	.75	[a]	15.0	1.07	12.0	1.7	8.0
II	1.50	.75	[a]	15.0	1.07	12.0	1.7	8.0
III	1.50	.75	[a]	15.0	1.07	12.0	1.7	8.0
IV	1.75	1.00	[a]	15.0	1.07	12.0	1.7	8.0

[a]Estimated fuel cost's chart furnished by Allis Chalmers, Inc., Sand Springs, Oklahoma.

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