ECONOMIES OF SCALE IN SOUTHWESTERN BEEF SLAUGHTER PLANTS

By

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ECONOMIES OF SCALE IN SOUTHWESTERN

BEEF SLAUGHTER PLANTS

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF ILLUSTRATIONS

CHAPTER I

INTRODUCTION

In recent years many important changes in the primary determinants of demand for the products of the livestock and meat industry have taken place. From 1950 to 1962, the total population of the United States increased from 151 million to 186 million, or 23.1 percent, and the number of consumer units increased from 48.9 million to 57.3 million, or 17.1 percent.

Significant changes have occurred also in the level and distribution of income. Per capita disposable income has risen from $1,506 in 1950 to $2,360 in 1962, and family personal income has increased from $4,444 to $6,916--a rise of more than 50 percent. Of greater significance, perhaps, is the fact that the percentage of consumer units in the United States with incomes between $5,000 and $10,000 increased from 23 percent in 1950 to 40 percent in 1961.

Over the decade ending in 1962, the retail price of choice grade beef declined from $0.89 per pound to $0.82 per pound, and the retail price of pork increased from $0.58 per pound to $0.60 per pound.

These changes in the primary determinants of demand have been important factors in bringing about the increase in per capita consumption of beef from 62.2 pounds in 1952 to 89.1 pounds in 1962. An examination of the trends in population and income growth and distribution suggests even further increases in the per capita consumption of beef in the future.

Far reaching changes affecting the supply of supply of beef also have occurred. Changes such as: (1) the growth of the feeding industry coupled with the expansion in feedlot capacity, (2) the decline in the ratio of farm to commercial feedlots, and (3) the steady growth trend in numbers of cattle and calves on farms have influenced markedly some fundamental changes occurring in the slaughtering industry.

As a result of the increased production by farms and feedlots, cattle slaughter has been increasing each year. Total cattle slaughter in Federally inspected plants, which slaughtered 78 percent of the cattle in 1960, has increased from 19 million head in 1955 to 20.3 million head in 1962. Total cattle slaughter in non-Federally inspected plants decreased from 6.7 million head in 1955 to 5.7 million head in 1962.

Not only is the total slaughter in Federally inspected plants increasing, but the number of Federally inspected plants is also increasing. Between 1955 and 1963, the number of Federally inspected slaughtering plants increased from 455 to 565. The increase was in evidence for almost every state in the union, but the largest increases occurred in Nebraska, Iowa, and Texas.

Coinciding with the decrease in number of cattle slaughtered in non-Federally inspected plants during the period 1955 to 1960, the number of large non-Federally inspected slaughtering plants decreased from 952 to 902. The number of this type of plant have decreased in more than half the states. In Oklahoma, however, the number increased from 27 to 37--the largest increase over the period in any state. Medium sized non-Federally inspected plants in the United States have exhibited a net decrease from 1,810 in 1955 to 1,712 in 1960. Significant increases in this size and type of plant, however, occurred in Kansas and Idaho.

Important changes in functional specialization are also evident. The number of Federally inspected establishments slaughtering cattle, calves, hogs, and sheep and lambs in the United States declined from 147 in 1955 to 126 in 1960. Over the same time span, the number of Federally inspected plants slaughtering only cattle and calves increased from 119 to 185--an increase of over 55 percent.

Associated with the changes in the number and type of plants are significant changes in the technology applied to beef slaughtering operations. For many years beef cattle have been slaughtered and dressed on the bed-type kill floor. Efficiency levels experienced by the industry with this system were established at one head per man per hour.[1] With the development of the "on-the-rail" kill floor and the associated equipment, such as hydraulically operated lift platforms, dehorners, hock cutters and hide pullers, air-powered knives, moving top viscera tables, and electrically operated splitting saws and hoists, efficiency levels have been increased to around two head per man per hour.

As the slaughtering industry continues to adjust to the dynamic forces underlying the demand for meat and the structure of supply at the farm and feedlot, additional specialized slaughtering facilities will be constructed, and newer technologies will be adopted by both present and new plants. The trend toward these developments prompts questions in the minds of investors and managers of slaughtering enterprises concerning the costs of constructing, equipping, and operating "on-the-rail" plants. These questions have

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[1]Rothra, H. L., ed., Meat Industry Trends, 1961 (Chicago, 1961) p. H-12.

particular relevance to the Southern Plains area in view of the recent shifts in the location of packer operations towards the sources of livestock supply and the marked increase in cattle feeding in the area.

The developments mentioned above suggest the possibility of future growth in the number of "on-the-rail" beef slaughtering facilities in the Southern Plains region. This study was conducted to provide members of the livestock industry with information pertaining to the costs associated with the construction and operation of specialized "on-the-rail" beef slaughtering plants located in the Southern Plains region. More specifically, the study was directed to the questions:

(1) What are the per head costs of constructing and equipping alternative "on-the-rail" beef slaughter plants designed for operation at rates of 20, 40, 60, 75, and 90 head per hour?

(2) What are the per head plant costs of operating each of these plants at output levels equivalent to 90, 95, 100, 105, 110, and 115 percent of rated line speed?

(3) What is the relationship between per head costs of dressing beef cattle and the size of the plant?

CHAPTER II

THEORETICAL CONSIDERATIONS

In order to examine the per unit cost functions of a firm, a logical theoretical framework is needed. This section will present a brief discussion of the conventional economic theory of production commonly used to describe and evaluate the operations of a firm. This theory will provide the basis for estimating the relevant economic relationships needed in the analysis.

A firm may be defined as an economic unit which acquires raw materials, transforms them in some manner, and sells the resulting products for the purpose of making a profit from the transactions. The firm, in transforming the raw materials into new products, operates within the limits of an input-output relationship known as a production function which can be expressed in mathematical form as:

$$Y = f(X_1, \mid X_2, X_3, \ldots, X_n) \qquad (2.1)$$

where Y is a measure of output and X_1, X_2, $X_3, \ldots, X_n$ are inputs.

This equation would be read: "The quantity of Y produced per unit of time is a function the quantity of the variable input X_1 utilized with the fixed amounts of the inputs X_2, $X_3, \ldots, X_n$." If the form of the function is specified, this relationship may also be shown graphically as presented in Figure 1.

In this generalized form, three possible stages of production may exist. In Stage I, as additional units of X_1 are employed, output increases at an increasing rate to point A. At point A the firm enters State II, where as the firm utilizes additional units of X_1, output increases at a decreasing rate to point B or where total product is at a maximum. Then beyond point B, as additional units of X_1 are employed by the firm, total output is diminished. The production function is important in the analysis of firm costs because it shows the limits to quantity of output that may be obtained from various quantities of inputs.

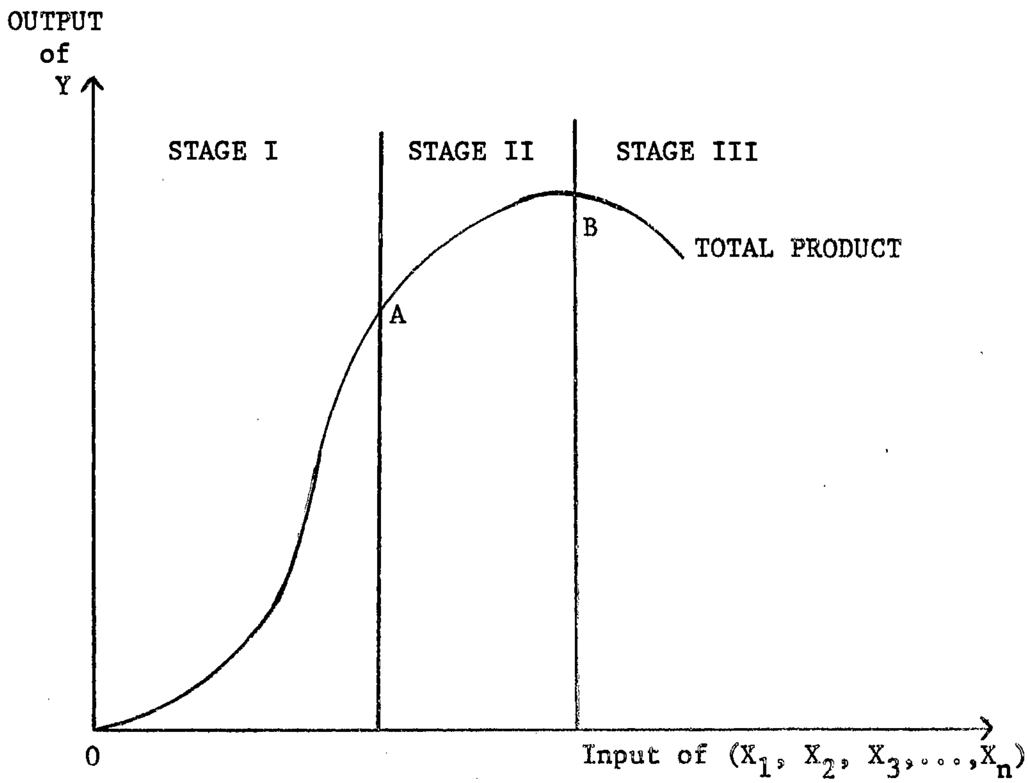

Figure 1. Hypothetical Production Function.

Assuming conditions of pure competition in the resource market, the total cost curve can be shown as in Figure 2. At the beginning of Stage I, total costs are established at OA, reflecting the cost of the fixed resources X_2, X_3,...,X_n. Then, as additional units of Y are produced, total cost will increase at a decreasing rate to point B. In stage II, or over the range of output of line BC, as additional units of Y are produced, the total cost increases at an increasing rate. At point B (Figure 1) the use of additional increments of X_1 results in a decrease in total product. Therefore, total costs increase in the manner shown along the line CD projected (Figure 2), obviously a noneconomic range of production.

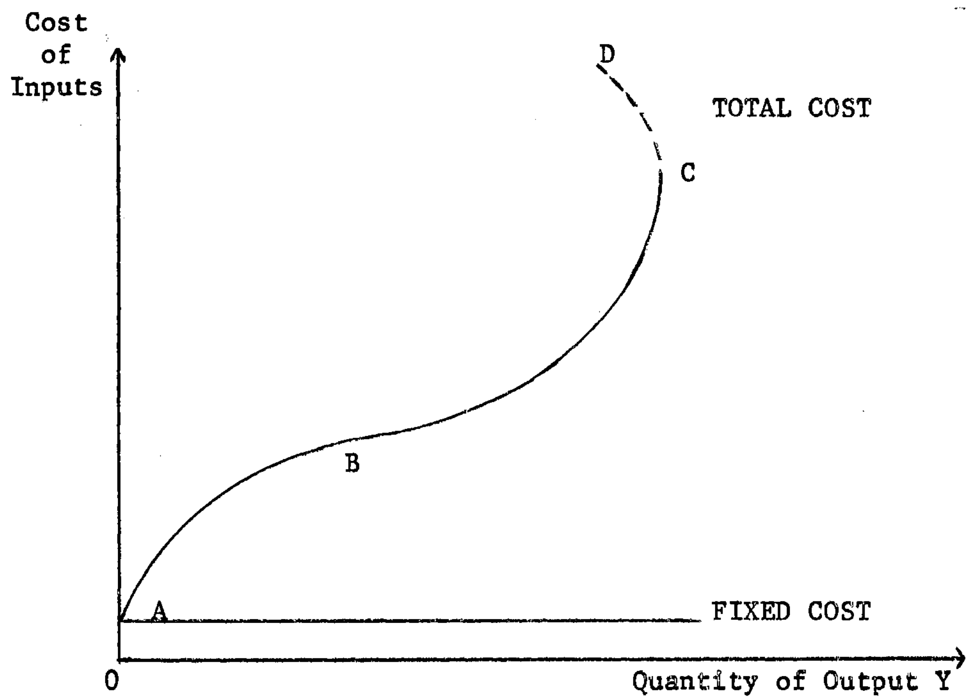

Figure 2. Hypothetical Total Cost Function.

This relationship between cost and output may be examined in more familiar terms by transforming the total costs into average or unit costs. This is done by dividing total cost by the number of units of output. Figure 3 represents a typical short-run average cost curve.

This diagram shows that in Stage I, or in the range of output from A to B, the per unit cost of each additional unit of output Y is decreasing. At the begining of State II (point B), the per unit cost is at a

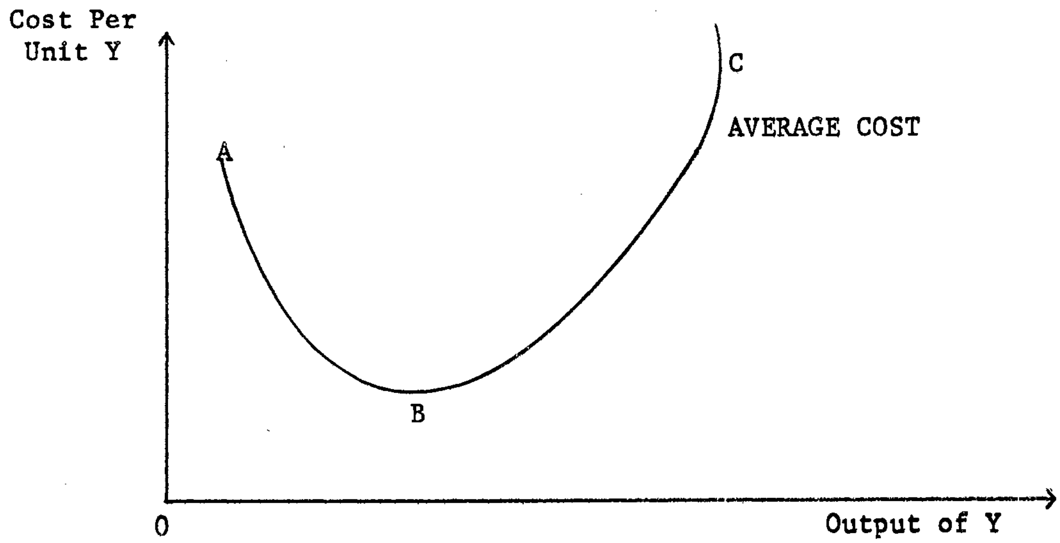

Figure 3. Hypothetical Average Cost Function.

minimum and is increasing throughout Stage II or from B to C. Stage III is again a noneconomic range of production.

Thus far, only the short-run situation of a single variable input and a single product has been considered. In the long-run, as techniques and technology of production change, it is possible to have many variable inputs and many combinations of inputs and outputs. For simplicity it will be assumed that technology remains the same in the long run, thus, the combination of fixed factors will be constant with only the quantities varied. Since in the long-run many alternative sizes of plants may be built, a situation as depicted in Figure 4 may occur. Each short-run average cost curve represents a different quantity of fixed inputs utilized with a single variable input.

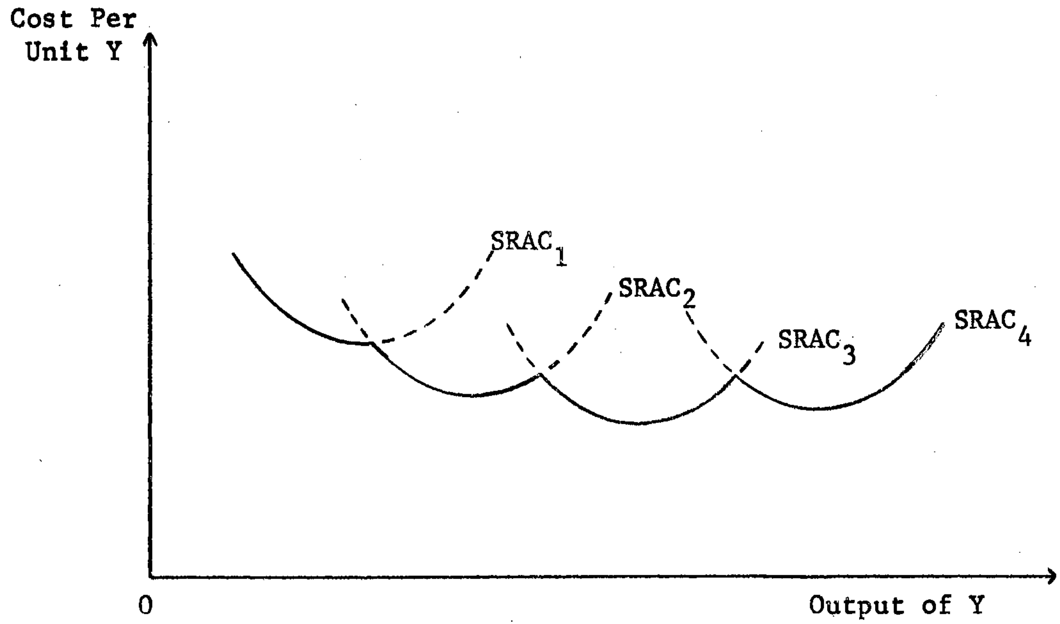

Figure 4. A Discrete Long-Run Average Cost Curve.

The minimum portions of these short-run average cost curves represent the long-run average cost curve facing the firm for producing various quantities of output Y. When only a few plant sizes are possible because of the indivisibility of some inputs, the long-run average cost curve takes on a scalloped appearance as shown in Figure 4 by the solid line. If we assume that all inputs are perfectly divisible, an infinite number of short-run average cost curves can be generated. Now by drawing a line tangent to an infinite number of short-run average cost curves, a smooth, continuous long-run average cost curve is obtained. This long-run average cost curve as shown in Figure 5 can be used by the firm as a planning curve, or to show economies of scale.

The long-run average cost curve is considered an economies of scale

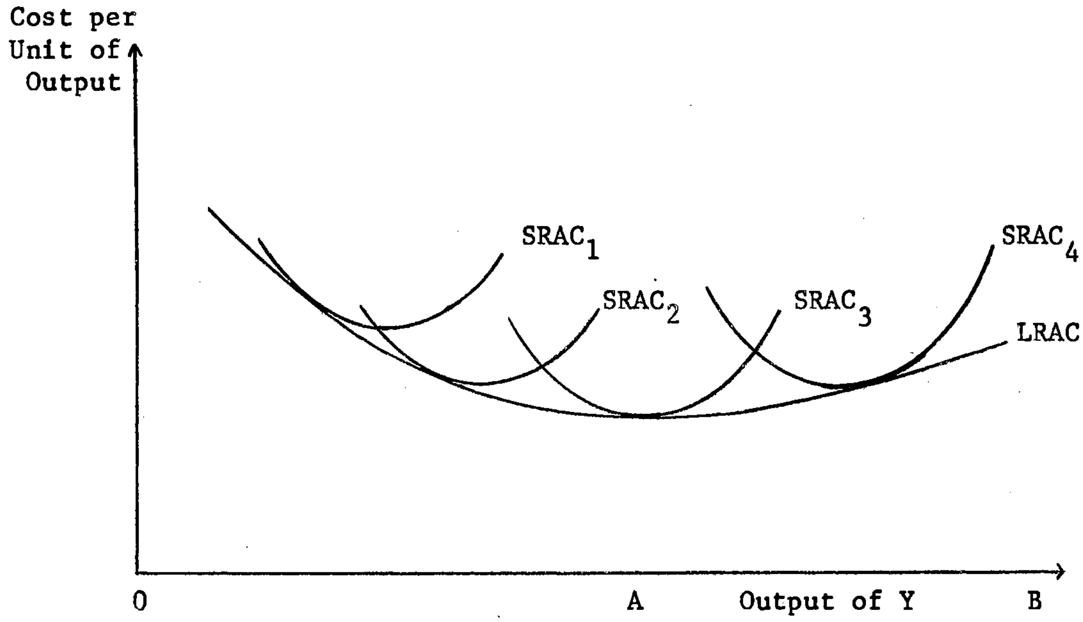

Figure 5. Hypothetical Long-Run Average Cost Curve.

curve. This is because it depicts the change in unit costs associated with increases in plant sizes and output in the long run. Three different theoretical types of scale effects may occur. These may be: (1) economies of scale--as plant size increases, the average or per unit cost at the most efficient level of production decreases; (2) diseconomies of scale--as plant size increases, the average cost at the most efficient level of production increases; and (3) neither economies nor diseconomies of scale--as plant size increases, the average cost at the most efficient level of production remains the same. In Figure 5 the output levels from 0 to A represent the economies of scale portion of the long-run average cost curve. The cost savings obtained from the larger sizes of plant can be credited to both physical and pecuniary economies. Examples of physical economies are the division and specialization of labor, better utilization of fixed plant and equipment, and better utilization of management. Examples of pecuniary economies are quantity discounts often obtained by larger plants on factors of production and quantity discounts obtained in shipping the finished products. These two types of economies work together to cause the long-run average cost curve or economies of scale curve to slope downward until at some point the minimum average cost is reached.

Diseconomies of scale, represented by the upward sloping portion of the curve from A to B, are usually credited to the pecuniary diseconomies, such as the increasing cost of management, increasing cost of resource procurement and increasing cost of marketing beyond some size of plant and level of output.

Some physical diseconomies can also exist. For example, at some level of output, it may be necessary to purchase additional large and expensive machinery in order to obtain any additional output. The nature of operating costs of this machinery may cause the unit cost of the entire output to be greater than it was with the smaller sized machinery.

The third effect, neither economies of scale nor diseconomies of scale is not shown in Figure 5. It would occur only if the production function, hence the total cost and average cost function, were linear over a range of output. In the linear case, the long-run average cost curve would be a horizontal straight line tangent to a series of short-run average cost curves at their respective minimum points. This would mean that the plant or plants involved are operating in a range where additional increments of all resources results in uniform additional increases in output.

In applying the theory previously discussed, a modification is necessary. This modification, stressing the time dimension for output variation, is discussed extensively in a study by French, Sammet, and Bressler[1] and will be discussed only briefly here.

The time dimension modification refers to plants where the rates of output are held constant and the total output is varied by varying the number of hours worked per day or week. An example of this, as discussed by French, Sammet, and Bressler,[2] is cotton gins. A cotton gin, in order to do an efficient job of ginning, normally operates at a constant rate and varies output by the hours worked per season. Therefore, variation in total volume and total cost results primarily from variations in total hours of operation per season. Thus cost and volume would be a linear function of hours as well as of each other. This would mean that the total cost of operating a plant would be the hourly cost times the number of hours the plant was operated. Thus, theoretically, the only limits to the time rate dimension would be the 24-hour day and seven-day work week. However, in beef slaughter operations there are at least two institutional factors that restrict the time rate dimension further. These are management-labor agreements designed to guarantee the employees steady employment for some minimum number of hours per day or week and the Federal Meat Inspection Services' requirements that the plant be completely cleaned at least once every 24 hours for sanitation purposes.

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[1] B. C. French, L. L. Sammet, and R. G. Bressler, "Economic Efficiency in Plant Operations with Special Reference to the Marketing of California Pears," Hilgardia, Vol. 24 No. 19 (July, 1956), pp. 548-549.

[2] Ibid., p.556.

Typical labor agreements found in slaughter plants are based on the eight-hour day and 40-hour work week, with a guaranteed 36-hour week and overtime pay for all hours over 40 hours per week. With this type of situation, the firm may find that it faces a discontinuous average unit cost function, even though the plant is operated at a constant rate of output per hour. However, in the situation where the firm desires to minimize unit cost and operate at close to theoretical capacity, a second shift could be employed. This would have the effect of duplicating the hourly costs of the first shift, so that the volume of the plant has been increased, but the variable production costs per hour have remained unchanged.

The volume of the plant could be further increased at a constant variable cost by adding a third shift, were it not for the institutional restriction of a complete cleaning each 24 hours. Ordinarily, however, plant volume will be adjusted around either the one-shift level or two-shift level by working the employees less than the full shift or by hiring overtime. If the plant volume falls below such a level that the employees are needed less than their minimum work week, then total labor cost for operating the plant becomes fixed and the hourly cost for the actual hours of operation increases. If the volume of the plant increases above the level that can be processed during the 40-hour week, then the total cost of operating the plant for additional hours increases in a "kinked" manner because of the overtime pay. This is demonstrated in Figure 6.

Under the previously assumed conditions of pure competition, the hiring of an additional hour of labor over the range of possible hours from an entire crew of workers would increase total cost linearly as

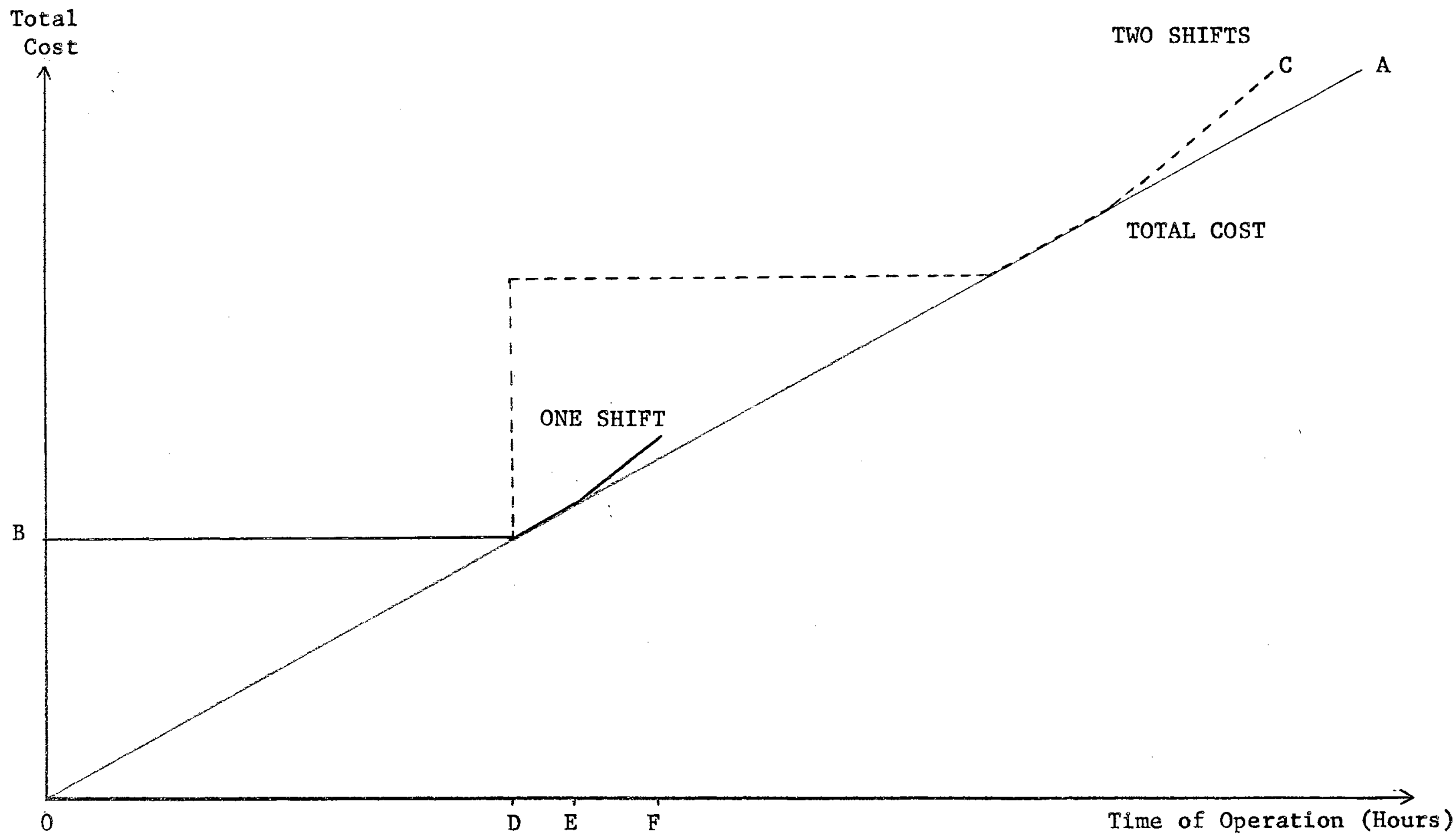

Figure 6. Total Variable Cost Functions for Labor with Institutional Restrictions.

shown by line OA. Therefore, the variable cost of the firm would not be affected by the level of output. However, in slaughter plants with the institutional restrictions of a minimum work week and overtime for all hours over 40, this does not hold. If two complete shifts are employed, then these institutional factors would cause the total cost function to take on an appearance as depicted by line OBC in Figure 6. Here the total cost function is shown to be constant when the plant is operated over the range OD.

At point D the guaranteed weekly wage is reached and the firm has the choice of hiring or not hiring additional labor, depending on the plant volume. Assuming that a large supply of animals is available, and the firm hires more labor, the total cost curve slopes linearly upward to point E or 40 hours. At this point the total cost "kinks" upward because of the increased wage rates as overtime pay begins. This continues to point F where it is assumed that to obtain more labor, the firm must hire a complete second crew.

This has the effect of increasing the total cost by the fixed cost of the guaranteed 36-work hours. In working the second crew more than 36 hours, the same effects occur to total cost as occurred with the first crew. It might be added here that it is common practice in slaughter plants, where two crews are employed, to divide the number of hours worked as equally as possible among the crews. Therefore, if less than the maximum number hours were worked, the total cost function might appear as shown by the dotted line.

CHAPTER III

THE NATURE OF BEEF SLAUGHTERING OPERATIONS

The application of the abstract theory of the preceding chapter to the problem of estimating the cost relationships relevant to slaughtering firms requires information pertaining to the nature of such firms. In this chapter, the functions performed by slaughtering firms will be presented and related to the cost concepts developed in the preceding chapter.

In the United States, firms conducting slaughtering operations range from the specialized slaughterer, who performs the basic slaughtering function and a minimum of related functions, to the integrated type of operator, who, in addition to the basic slaughtering function, performs many functions pertaining to the processing of beef and its by-products. In this study attention is focused on the slaughter specialist.

The slaughterer, like any other firm, has three general functions to perform--procurement, processing, and sales. These three functions jointly determine the cost and revenue structure of the firm and, consequently, the optimum scale and location of plant (s). A satisfactory treatment of the procurement and sales functions would require an analysis of the spatial aspects of beef slaughtering operations. Although extremely important, such an analysis is beyond the scope of this study.

The processing function takes place as a sequence of stages. One such sequence of stages and the associated operations is presented in Figure 7 and described below.

The processing function is postulated to begin following the receipt of the livestock at the plant site. At this point the livestock are sorted by lot and driven into holding pens. The holding pens permit an ante mortem inspection to be performed and provide the necessary conditions for carrying an inventory of livestock with which to maintain an uninterrupted flow. Some feeding and watering of stock may also occur at this stage.

Following the holding stage, the stock are driven into catch pens, thence through a chute where they are admitted to the knocking pen. Here, each animal is carefully positioned and then stunned by means of a .22 caliber weapon or a captive bolt stunner.

The stunned animal is next released from the pen through either a vertically operated or a revolving type door to the dry landing area. The left hind leg is shackled, and the animal is raised to rail height by means of an electric hoist. By means of an automatic landing device, the loaded beef shackle is placed on the rail, after which it is moved to the bleeding pit.

The animal is stuck and allowed to bleed freely. As soon as the initial flow of blood subsides, the scalping stage is performed. At this stage the forehead, left and right jaws are skinned, ears are removed, and head is cut free of the carcass and left hanging by the trachea and esophagus.

Identifying tags are placed on the head and carcass, and the head is

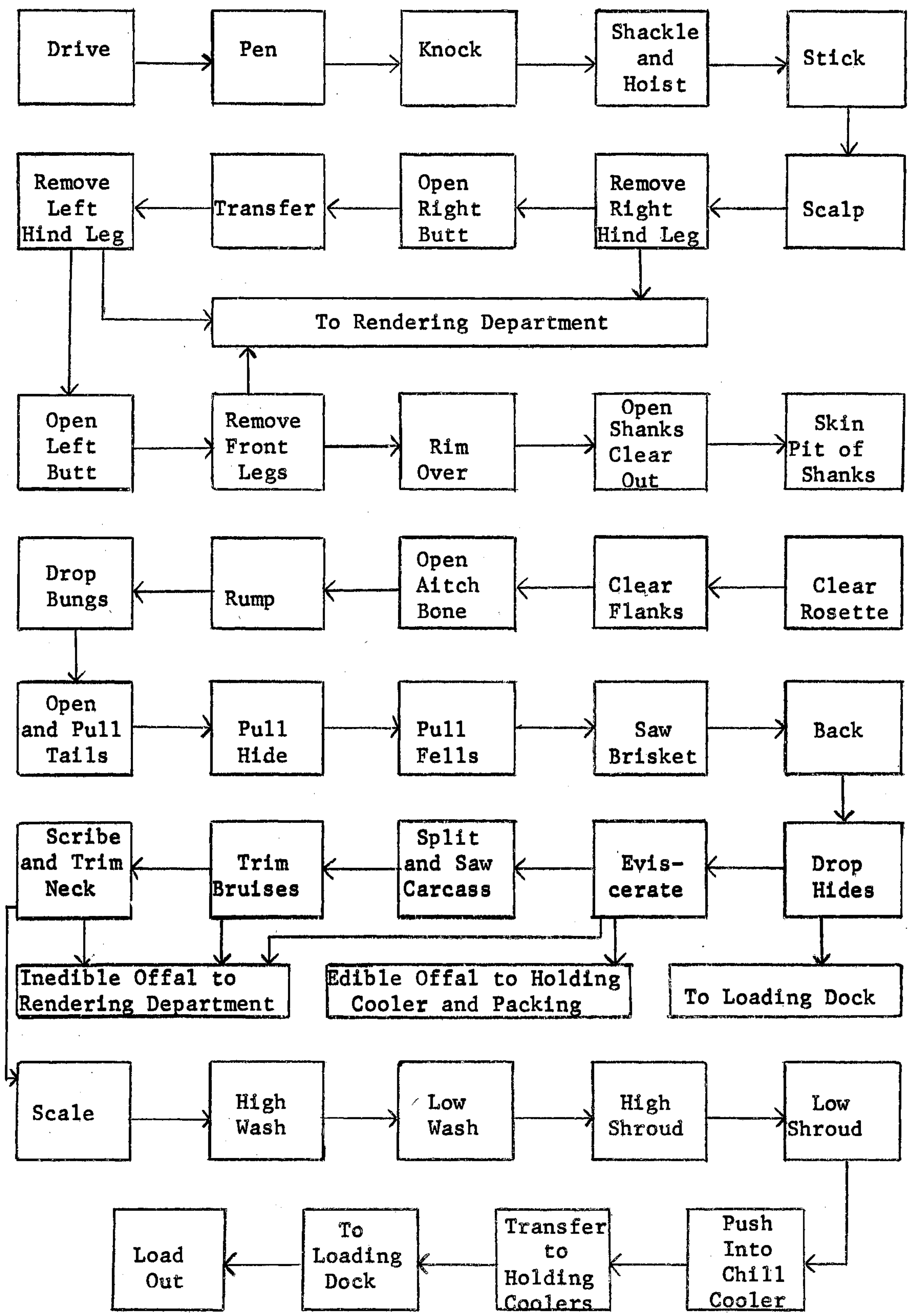

Figure 7. Operations Involved in Processing a Beef Carcass.

removed, flushed, and prepared for inspection by dropping the tongue and removing the tonsils.

After the head is severed, the carcass is moved along the rail to the next stage. Here the dewclaws are removed from the right hind leg, the hide is ripped open a distance about eight inches above the knee, the leg is skinned with an air driven dehider, and the foot is removed.

Opening of the right butt constitutes the next stage. From the cut along the leg, the hide is split back to the crotch. The hide is skinned back taking care to minimize hide damage and the amount of fat cut from the carcass. The carcass is now ready for the transfer stage.

At the transfer stage the weight of the carcass is shifted by means of an electric hoist to a hook placed through the gam on the right hind leg. The shackle on the left hind leg is removed and returned to the dry landing area by means of a gravity return rail.

With the weight of the carcass on the right hind leg, skinning of the left hind leg can be accomplished. The dewclaws are removed, the hide is ripped open a distance of about eight inches above the knee, the leg is skinned, and the foot removed. Skinning of the left butt is then accomplished.

Following the skinning of the left hind leg, a spreader hook is placed through the gam, the hoist motor is activated, and the right hind leg transferred to the spreader. The spreader maintains a four-foot distance between the two hind legs and facilitates splitting the aitch bone and subsequently the spinal column.

Skinning of the forelegs can be accomplished at several points in the slaughtering operation. The decision regarding the choice of location in the sequence of the operations depends upon the extent to which the location aids in balancing the line. Irrespective of the point at which the operations are performed, however, they include removal of the dew-claws, ripping open the hide to a distance about four inches above the knee, skinning the knee and shinbone, and removing the feet.

The operations of rimming over are performed next. With a hand knife the cattle are opened starting from where the sticker left off and ending just clear of the navel. Using an air driven dehider, the hide is skinned back on the left and right sides clearing the brisket. At this point the inside of each shank is skinned back to meet the front leg breaker's cut.

The next steps include opening the shanks, clearing out, skinning the pit of the shanks, and clearing the rosette. Clearing out entails a series of cuts that free the hide from the carcass back to the neck. Clearing the rosette includes those cuts necessary to remove the hide from the strip of lean along each shoulder of the carcass.

The work proceeds next to clearing of the flanks, splitting of the aitch bone, and then to the rumping operations. Rumping begins where the butt opener left off and continues downward, level with the pin bone, back to the tail, and down ten inches along the backbone.

The sequence of operations continues with dropping of the bung and pulling of the tail. Pulling of the tail is commonly accomplished by means of an hydraulic puller. The tail is first split with a hand knife and clamped into the puller. A pedal operates the puller stripping the hide free of the tail.

In plants designed to operate at a speed of 60 head per hour or less, the hide is cut away from the carcass side using the air driven dehider. In plants designed for speeds greater than 60 head per hour, a mechanical hide-puller is frequently employed. This equipment is positioned directly behind the carcass, and the hide on each side is clamped into the pulling arms. The equipment is activated pulling the hide away from the sides. The arms are then released and fells are pulled steadily downward and towards the worker until the hip bone is reached.

The brisket is split by means of a small electric saw. The saw blade is inserted at the upper point of the brisket and guided down the center of the brisket bone, pushing inward slightly, and finishing in the center of the sticker's opening.

Backing is accomplished by lifting the side and pulling toward the worker, cutting with short strokes inward to the center of the backbone and downward from the hip bone to the neck. These operations are performed on both the right and left sides. The hide is then loosened with a knife at the top of the loin bone, and with short knife strokes, dropped down to the neck gradually, so as not to tear off any fat from the loin, and finally skinned to the end of the neck and released.

Following completion of the hide removal operations, evisceration of the carcass takes place. In plants with a capacity of less than 60 head per hour, the belly is cut open and the viscera pulled out onto a paunch truck where inspection takes place prior to removal from the kill floor. In plants greater than 60 head per hour, the use of a moving top viscera table is mandatory.

Upon completion of evisceration, the carcass is moved to a splitting station. Here the carcass is divided into two halves by cutting through the vertebral column with a power saw with as much as a two horsepower motor in the larger plants. At this point scribing of the chine and trimming of the neck and bruises may be accomplished.

The carcass sides are moved next to the washing station passing over a track scale enroute. Both the upper and lower portions of each side are given a thorough washing with the use of high pressure nozzles.

The shrouding operations are performed next. The shroud, a rectangular cotton cloth soaked in brine, is place around the upper portion of the side and pinned in place. Shroud clamps are used to pull the shroud tightly around the side, and then the lower portion of the side is pinned and the neck skewers positioned. The sides are then moved into the chill cooler where they are generally held overnight at temperatures of 30-32^{o} F. to remove the initial body heat.

The operations performed in the coolers include transporting carcasses to the chill coolers, removal of shrouds, grading, quartering of sides, and assembly of orders. Grading operations will not be considered in this study. Each side or quarter of an order is weighed and transported to the loadout dock where it is loaded onto a refrigerated truck or railroad car.

The kill floor and cooler operations comprise the heart of a beef abattoir. However, many essential supporting operations must be performed if the plant is to function effectively. These supporting operations include the handling of the hides, the edible offal, rendering of the inedible offal, plant sanitation and maintenance, and the accounting, clerical, and secretarial duties.

Slaughterhouses may either sell their hides green (uncured) or they may perform the curing with their own labor and equipment. In this study each plant was assumed to sell all of its hides green.[1]

The edible offal is transported, along with the other viscera, from the kill floor to the separate (but usually adjacent) part of the plant for processing. The heart, lungs, liver, and trachea (or pluck) are separated, washed, trimmed, and placed in storage containers. The tails, tongues, boned meat from the heads, and the brains are processed with the pluck. Upon completion of processing, the edible offal is stored in 35^{o} F. coolers until sold.

Bones, paunch contents, condemned carcasses and carcass parts, and blood are transported to the rendering area. The blood is pumped from the kill floor to the blood tanks where it is dried. Other inedible materials are conveyed from the kill floor to the rendering area where it is fed through grinders and hashers to the cooking tanks where the inedible tallows and greases are drawn off, thus, producing tankage products.

In order to perform the previously discussed operations of slaughtering, offal work-up, chilling, holding, and preparation for distribution, an investment in a group of physical resources is necessary. In keeping with the economic theory presented in Chapter II, these resources consist of both fixed and variable resources. The fixed resources, usually lump sum investments which are utilized over many production periods,

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[1]Information on the handling and curing of hides can be found in: A Technical-Economic Evaluation of Four Hide-Curing Methods, Agricultural Economic Report No. 16, U. S. Department of Agriculture, September, 1962.

consist of land, plant facilities, and equipment. Once these resources are purchased their nature is such that the firm is faced with an annual cost of owning them, as well as an annual insurance cost to protect the investment, regardless of the level of output maintained by the plant. Since these annual costs do not vary appreciably over the life of the investment, they are considered fixed investment costs and are used as the fixed cost component of a firm's total cost from year to year.

After the plant size has been selected and the fixed investment costs determined, the variable costs will be a function of the quantity of variable resources, labor, utilities, and miscellaneous supplies required to operate the plant at various levels of output. The requirements of the variable resources can be determined by time-study analysis and accounting record analysis of plants of similar design and rated capacities to the model plant. Upon obtaining the variable resource requirements, the variable costs at several levels of production may be estimated and added to the fixed cost to find the total cost curve for the plant. This total cost curve can then be converted to an average cost curve to examine per unit cost.

CHAPTER IV

METHOD OF ANALYSIS AND MODEL PLANT SPECIFICATIONS

Estimation of the various cost elements necessary to examine the economies of scale curve may be approached by several alternative methods. Two methods, the Accounting Records Method of Cost Analysis and the Economic-Engineering Synthetic Method of Cost Analysis, will be discussed. The most efficient method depends upon the specific objective of the study and the resources that are available.

Accounting Records Method of Cost Analysis

The Accounting Records Methods of Cost Analysis, as implied by its name, relys upon the accounting records of actual firms. The use of records from actual plants necessitates the selection of a sampling model that is consistent with the objective of the study. In a study of the effects of size or scale on plant costs, a minimum condition is that the sample be drawn from a population stratified on size.

Once the sample has been determined, the records of the plants in each stratum are examined. Detailed information concerning the plants and their operations are recorded for analysis. Information pertaining particularly to fixed cost items, variable cost items, and the associated volume of output are recorded. These data are used to estimate the average unit cost for each sampled plant.

The average unit cost estimated for each plant is treated as a single observation, and a regression equation of average unit cost on volume of output may be fitted, thus, providing an estimate of the long-run cost curve.[1]

In general, the long-run cost curve estimated by a regression analysis, $LRAC_2$, will be above the true curve, $LRAC_1$, primarily because few, if any, plants will operate continuously at that point where the short-run average cost curve is tangent to the long-run average cost curve (points P_i, Figure 8), but also because not all plants will, at the time of the study, be employing the most recent technology.

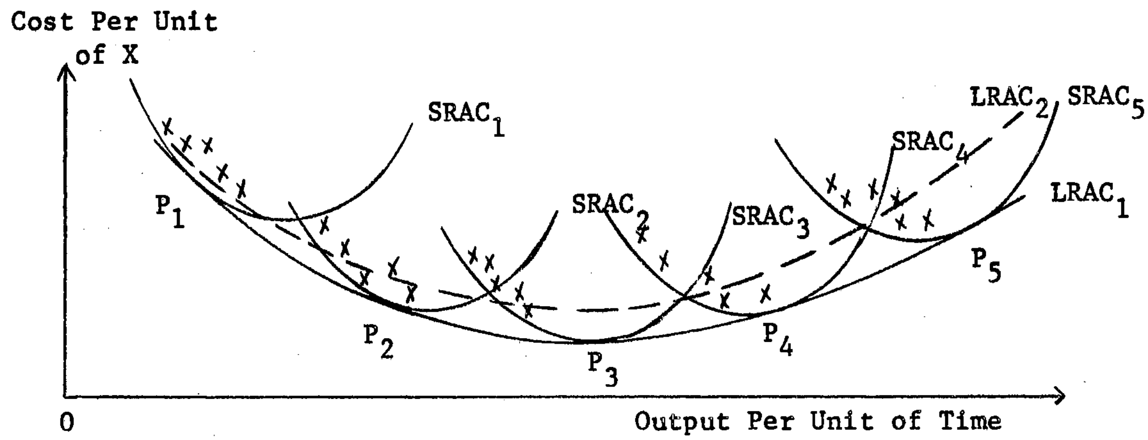

Figure 8. Hypothetical Long-Run Average Cost Curves.

Further, if diseconomies of scale exist, regression analysis is likely to introduce a greater upward bias in this region of the curve, provided the sampled plants operate at volumes of output no greater than that which attains minimum short-run average cost.

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[1]For an example of a study employing the Accounting Records Method see: R. C. Linderg, and G. G. Judge, Estimated Cost Functions for Oklahoma Livestock Auctions, Oklahoma Agricultural Experiment Station Bulletin B-502 (Stillwater, 1958), p. 13.

Part of the foregoing problem may be handled by using only those records from a sample drawn from a population defined to include only those plants which employ the most efficient technology. Then by observing the average unit costs for these plants at <u>several</u> operating levels, points such as P_1, P_2, and P_3 may be estimated. Difficulty would still be encountered in estimating points such as P_4 and P_5, unless some points of operation greater than minimum short-run average cost are contained in the accounting records of plants of these scales, or the function form of the short-run average cost curve is known.

The use of accounting data in a regression analysis encounters a number of additional drawbacks including the following: (1) it may be difficult, if not impossible, to obtain the cooperation of a sufficiently large number of firms operating plants of the desired sizes;[2] (2) accounting records may not express the time period in which various resources were used, but only the date of purchase; (3) prices paid for the various factors of production may vary from firm to firm, and the accounting records may not provide a basis for making these data comparable; (4) units of account for resource inputs may not be a uniform and consistent with the unit of output; (5) a satisfactory measure of capacity is difficult to establish from accounting data alone; (6) comparisons of accounting data among plants reflect the combined effects of changes in proportion and changes in scale; (7) fixed costs taken from accounting records reflect variations in purchase date and

[2] Some sizes or scales of plants may not exist.

and rates and methods of depreciation; and (8) a study of accounting records may not provide a basis for comparing the relative efficiency of alternative methods of operation, because accounting records do not reveal detailed information regarding technology, work methods, delays, and idle time.

Many, though not all, of the foregoing criticisms leveled against the use of accounting data in a regression analysis may be partly or wholely handled by supplementary data and statistical techniques. However, collection of the necessary supporting data and employment of the additional statistical analysis would weaken the method's primary advantage--a small demand on research resources.

The Economic-Engineering Synthetic Method of Cost Analysis

In view of some of the weaknesses of the Accounting Records Method, it appears that an alternative means of estimating cost relationships is desirable. The Economic-Engineering Method provides an alternative with several desirable features.[3]

Basic to the method is the division of the entire productive process into a series of stages of production. The resource requirements and their relationship to alternative levels of output are determined for each stage for each scale of plant. Total resource requirements

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[3] For a more complete discussion of this method see Guy Black, "Synthetic Method of Cost Analysis in Agricultural Marketing," *Journal of Farm Economics*, XXXVII (1955), pp. 270-279.

R. G. Bressler, Jr., "Research Determination of Economies of Scale," *Journal of Farm Economics*, XXVII (1945), p. 536.

B. C. French, L. L. Sammet, and R. G. Bressler, "Economic Efficiency in Plant Operations with Special Reference to the Marketing of California Pears," *Hilgardia*, Vol. 24, No. 19 (1956), p. 581.

for alternative levels of output for each scale of plant can then be determined, and by application of appropriate price data, the short-run and long-run average cost curves can be derived.

A prime advantage of this method is that estimates of cost relationships can be provided in instances where historical records are non-existant, span a period too short for a statistical analysis, or span a period which does not encompass a relevant technology.

A second important advantage of the synthetic method is that a greater flexibility of analysis is possible by virtue of the requirement for detailed information concerning the productive process. The mass of input-output data permits analysis of resource price changes to be readily made. Cost curves can be developed, therefore, which facilitate planning in the framework of anticipated resource prices rather than historical prices.

In an industry where competition is keen, there is a natural reluctance on the part of businessmen to disclose complete, detailed records pertaining to the financial and production activities of the firm. The synthesis of cost relationships minimizes the need for access to actual plant records.

In addition to the foregoing, the method of synthesis: (1) permits analysis covering the same period of time for a comparable set of plants, (2) permits scale effects to be examined apart from the effects of varying resource proportions, (3) permits the use of uniform rates and methods of depreciation, and (4) provides a basis for measures of efficiency.

Despite its advantages the Economic-Engineering Method does not provide a panacea for the cost analysis problems. The method does not lend itself to tests by the standard measures of statistical reliability and important problems in the aggregation and coordination of stages may be overlooked. In addition, some cost items may be omitted, and because of the detailed analysis necessary at each stage, it is time consuming and expensive.

The Methods Employed

The approach selected to provide the cost estimates presented in this study combines an economic-engineering analysis of the fixed investment costs and labor costs, and an accounting record analysis of utility costs and certain other cost items.

The modified economic-engineering synthetic procedure was chosen because: (1) the Southern Plains area does not contain a sufficiently large number of specialized on-the-rail beef slaughtering plants of the necessary sizes to permit a proper statistical sample to be drawn; (2) many plant owners were reluctant to provide the detailed information required for analysis; and (3) synthesis of the utility costs proved impractical. For this reason accounting records were used to estimate the utility costs.

General Specifications of the Model Plants

For this analysis, the input-output relationships of five selected sized of plants with designed maximum kill rates of 20, 40, 60, 75, and 90 head per hour were synthesized. Each plant is designed to comply with the regulations set forth by the Meat Inspection Division of the United States Department of Agriculture. Construction details, where necessary in the analysis, are specified in the appropriate cost estimate section.

The synthesized plants were designed to perform the general function described in the preceding chapter. Each plant, therefore, consists of corral facilities, a kill and dressing area, chill and holding coolers, an offal work-up area, an equipment cleaning area, an employee dressing area, a rendering department, office space, and sufficient parking space for employees and visitors.

The plants are presumed to operate at the rated speed with a single labor shift of eight hours duration for 255 operating days per year. Cost estimates were also made for each plant when operating at output levels equivalent to 90, 95, 105, 110, and 115 percent of the rated line speed.[4] To allow for output levels equivalent to up to 15 percent greater than the rated line speed, the capacity of the chill and holding coolers were altered accordingly.

Data Sources

The data requirements can be classified into the three broad categories of investment, operation, and other costs. Investment costs can be classified further into real estate, building, and equipment costs. Operation costs include labor, water, electricity, gas, telephone, laundry, repair and maintenance, and miscellaneous supplies. Other

[4]The output level was adjusted by varying the length of the kill day rather than the line speed. Although slaughtering plants do vary line speed to alter the level of plant output, such a practice requires rebalancing of the kill floor crew. No attempt was made to determine the adjustments in labor requirements necessary to achieve a balanced kill floor crew for a series of line speeds. For output levels less than equivalent to rated line speed a reduced length of workday was assumed; for output levels greater than equivalent to rated line speed, overtime was assumed.

costs include taxes, insurance, and interest.

Investment Costs

Price data for real estate located in industrial tracts and suited for abattoir operations were obtained through the Oklahoma City Chamber of Commerce.[5] Real estate requirements were synthesized from the data on the estimated area of each plant, associated holding pens, and parking lots.

Area requirements for the corrals, parking lots, and various sections of each plant were obtained from several sources. Data on kill floor areas were extracted from architectural drawings of on-the-rail systems.[6] Area requirements for the rendering operations were developed from data reported in Meat Industry Trends, 1961,[7] and area requirements for corrals, parking lots, and all other portions of the plants were synthesized.

Cost rates per square foot of kill floor, rendering, employee dressing, equipment clean-up, dry storage, and dock areas were taken from the rates published in Meat Industry Trends, 1961.[8] Cost rates applied to chill and holding coolers, corrals, dock aprons, offices and parking lots were supplied by local contracting firms.

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[5]Correspondence with Mr. John Conner, Manager, Agriculture and Livestock Division, Oklahoma City Chamber of Commerce.

[6]Architectural drawings were provided by the Allbright-Nell Company, Chicago, Illinois.

[7]H. L. Rothra, ed., Meat Industry Trends, 1961, (Chicago, 1961), p. H-12.

[8]Ibid., p. I-7.

Equipment requirements and costs for the kill floor and rendering operations were supplied by the Allbright-Nell Company. Refrigeration equipment needs were synthesized and checked against the rules of thumb used in the industry. Cost estimates for refrigeration equipment were taken from the ASHRAE Guide and Data Book, 1962[9] and checked against the estimates of cost per ton of refrigeration supplied by manufacturers and local contractors.

Office equipment prices were obtained from manufacturers' price lists. Office equipment requirements were synthesized on the basis of the number of office employees and their functions.

Operating Costs

Labor requirements for the kill floor, coolers, offal, and dock operations were developed in consultation with Mr. Donald R. Hammons[10] from time study data supplied by the Allbright-Nell Company and selected slaughtering plants. Labor requirements for the rendering operations were developed from data published in Meat Industry Trends, 1961.

Wage practices were based upon an agreement between the Texas Meat Packers, Incorporated, and the Amalgamated Meat Cutters and Butcher Workmen of North America, AFL-CIO, Local No. 540. Wage and salary data for office personnel were developed from information supplied by managers of selected plants in the Southwest.

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[9] ASHRAE Guide and Data Book, 1962, Application for Heating, Refrigeration, Ventilating and Air Conditioning, American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., New York, p. 860.

[10] Industrial Engineer, Handling and Facilities Research Branch, Transportation and Facilities Research Division, Agricultural Marketing Service, U. S. Department of Agriculture.

Costs for utilities, telephone, laundry, and miscellaneous supplies were estimated from accounting records of selected plants. Repair and maintenance costs were assumed to be equal to cost derived in a California study.[11]

Other Costs

The tax procedures and rates used were obtained from the County Assessor's Office, Oklahoma County Court House in Oklahoma City.

The cost of insurance against losses due to fire and unexpected interruptions of business was estimated from rates obtained from the Oklahoma Inspection Bureau, Oklahoma City, Oklahoma.

The interest cost of ownership or interest foregone on invested funds was assumed as six percent of the nondepreciating salvage value of the equipment and land investment and three percent of the depreciable balance of buildings, equipment, and parking lots.

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[11] S. H. Logan, and G. A. King, Economies of Scale in Beef Slaughter Plants, Giannini Foundation Research Report No. 260, December, 1962, p. 93.

CHAPTER V

TOTAL CONSTRUCTION AND EQUIPMENT COSTS

The operation of a beef dressing plant requires an initial investment in buildings, equipment, and real estate. To the fixed investment costs must be added those costs associated with variations in the level of output. Investment costs will be presented in this chapter and variable costs will be presented in the succeeding chapter.

Construction costs were estimated for corrals, each area of the plant, and for the parking area. From the area requirements for the corrals, buildings, and parking lots, an estimate of the land requirements was derived from which the real estate investment was estimated. The fixed investment costs then were converted to annual costs through the application of appropriate depreciation methods and rates.

Building Costs

The cost of constructing a beef slaughtering plant depends upon many factors, not all of which are considered in detail in this study. In this analysis it was assumed that the plants would be constructed on level ground in industrial areas suitable for slaughterhouse operations and that the plants would meet all the requirements for Federal inspection.[1] Cost estimates are based, insofar as possible, on the costs of construction in the Oklahoma City area.

Corrals

To provide flexibility in purchasing cattle and to maintain an adequate supply of animals for plant operations, many slaughtering plants in the Southwest commonly maintain holding pens large enough for 1.5 to 3.0 days' kill. For the model plants, corral space sufficient to handle 2.5 times one day's kill at rated line speed was specified.

The corral area was divided into sets of pens ten feet wide and twenty feet deep, each capable of holding eleven head of cattle. Corrals of this type permit the separation of buyer's lots, if desired, and also aid in the prevention of injuries from crowding.

Each pen was provided with a ten foot gate which, when opened, blocks the ten foot wide alley which separates the sets of pens and leads to the kill floor entrance.

In compliance with the requirement of Federal inspection that a reasonable portion of the holding pens be covered with a weather-tight roof to facilitate the ante mortem inspection of animals in inclement weather, one-fifth of the pen area was covered.

The corral fencing designed with five rails spaced at 15, 23, 33, 45, and 60 inches from the ground, was constructed of 2 inch structural steel pipe. Supporting posts were 7 feet long, set 24 inches deep in

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[1] For detailed requirements of Federal inspection, see U. S. Inspected Meat Packing Plants, Agriculture Handbook No. 191, Agricultural Research Service, U. S. Department of Agriculture (Washington, 1961).

concrete, and spaced on 10 foot centers. Pen floors and alleys were constructed of 4 inch concrete with 12 inch curbs, except at gateways.

The cost of galvanized metal roofing using pole type support was estimated at $1.00 per square foot. The structural steel pipe was priced at $.21 per linear foot and the cost of the concrete paving was estimated on the basis of $.45 per square foot. Details of the corral construction costs are presented in Appendix A, Table I. Total costs of corrals and other building construction for each of the model plants are presented in Table I.

Kill Floor

The kill floor is the heart of the beef slaughtering plant. Kill floors must be of such size and arrangement "to facilitate the conduct of sanitary operations and the efficient performance of the inspection."[2] "The rate of slaughter is dependent on the ability of the establishment to present carcasses, their viscera, and parts in an orderly and clean manner which permits a complete and efficient inspection at all times and does not create congestion or other objectionable conditions of any kind."[3]

The kill floor specifications used to estimate the cost of construction were taken from architectural drawings of on-the-rail kill floor layouts approved by the Meat Inspection Division of the United

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[2]Ibid., p. 16

[3]Ibid.

TABLE I

SYNTHESIZED BUILDING REQUIREMENTS AND COSTS FOR THE FIVE MODEL PLANTS

Item	Cost per Sq. Ft.	Plant Size, Head Per Hour: 20 Floor Area[f]	20 Total Cost[g]	40 Floor Area[f]	40 Total Cost[g]	60 Floor Area[f]	60 Total Cost[g]	75 Floor Area[f]	75 Total Cost[g]	90 Floor Area[f]	90 Total Cost[g]
	(Dollars)	(Sq. Ft.)	(Dollars)	(Sq. Ft.)	(Dollars)	(Sq. Ft.)	(Dollars)	(Sq. Ft.)	(Dollars)	(Sq. Ft.)	(Dollars)
Kill Floor	18.00[a]	1,750	31,500.00	2,990	53,820.00	3,280	59,040.00	4,260.	76,680.00	5,247	94,446.00
Chill Cooler	[b]	1,710	23,138.00	3,132	39,282.00	4,692	56,103.00	5,712	67,481.00	7,490	85,934.00
Holding Cooler	[c]	2,247	30,168.00	3,782	40,852.00	5,472	66,060.00	6,912	78,238.00	7,917	92,604.00
Rendering	15.00[a]	1,500	22,500.00	1,800	27,000.00	2,825	42,375.00	3,425	51,375.00	4,040	60,600.00
Corrals	[d]	8,800	8,460.20	17,800	16,889.80	27,800	26,534.90	33,400	31,033.35	39,800	37,188.95
Employee Dressing	6.00[a]	391	2,346.00	765	4,590.00	1,054	6,324.00	1,343	8,058.00	1,683	10,098.00
Equipment clean-up	6.00[a]	224	1,344.00	224	1,344.00	224	1,344.00	224	1,344.00	224	1,344.00
Dock	15.00[a]	420	6,300.00	620	9,300.00	720	10,800.00	720	10,800.00	870	13,050.00
Dock Apron	0.50[e]	840	420.00	1,240	620.00	1,440	720.00	1,440	720.00	1,740	870.00
Dry Storage	6.00[a]	100	600.00	150	900.00	344	2,064.00	429	2,574.00	514	3,084.00
Office	10.00[e]	1,320	13,200.00	2,160	21,600.00	2,880	28,800.00	3,240	32,400.00	3,600	36,000.00
Parking lots	0.56[e]	9,486	5,312.16	18,414	10,311.84	25,389	14,217.84	31,527	17,655.12	38,502	21,561.12
TOTAL		28,788	145,288.36	53,077	226,509.64	76,120	314,382.74	92,632	378,358.47	111,627	456,780.07

[a]H. L. Rothra, Editor, Meat Industry Trends, 1961, Chicago, 1961 were verified for the Oklahoma City area in an interview with Lipperd Brothers, General Industrial Contractors, Oklahoma City, Oklahoma.

[b]Taken from Appendix B, Table II.

[c]Taken from Appendix B, Table III.

[d]Taken from Appendix A, Table I.

[e]Figures were obtained from local contractors and verified in an interview with Lipperd Brothers, General Industrial Contractors, Oklahoma City, Oklahoma.

[f]See text for methods of estimating area requirements of the various departments within the plant.

[g]Column 2, 4, 6, 8, and 10 times the cost figure in column 1, except for the coolers and corrals.

States Department of Agriculture.[4] A rate of $18.00 per square foot was used to estimate the construction costs.

Chill and Holding Coolers

Upon completion of the slaughtering process, the hot beef carcass is moved into a chill cooler where most of the body heat is removed during the first 24 hour period. A properly constructed chill cooler will remove the body heat in a minimum of time with a carefully controlled drying of the carcass surface.[5] In recent years the industry practice has been to remove about one-half of the total heat load during the first one-third of the chill cycle.[6]

Properly constructed holding coolers provide storage for the carcasses under optimum conditions of temperature, humidity, and air motion. Proper design of these coolers is important to the elimination of excessive shrinkage, bone taint or sour rounds, surface slime or mold, discoloration, and freezing.

Chill and holding coolers are built in a great variety of sizes and

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[4]Architectural drawings from which the kill floor area requirements were taken were provided through the courtesy of the Allbright-Nell Company.

[5]ASHRAE Guide and Data Book, 1962, Application for Heating, Refrigeration, Ventilating and Air Conditioning, p. 339. "A certain dryness of the carcass surface is necessary during storage to prevent formation of surface slime. Exposed beef muscle chilled to an actual temperature of 36° F. will not slime readily if dried at the surface to a water content of 90 percent of dry weight (47.4 percent of total weight). Such a surface is in vapor pressure equilibrium with a surrounding atmosphere at the same temperature (36° F.) and 96 percent relative humidity. In practice, a room atmosphere at 32 to 34° F. and 90-95 percent relative humidity will maintain a well chilled carcass in nonsliming condition."

[6]H. L. Rothra, ed., p. H-12.

shapes, usually being designed to meet the particular needs of the individual plant. Several important factors involved in the design of coolers are: (1) the type and amount of construction materials used, (2) the amount and type of product to be handled, (3) the cooler room temperature to be maintained, (4) the outdoor temperature, (5) the amount and size of electrical equipment in the cooler, (6) the number of individuals working in the coolers, (7) the frequency of air changes, and (8) the orientation of the coolers to the compass.

No attempt was made in this study to provide detailed specifications for chill and holding coolers. Although certain construction detail was assumed to aid in the estimation of refrigeration equipment needs, these specifications were not used to estimate construction costs.[7]

To estimate the chill cooler size, the following specifications were employed: (1) the rails were spaced on three foot centers with an allowance of 30 inches of rail space per carcass, (2) an allowance of two feet was made on each rail for space used by switches, and (3) all rails were spaced three feet from any obstructions. Sufficient rail space was provided to allow for a kill equivalent to that which would result from operating at 115 percent of the designed line speed. The total area required for the chill coolers was determined on the basis of the foregoing specification. A rate of $4.00 per square foot of exterior wall was used to estimate the construction costs not including the costs of doors, floor drains, and railing. The cost of these latter items is reported in

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[7]When construction of an actual plant is contemplated, detailed specifications should be obtained from competent architects and engineers specializing in packing plant design, construction, and equipment.

Appendix B, Tables II and III.

The procedure employed to estimate the area requirements for the holding coolers was the same as for the chill coolers. However, in the holding coolers railing was spaced on two and one-half foot centers with an allowance of 24 inches of rail space per carcass.

Dock and Apron

A loading dock 10 feet wide, used for transferring carcasses and edible by-products from the refrigerated areas of the plant into trucks or railroad cars, was provided along the length of the narrow side of the holding cooler. To comply with the requirements of Federal inspection, a dock apron 20 feet wide and extending the length of the loading dock was also provided.

A rate of $15.00 per square foot was used to estimate the construction cost of the dock and a rate of $.50 per square foot was used to estimate the construction cost of the dock apron.

Rendering

Slaughtering plants have a wide range of alternatives facing them with respect to the method of handling by-products. At one extreme, all the by-products may be sold to commercial rendering firms. At the other extreme, plants may engage in extensive by-product processing.

For the purposes of this study, it was assumed that each of the model plants sold their hides daily on a green basis and that only inedible rendering operations would be conducted.

The space requirements and the cost of construction for the rendering department were based on information taken from the estimates reported in Meat Industry Trends, 1961.[8]

Equipment Clean-up and Dry Storage

Most of the equipment used in a slaughterhouse is cleaned in place. The trolleys, however, are removed from the rail and transported to the equipment cleaning area. Here the trolleys are cleaned, rinsed, and oiled in a three section vat prior to reuse.

Each of the model plants was provided with an equipment cleaning area equal to 224 square feet. A cost rate of $6.00 per square foot was used to estimate the cost of the equipment clean-up area.

Stocks of items such as boxes, strapping, extra trolleys, aprons, shrouds, and general supplies require a dry storage area in each plant. The amount of space allocated to this function varies widely. The area specifications used in this study were obtained from selected plants in the Southwest.

A rate of $6.00 per square foot was used to estimate the cost of construction the equipment clean-up and dry storage areas.

Employee Dressing

Federally inspected slaughtering establishments are required to provide dressing rooms properly separated from toilet rooms by tight, full height walls or partitions.

Employee dressing rooms meeting the requirements for Federal inspection were specified for each of the model plants. The area of the dressing room was estimated on the basis of 17 square feet per production

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[8] Ibid., pp. G-8 and I-7.

employee. A rate of $6.00 per square foot was used to estimate the cost of the dressing rooms.

Offices

Three types of offices are found in a packing plant. These consist of a general office, a manager's office, and the Federal inspector's office. The size of these offices varies widely among plants except that the inspector's office must be at least seven feet by nine feet in size. The size of the manager's office and the general office often reflects the personal preference of the manager more than any other factor.

The office space for the model plants was estimated on the basis of 360 square feet for lobbies and hallways plus 120 square feet for each office employee.

The cost of constructing office space can vary greatly depending upon the type of materials used in finishing. Tastes in office decor vary widely and are reflected in the cost of the office space. A rate of $10.00 per square foot was used to estimate the cost of the office space in the model plants.

Parking lots are required by packing plants for the use of the plant employees and visitors. For the model plants, an area of 9 feet by 30 feet (including the drive area between lines of cars) was allocated for each employee. An area equal to ten percent of the total employee parking area was provided for visitor parking.

A rate of $0.56 per square foot of asphaltic concrete was used to estimate the cost of parking lot construction.

Real Estate Cost

In determining the amount of land needed for a new plant, consideration must be given to: (1) the amount of space needed for the buildings, corrals, parking lots, and landscaping, (2) plans for future plant expansion, (3) expectations with regard to the future price of adjacent tracts of real estate, and (4) the available supply of investment capital.

In this study, no assumptions were ventured with respect to items (3) or (4). However, provision was made for an expected expansion in chill cooler facilities equal in size to the original chill cooler. In addition to the provision for expanded chill cooler facilities, sufficient real estate was provided for the construction of the corrals, various plant departments, and parking lots as described above.

Values of land suitable for slaughtering plant sites in the Oklahoma City area ranged from $1,500 per acre to $10,000 per acre.[9] In the absence of any good criteria for assigning values in this range to particular scales of plant, a cost of $4,356 per acre was arbitrarily selected as the basis for estimating the magnitude of the real estate investment for the model plants. These costs are presented in Table II.

Equipment Costs

The equipment needs of the slaughtering plants considered in this study may be placed in four general categories: (1) kill floor and supporting operations, (2) inedible rendering, (3) refrigeration, and

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[9] Land values were obtained through correspondence with Mr. John Connor, Manager, Agriculture and Livestock Division, Oklahoma City, Chamber of Commerce, Oklahoma City, Oklahoma.

(4) office. The specification of equipment for the kill floor and inedible rendering operations was provided by the Allbright-Nell Company and are presented in Appendix C, Table I.

TABLE II

LAND REQUIREMENTS AND COSTS FOR THE FIVE MODEL PLANTS

Plant Size Head Per Hour	Plant Area[a]	Future Expansion Area[b]	Total Area[c]	Total Land Cost[d]	Annual Cost of Interest[e]
		(Square Feet)		(Dollars)	
20	28,788	1,710	30,498	3,049.80	182.99
40	53,077	3,132	56,209	5,620.09	337.20
60	76,120	4,692	80,812	8,081.20	484.87
75	92,632	5,712	98,344	9,834.40	390.06
90	111,627	7,490	119,117	11,911.70	714.70

[a]Taken from Table I.

[b]Since the chill cooler limits the capacity of the plant, an area equal to the size of the present chill cooler is allowed for future expansion.

[c]Sum of columns 2 and 3.

[d]Column 4 times $0.10 per square feet.

[e]An interest rate of 6 percent was applied to column 5.

No attempt was made to estimate the specific items of refrigeration equipment required for each scale of plant. The capacity of the equipment was estimated in terms of tons of refrigeration required to remove the total heat load. The procedures used in obtaining these estimates were taken from Gunther[10] and checked against the information published in the ASHRAE Guide and Data Book, 1962, and against the general rule of thumb of one ton of refrigeration per ton of beef. The specification and assumptions used in estimating the total heat load are presented in Appendix B and Appendix B, Table I.

Estimates of the cost of refrigeration equipment varied considerably among the manufacturers contacted. The cost rates used for the model plants were taken from those published in the ASHRAE Guide and Date Book, 1962.[11] The estimated cost of the refrigeration equipment is reported in Table III.

Office equipment requirements were synthesized on the basis of the functional operations of the office and the number and type of personnel. Cost rates for the various items of office equipment were taken from prices supplied by the purchasing office, Oklahoma State University.[12] Total costs of the office equipment are presented in Table III.

Annual Cost of Investment

Since the services of buildings, equipment, and real estate are used over many production periods, they may be considered as flow resources and converted to annual costs by amortizing the investment over

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[10] R. C. Gunther, Refrigeration, Air Conditioning, and Cold Storage, Chilton Co. (Philadelphia, 1957), pp. 1125-1130.

[11] ASHRAE Guide and Data Book, 1962, Application for Heating, Refrigeration, Ventilating and Air Conditioning, American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., New York, p. 860.

[12] The cost rates used do not include discounts arising from purchase by a state agency.

TABLE III.

TOTAL EQUIPMENT COSTS AND ANNUAL EQUIPMENT DEPRECIATION COSTS FOR THE FIVE MODEL PLANTS

Plant Size Head Per Hour	Ton of Refrigeration Equipment Required[a] Chill Cooler	Holding Cooler	Total	Refrigeration Equipment Cost Per Ton[b]	Total[c]	Kill Floor Equipment Cost[d]	Rendering Equipment Cost[d]	Office Equipment Cost[e]	Total Equipment Cost[f]	Equipment Salvage Value[g]	Balance For Depreciation[h]	Annual Depreciation Cost[i]
	(Number)			(Dollars)					(Dollars)			
20	43	12	55	772.00	42,460.00	33,000.00	65,000.00	6,481.44	146,941.44	14,694.14	132,247.30	6,904.03
40	84	22	106	744.00	78,864.00	62,000.00	114,000.00	10,343.28	265,207.28	26,520.73	238,686.55	12,399.78
60	125	30	155	715.00	110,825.00	75,000.00	126,000.00	14,302.94	326,127.94	32,612.79	293,515.15	15,319.40
75	157	41	198	701.00	138,798.00	120,000.00	150,000.00	17,871.05	426,669.05	42,666.90	384,002.15	20,004.31
90	210	50	260	677.00	176,020.00	130,000.00	150,000.00	21,312.71	477,332.71	47,733.27	429,599.44	22,439.04

[a] See Appendix B and Appendix B Tables I, II, and III for assumption and specifications used in estimating equipment requirements.

[b] Cost figures taken from the ASHRAE Guide and Data Book 1962, Application for Heating Refrigerating Ventilating and Air Conditioning, American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., New York, page 860.

[c] Column 4 times Column 5.

[d] Equipment costs supplied by the Albright-Nell Co., Chicago.

[e] Cost figures secured from Office Supply Companies and applied to equipment lists in Appendix C, Table I.

[f] Sum of Columns 6, 7, 8, and 9.

[g] Assumed to be 10 percent of original cost.

[h] Column 10 less column 11.

[i] Sum of Columns 6, 7, and 8, less 10 percent salvage value divided by 20 years, plus column 9 less 10 percent salvage value divided by 10 years.

a suitable time period. The length of the amortization period depends on the policy of the firm.

Depreciation of buildings and equipment consists of: (1) depreciation from actual wear and tear associated with use, and (2) depreciation from obsolescence due to technological changes.[13]

Depreciation of buildings and equipment, especially where buildings and equipment are maintained, is difficult to measure empirically. Data on the depreciation of buildings and equipment due to wear and tear are scarce and to know depreciation from obsolescence is to know the future. The impracticality of estimating the three components of depreciation separately leads to an alternative, commonly used, procedure which attempts to estimate the loss in value of all three simultaneously.

The annual depreciation cost for buildings was estimated by dividing the total cost of the building, including estimated architectural costs, by the estimated useful life of the buildings. For all equipment, an estimate of the salvage value was subtracted from the total cost before dividing by the estimated useful life.[14] The annual depreciation cost for buildings is presented in Table IV, and the annual

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[13] Land was not considered for depreciation purposes because its services are not affected by extent of use, the ravages of time, nor obsolescence.

[14] The salvage value of all equipment was assumed to be equal to 10 percent of the initial cost. Buildings were assumed to be fully depreciated in 25 years. The estimated useful life of buildings and equipment were taken from U. S. Treasury Department, Bureau of Internal Revenue, Income Tax Depreciation and Obsolescence, Estimated Useful Lives and Depreciation Rates, Bulletin "F" revised January, 1942 (Washington, 1948), pp. 55-56.

TABLE IV.

ANNUAL DEPRECIATION, INSURANCE, AND INTEREST COSTS FOR THE BUILDINGS AND EQUIPMENT

Plant Size Head Per Hour	Building Costs[a]	Archi-tectural Costs[b]	Total Building Costs[c]	Building Depreciation Cost[d]	Total Cost of Buildings & Equipment[e]	Insured value of Building & Equipment[f]	Annual Insurance Cost[g]	Annual Interest Cost[h]	Equipment Depreciation Cost[i]	Total Annual Cost[j]
20	145,288.36	8,717.30	154,005.66	6,160.23	300,947.10	240,757.68	337.06	9,028.41	6,904.03	22,429.73
40	226,509.64	13,590.57	240.100.21	9,604.00	505,307.49	404,245.99	565.94	15,159.22	12,399.78	37,728.94
60	314,382.74	18,862.96	333,245.70	13,329.83	659,373.64	527,498.91	738.49	19,781.21	15,319.40	49,168.93
75	378,358.47	22,701.50	401,059.97	16,042.40	827,729.02	662,183.22	927.06	24,831.87	20,004.31	61,805.64
90	456,780.07	27,406.80	484,186.87	19,367.47	961,519.58	769,215.66	1,076.90	28,845.59	22,439.04	71,729.00

[a]Taken from Table I.

[b]A figure of 6 percent of total building costs was used.

[c]Column 2 plus column 3.

[d]Column 3 divided by 25 years.

[e]Column 3 plus total equipment cost taken from Table III.

[f]The Oklahoma Inspection Bureau recommended practice is to insure buildings and equipment for 80 percent of their original cost.

[g]An estimated fire and business interruption insurance rate of $0.14 per $100.00 was obtained from the Oklahoma Inspection Bureau, 2000 Classen Building, Oklahoma City, Oklahoma and was applied to column 6.

[h]An interest rate of 6 percent was applied to one-half of column 6.

[i]Taken from Table III.

[j]Sum of columns 5, 8, 9, and 10.

depreciation cost for equipment is presented in Table III.

In addition to depreciation costs, the firm must face the cost of the interest foregone on the funds invested. An interest rate of six percent was applied to the real estate investment and to the nondepreciating salvage value of the equipment. A three percent rate was applied to the depreciable balance of the buildings, equipment, and parking lots. The interest charges for the model plants are presented in Table IV.

Of concern to any company when examining their annual fixed costs is the amount of personal property taxes they will have to pay. For the purposes of this study, personal property taxes were computed by the procedures and with the rates presently used in Oklahoma County.[15]

Since tax rates vary to some extent among tax districts, an average rate of $7.69 per $100.00 of assessed valuation, typical of the industrial areas of Oklahoma city, was used. The assessment value of the plant, usually some percentage of actual market value, was determined by assessing the model plants at the following rates: 25 percent of the market value of land, buildings, and parking lots; and 35 percent of the value of the equipment.

The full tax rate was applied to the assessed value of the land, buildings, and parking lots (for personal property tax purposes no depreciation is allowed on these). Since the value of the equipment is decreasing over time, application of the full tax rate to the assessed valuation would be overestimating the taxes of the plant. For this

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[15]Procedures used and tax rates applied were obtained from the County Assessor's Office, Oklahoma County Court House, Oklahoma City, Oklahoma.

reason, the salvage value of the equipment was subtracted and a tax rate of $3.845 per $100.00 (equal to one-half of the full rate) was applied to the depreciable balance. The salvage value, which does not depreciate, was taxed at the full rate.

Personal property taxes must also be paid on the average number of animals and carcasses owned by the plant. The current practice in Oklahoma County is to average the number of head on hand January 1 and December 31 of each year and assess each head at a value of $20.00. The tax rate of $7.69 per $100.00 of assessed valuation is then applied to the assessment to determine the taxes. The tax costs for the model plants are listed in Table V.

Insurance against losses due to fire and unexpected interruptions of business is carried by most slaughtering plants to protect their investment. Rates for both of these types of insurance are determined by the Oklahoma Inspection Bureau in Oklahoma City. Several factors such as the exposure to the elements, accessibility of the plant to fire department equipment, and building construction affect the insurance rate, but the most important factor is whether the plant is equipped with a sprinkler system. For example, rates for slaughtering plants which are equipped with sprinkler systems range from $0.08 to $0.50 per $100.00; whereas, rates for similar plants not equipped with sprinkler systems range from $0.80 to $2.55 per $100.00.[16] Because of the additional fire protection provided and the lower insurance rates involved, the model plants were specified to be protected by sprinkler systems.

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[16] Rates obtained from Oklahoma Inspection Bureau, 2000 Classen Building, Oklahoma City, Oklahoma.

TABLE V

ANNUAL PERSONAL PROPERTY TAX COSTS FOR THE FIVE MODEL PLANTS

Plant Size Head Per Hr.	Assessed Real Estate Value[a]	Taxes on Real Estate[b]	Assessed Equipment Value[c]	Taxes on Equipment[d]	Assessed Salvage Value[e]	Taxes on Equipment Salvage Value[f]	Assessed Value of Cattle Inventory[g]	Taxes on Cattle[h]	Total Taxes[i]
20	39,263.86	3,019.39	46,286.55	1,779.72	5,142.95	395.49	6,000.00	461.40	5,656.00
40	61,430.28	4,723.99	83,540.29	3,212.12	9,282.25	713.80	12,000.00	922.80	9,572.71
60	80,615.98	6,199.89	102,730.30	3,949.98	11,414.48	877.77	18,000.00	1,384.20	12,411.84
75	97,048.22	7,463.00	134,400.75	5,167.71	14,933.41	1,148.38	22,520.00	1,731.79	15,510.88
90	124,024.64	9,537.49	150,359.80	5,781.33	16,706.64	1,284.74	27,000.00	2,076.30	18.679.86

[a]Twenty-five percent of actual market value of land, buildings, and improvements.

[b]A tax rate of $7.69 per $100.00 of assessed valuation in column two was used.

[c]Thirty-five percent of actual market value, less the salvage value of the equipment.

[d]Since value of the equipment is being depreciated out over time, a tax rate equal to one-half the tax rate (0.5 times 7.69 equals 3.845) per $100.00 was applied to column four.

[e]Thirty-five percent of the salvage value of the equipment.

[f]A tax rate of 7.69 per $100.00 was applied to the assessed salvage value in column six since salvage value is assumed not to depreciate over the life of the equipment.

[g]Personal property tax on cattle is based on an average of the cattle on hand January 1 and December 31 of the tax year, including both live and dressed animals. For the purpose of this study, two days normal kill is assumed to be the average. These cattle are assessed at $20.00 per head.

[h]A tax of 7.69 per $100.00 was applied to assessed value of cattle.

[i]Sum of columns 3, 5, 7, and 9.

Source: The procedures used for assessment and tax rates applied to assessments were obtained from the County Assessor's Office, Oklahoma County Court House, Oklahoma City, Oklahoma.

In computing the insurance, a cost rate of $0.14 per $100.00 was applied to 80 percent of the cost of the buildings and equipment.[17] The $0.14 rate was selected from the lower end of the range because the model plants were assumed to approximate "ideal" risks. The insurance cost on the buildings and equipment are listed in Table IV.

[17] Present practice is to insure buildings for 80 percent of their value. One hundred percent coverage is offered only at a much higher rate.

CHAPTER VI

VARIABLE COSTS

Within the constraints imposed by the size of the work areas and the size, type, and arrangement of equipment, a plant is capable of some particular maximum, efficient level of output in a given length of time. Changes in the level of product demand or in the supply of cattle, however, may suggest the need to operate the plant at other than the designed level of output.

In the beef slaughtering plants considered in this study, six operating levels were considered. The lowest level investigated was at an output level equivalent to 90 percent of the output attainable at the rated line speed.[17] The highest level investigated was at an output level equivalent to 115 percent of the output attainable at the rated line speed. The remaining levels investigated were at 95, 100, 105, and 110 percent of the output attainable at the rated line speed.

[17] The output attainable at the rated line speed is defined as 7.5 hours (eight hours less two 15 minute breaks) times the rated line speed for the particular scale of plant, i.e., 20, 40, 60, 75, or 90 head per hour for the plants considered in this study.

Labor Costs

Apart from the cost of the livestock input, wages and salaries constitute the largest expense item in the meat packing industry.[18] Changes in the cost of the labor input may arise from changes in the size of the work force or from changes in the length of the work week. In this study only changes in the length of the work week were considered.[19]

Labor specifications for the kill floor, coolers, and supporting operations, shown in Appendix D, Tables III and IV, were developed by Mr. Donald R. Hammons from time study analysis supplied by the Allbright-Nell Company and selected slaughtering plants. Labor requirements for the rendering operations were developed from data published in Meat Industry Trends, 1961. Requirements for office personnel, Appendix D, Table II, were synthesized on the basis of the functions to be performed and discussions with several packing plant managers.

The wages of the production workers were based on an agreement between the Texas Meat Packers, Inc. and the Amalgamated Meat Cutters and Butcher Workmen of North America, AFL-CIO, Local No. 540.[20]

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[18] Financial Facts about the Meat Packing Industry, Department of Marketing, American Meat Institute, (Chicago, 1962).

[19] Changes in the size of the labor force entail rebalancing of the kill floor crew for each kill level. Time study data for such an analysis was not available for use in this study. Data pertaining to the changes in cost associated with changes in the size of the work force would also be needed. This type of data also was not available.

[20] Agreement between Texas Meat Packers, Inc. and Amalgamated Meat Cutters and Butcher Workmen of North America, AFL-CIO, Local No. 540, effective November 11, 1964.

The wages of salaried workers were developed on the basis of conversations with packing plant managers. The wage and salary scales used in this study are presented in Appendix D, Tables I, Ia, and II. Total wage costs are shown in Table VI.

Two additional variable costs directly associated with the number of employees and their wages are Social Security tax and insurance. It is required by law that Social Security tax be paid on all employees and general liability and workman's compensation should be carried to protect both the firm and employees. The present law effective in 1963-64 states that Social Security tax at a rate of 3.625 percent must be paid on wages paid to employees to a maximum of $4,800 per employee. Wages over $4,800 per employee are not taxable for Social Security purposes. The Social Security tax costs for the six levels of production are listed in Table VI.

The option as to whether general liability and workman's compensation is carried is a decision of the individual firm. However, in this analysis, it will be assumed that both are carried. Rates for these types of coverages are the same for all slaughter plants in the state and were obtained from a local insurance agent.[21] A general liability coverage of $25,000 Bodily Injury and $100,000 Property Damage was specified for all plants. The insurance rates based on the total payroll are: for the bodily injury $0.1183 per $100.00 of payroll, and for the property damage $0.02704 per $100.00 of

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[21]C. R. Millard of the Millard Agency, Stillwater, Oklahoma.

TABLE VI

ESTIMATED TOTAL COSTS OF LABOR[a]

Plant Size Head/ Hour	Percent Rated Line Speed	Kill Floor[b]	Supporting Operations[c]	Salaried Personnel[d]	Social Security Tax	Insurance	Total
			(Dollars)				
	90	47,387	51,138	52,100	4,752	8,244	163,621
	95	49,842	53,786	52,100	4,924	8,553	169,205
20	100	52,296	56,434	52,100	5,054	8,863	174,747
	105	55,970	60,408	52,100	5,192	9,327	182,997
	110	59,663	64,383	52,100	5,280	9,792	191,218
	115	63,347	68,358	52,100	5,285	10,256	199,346
	90	80,340	106,478	106,600	9,010	16,031	318,459
	95	84,499	111,985	106,600	9,348	16,617	329,059
40	100	88,658	117,492	106,600	9,632	17,203	339,585
	105	94,892	125,762	106,600	9,977	18,083	355,314
	110	101,145	134,032	106,600	10,247	18,963	370,987
	115	107,388	142,202	106,600	10,266	19,824	386,280
	90	128,023	126,540	150,500	12,411	22,429	439,903
	95	134,646	133,084	150,500	12,876	23,227	454,333
60	100	141,269	139,627	150,500	13,274	24,032	468,702
	105	151,189	149,455	150,500	13,779	25,230	490,153
	110	161,149	159,283	150,500	14,190	26,424	511,546
	115	171,090	169,111	150,500	14,245	27,623	532,569
	90	156,875	166,175	196,900	15,341	28,767	564,058
	95	164,990	174,766	196,900	15,933	29,781	582,370
75	100	173,105	183,358	196,900	16,455	30,794	600,612
	105	185,265	196,262	196,900	17,128	32,314	627,869
	110	197,466	209,166	196,900	17,668	33,837	655,037
	115	209,646	222,071	196,900	17,725	35,358	681,700
	90	194,379	209,795	226,000	18,676	35,093	683,943
	95	204,496	220,640	226,000	19,418	36,364	706,918
90	100	214,555	231,485	226,000	20,083	37,632	729,755
	105	229,623	247,775	226,000	20,935	39,534	763,867
	110	244,751	264,066	226,000	21,613	41,440	797,870
	115	259,848	280,356	226,000	21,683	43,343	831,230

[a]All cost items rounded to nearest dollar.

[b]Taken from Table VI.

[c]Taken from Table VII.

[d]Taken from Table VIII.

payroll. The rate for the workman's compensation insurance for all employees other than clerical is \$5.92 per \$100.00 of payroll. For the clerical employees it is \$0.12 per \$100.00 of payroll. Also, there is charge of \$25.00 per policy for all plants purchasing workman's compensation insurance.

The insurance costs for both general liability and workman's compensation are listed in Table VI.

Utilities

The availability of an adequate supply of each utility is important to the operation of a slaughtering plant. Large amounts of electricity are required for the operation of the electrical equipment used including the large motors associated with the rendering and refrigerating functions. Substantial quantities of water are consumed in washing carcasses and edible offal, in plant cleanup operations, and in the rendering operations. Natural gas is used primarily for heating the nonrefrigerated work areas in the winter season, and for the heating of boilers.

Electricity

Data obtained from the accounting records of selected slaughtering plants were used to estimate, by linear multiple regression, the relationship between the number of kilowatts consumed per month; and, (1) the number of head slaughtered per month, (2) the average hourly rate of slaughter, and (3) the mean outdoor temperature.

On the basis of the usual statistical criteria for goodness of fit, only the estimate for the 90 head per hour plant produced satisfactory results.[22] Several alternative model formulations, which included quadratic terms, were tried without success.

Electrical consumption for the 90 head per hour plant was estimated directly from a multiple regression equation, the coefficients of which are shown in Table VII. Estimates of the electrical consumption for each of the other model plants were obtained from functional relationships obtained in the following manner: Each of the coefficients estimated for the 90 head per hour plant, except the coefficient connecting monthly kilowatt consumption with the variable, head per hour, was multipled by a factor equal to the ratio of the rated line speed of the plant under consideration to the rated line speed of the 90 head per hour plant. The constant term was adjusted in a second step such that the deviations of the accounting records data from the estimates from the functional equations summed to zero.

The coefficient connecting the hourly rate of slaughter with electrical consumption was not adjusted since a change in the rate of slaughter of one head per hour (holding total head slaughtered per month constant) results in an invariant change in the number of animals slaughtered. Thus although the larger plants operate more

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[22]The coefficient of multiple determination was estimated at .8675. The "t" statistic for the variable head per month, temperature °F, and head per hour were estimated at 5.10, 4.64, and -3.5, respectively, with eight degrees of freedom. Estimates of the coefficients of the relationship are presented in Table VII.

electrical equipment and equipment of greater size, the length of time the equipment must be operated to accomodate a fixed change in the number of animals slaughtered is less than for the smaller scale plants. It was assumed that the differences in time required offset the effects of the differences in size and amount of equipment.

TABLE VII

ESTIMATED FUNCTIONAL COEFFICIENTS FOR ELECTRICITY EQUATIONS

Plant Size Head/Hour	Dependent Variable	Constant Term	Coefficient Head/Month	Temperature Coefficient	Coefficient Head/Hour
20	K.W.H./mo.	38,763	2.833175	636.762	-2009
40	K.W.H./mo.	125,433	5.666351	1273.524	-2009
60	K.W.H./mo.	210,052	8.499952	1910.305	-2009
75	K.W.H./mo.	274,203	10.624472	2387.881	-2009
90	K.W.H./mo.	306,980	12.749418	2865.469	-2009

The cost of the electricity consumed by each plant at each operating level was estimated by applying the electrical rates for the Oklahoma City area to the estimates of consumption. The rates used were as follows:[23]

Rate:

<u>Primary Charge</u>

First	100	kw of billing demand	$1.90 per kw per month
Next	400	kw of billing demand	$1.45 per kw per month
Next	500	kw of billing demand	$1.25 per kw per month
Excess		kw of billing demand	$1.15 per kw per month

[23]The electrical rate was taken from the <u>Industrial Power Rate Schedule</u> "Pid-1", Oklahoma Gas and Electric Co., Oklahoma City, Oklahoma.

<u>Secondary Charge</u>

First	200,000	kwh per month at .76¢ per kwh
Next	800,000	kwh per month at .6¢ per kwh
Excess		kwh per month at .44¢ per kwh.

The billing demand was estimated as .228 percent of the total electrical consumption. The factor of .228 percent of the total electrical consumption was derived from the records of the 75 and 90 head per hour plants. The validity of this estimating factor for the smaller scale plants was verified through consultation with utility company engineers. Electricity requirements and costs are listed in Table VIII.

Water

Data obtained from the accounting records of selected slaughtering plants were used to estimate, by linear multiple regression, the relationship between the consumption of water; and, (1) the number of head slaughtered per month, and (2) the average hourly rate of slaughter.

As in the case of electrical consumption, the estimate for the 90 head per hour plant produced the most satisfactory results[24] and was used to estimate the water consumption for that scale of plant. The coefficients for the equations used to estimate the water consumption for other than the 90 head per hour plant were

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[24]The coefficient of multiple determination was estimated at .655. The "t" statistic for the variables head per month and head per hour were estimated at .70 and 1.60, respectively, with a single degree of freedom. The restriction in degrees of freedom results from the fact that only quarterly data for the year were available.

TABLE VIII

ESTIMATED CONSUMPTION AND COST OF UTILITIES[a]

Plant Size Heat/ Hour	Percent Rated Line Speed	Electricity Monthly Consumption (K.W.H.)	Electricity Yearly Cost (Dollars)	Gas Monthly Consumption (M.C.F.)	Gas Yearly Cost (Dollars)	Water & Sewer Monthly Consumption (1000 Gal.)	Water & Sewer Yearly Cost (-Dollars-)	Total Cost (-Dollars-)
	90	45,525	6,536	1,083.8	3,280	1,257.19	6,095	15,911
	95	45,947	6,575	1,140.0	3,436	1,333.19	6,341	16,352
20	100	46,428	6,619	1,204.2	3,613	1,420.05	6,622	16,854
	105	46,910	6,663	1,268.4	3,790	1,506.91	6,904	17,357
	110	47,331	6,701	1,324.6	3,945	1,582.91	7,150	17,796
	115	47,813	6,745	1,388.8	4,123	1,669.77	7,431	18,299
	90	155,538	21,041	2,167.6	6,192	4,762.22	16,394	43,627
	95	157,344	21,206	2,288.0	6,466	4,925.08	16,824	44,496
40	100	159,150	21,371	2,408.4	6,741	5,097.94	17,211	45,323
	105	160,957	21,535	2,528.9	7,016	5,250.80	17,563	46,114
	110	162,763	21,700	2,649.3	7,290	5,413.66	17,915	46,905
	115	164,569	21,864	2,769.7	7,565	5,576.53	18,267	47,696
	90	279,082	35,499	3,251.4	8,663	10,515.13	29,916	74,078
	95	283,086	35,787	3,428.0	9,066	10,753.99	30,493	75,256
60	100	287,240	36,086	3,612.7	9,487	11,003.79	30,913	76,486
	105	291,395	36,385	3,797.3	9,907	11,253.43	31,422	77,714
	110	295,368	36,671	3,974.0	10,310	11,492.30	31,910	78,891
	115	299,523	36,971	4,158.6	10,712	11,742.02	32,419	80,102
	90	383,553	46,741	4,070.3	10,521	16,313.10	41,744	99,006
	95	389,874	47,196	4,295.1	11,007	16,617.10	42,364	100,567
75	100	396,196	47,651	4,519.9	11,493	16,921.11	42,984	102,128
	105	402,518	48,106	4,744.7	11,978	17,225.12	43,604	103,688
	110	408,839	48,561	4,969.4	12,464	17,529.13	44,225	105,250
	115	415,161	49,017	5,194.2	12,949	17,833.14	44,845	106,811
	90	465,307	55,503	4,873.1	12,255	23,353.83	56,107	123,865
	95	474,512	56,166	5,146.1	12,845	23,722.98	56,864	125,875
90	100	483,717	56,781	5,419.0	12,787	24,092.13	57,613	127,181
	105	492,935	57,493	5,692.0	14,024	24,461.29	58,366	129,883
	110	502,153	58,156	5,964.9	14,614	24,830.44	59,119	131,889
	115	511,154	58,804	6,231.9	15,191	25,191.46	59,856	133,851

[a]All cost items rounded to nearest dollar.

developed by a procedure similar to that used to derive the coefficients for the functions used to estimate the electrical consumption. The coefficients linking water consumption with the quarterly and hourly slaughtering rates are presented in Table IX.

TABLE IX

ESTIMATED FUNCTIONAL COEFFICIENTS FOR WATER EQUATIONS

Plant Size Head/Hour	Dependent Variable	Constant Term	Coefficient Head/Quarter	Coefficient Head/Hour
20	1000 Gal/q.	-3,997.41	.5109379	168.5871
40	1000 Gal/q.	-7,994.82	.5109379	337.1742
60	1000 Gal/q.	-11,992.36	.5109379	505.7664
75	1000 Gal/q.	-14,990.45	.5109379	632.208
90	1000 Gal/q.	-17,988.61	.5109379	758.6526

The cost of the water consumed by each plant at each operating level was estimated by applying the water rate schedule for the Oklahoma City area to the estimates of consumption. The rate[25] schedule used was as follows:

[25]Water rate taken from the Oklahoma City Council's Ordinance No. 9303, "Rates and Charges for Water Service of Various Kinds. Including Minimum Bills, Meter Setting and Service Installation Charges."

			Per 1,000 Gallons		
			Gross	Discount	Net
(A)	First	1,000 Gallons	Included	in Minimum	Bill
	Next	4,000 Gallons	.62	.02	.60
	Next	10,000 Gallons	.54	.02	.52
	Next	135,000 Gallons	.39	.02	.37
	Next	350,000 Gallons	.29	.02	.27
	Next	4,000,000 Gallons	.22	.02	.20
	All Over	5,000,000 Gallons	.18	.02	.16

The 20 and 40 per hour plants had a minimum fixed charge of $73.00 per month, and the three larger plants had a minimum fixed charge of $200.00 per month. The water requirements and costs are listed in Table VIII.

Natural Gas

Several attempts were made to relate the consumption of natural gas to the output of beef. An analysis of the accounting record data indicated that no satisfactory relationship could be detected between these variables. For this reason, an average consumption of 3.778 hundreds of cubic feet per head, estimated from the plant records, was used to estimate the natural gas consumption of the model plants. The gas rate, obtained from Schedule "D" of the Oklahoma Natural Gas Company's Industrial Gas Service rate and presented below, was applied to the consumption estimates to determine the cost of the gas.

Rate:

First	1 M c.f. or fraction thereof $1.60
Next	99 M c.f. per month at 46¢ per M c.f.
Next	1,900 M c.f. per month at 23¢ per M c.f.
Next	2,000 M c.f. per month at 19¢ per M c.f.
Next	6,000 M c.f. per month at 18¢ per M c.f.
Next	20,000 M c.f. per month at 17.5¢ per M c.f.
All over	30,000 M c.f. per month at 17¢ per M c.f.

Sewer Services

The cost of the sewer services depends directly on the amount of water consumed by the model plant. Sewer charges are based on the amount of water metered to the plant and are calculated by multiplying the rate by the number of gallons of water consumed. The sewer rate presented below, was obtained from Oklahoma City Ordanance No. 6666.

First 200,000 gallons of water used at 10¢ per 1,000 gallons per month.
Next 300,000 gallons of water used at 9¢ per 1,000 gallons per month.
Next 500,000 gallons of water used at 8¢ per 1,000 gallons per month.
Next 1,000,000 gallons of water used at 7¢ per 1,000 gallons per month.
Next 1,000,000 gallons of water used at 4¢ per 1,000 gallons per month.
Next 2,000,000 gallons of water used at 2¢ per 1,000 gallons per month.
All over 6,000,000 gallons of water used at 1¢ per 1,000 gallons per month.

The sewer service also includes a minimum fixed charge of $29.00 per month. The sewer costs are listed in Table VIII.

Miscellaneous Supplies and Services

Four other minor cost items were considered. These were repair and maintenance, telephone, laundry, and miscellaneous supplies. Insufficient data were available from the selected plants to estimate repair and maintenance costs. Therefore, an average cost of $.339 per head per year[26] was assumed to be valid in the Oklahoma City area.

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[26] S. H. Logan and G. A. King, Economies of Scale in Beef Slaughter Plants, Giannini Foundation Research Report No. 260, (December 1962), p. 93.

Average costs, taken from the accounting records, were used to reflect the costs of telephone, laundry, and miscellaneous supplies. The rates used to estimate the costs for the model plants were: \$.2662 per head per year for telephone expenses, \$.2232 per head per year for laundry expenses, and \$.3833 per head per year for miscellaneous supplies expenses. These costs are listed in Table X.

TABLE X

ESTIMATED COST OF OTHER SUPPLIES AND SERVICES[a]

Plant Size Head/ Hour	Percent Rated Line Speed	Telephone	Laundry	Miscel-laneous Supplies	Repair and Maintenance	Total
			(Dollars)			
	90	9,164	7,684	13,195	11,670	41,713
	95	9,639	8,082	13,879	12,273	43,875
20	100	10,182	8,537	14,661	12,967	46,347
	105	10,725	8,993	15,443	13,658	48,819
	110	11,200	9,391	16,128	14,263	50,982
	115	11,743	9,846	16,909	14,955	53,453
	90	18,328	15,367	26,390	23,340	83,425
	95	19,346	16,221	27,856	24,637	88,060
40	100	20,364	17,075	29,322	25,934	92,695
	105	21,383	17,929	30,789	27,230	97,331
	110	22,401	18,782	32,255	28,527	101,965
	115	23,419	19,636	33,721	29,824	106,600
	90	27,492	23,051	39,585	35,010	125,138
	95	28,985	24,303	41,736	36,912	131,936
60	100	30,546	25,612	43,984	38,900	139,042
	105	32,108	26,921	46,232	40,888	146,149
	110	33,601	28,173	48,382	42,790	152,946
	115	35,162	29,482	50,630	44,779	160,053
	90	34,856	28,856	49,555	43,828	156,655
	95	36,316	30,450	52,292	46,248	165,306
75	100	38,217	32,044	55,028	48,669	173,958
	105	40,118	33,637	57,765	51,089	182,609
	110	42,018	35,231	60,502	53,509	191,260
	115	43,919	36,825	63,239	55,930	199,913
	90	41,204	34,548	59,329	52,472	187,553
	95	43,512	36,483	62,652	55,411	198,058
90	100	45,820	38,418	65,976	58,350	208,564
	105	48,128	40,353	69,299	61,290	219,070
	110	50,436	42,289	72,622	64,229	229,576
	115	52,693	44,181	75,872	67,103	239,849

[a]Figures rounded to nearest dollar.

CHAPTER VII

TOTAL AND AVERAGE UNIT COSTS

Estimates of the cost of constructing and equipping five model beef slaughtering plants were presented in Chapter V. Estimates of the variable costs associated with the operation of each of these plants at six alternative levels of output were presented in Chapter VI. In this Chapter, the total and average costs will be examined and an analysis of the relationships between average cost and volume of output will be presented.

Total Costs

The total annual costs for the five model plants, estimated at rated line speeds, ranged from over a quarter of a million dollars for the 20 head per hour plant to over one million dollars for the 90 head per hour plant. Total costs increased nonlinearly for each scale of plant as the output level was increased from 90 to 115 percent of the rated line speed.

The annual cost of ownership, or the total annual investment cost comprised a relatively small part of the total annual cost. Investment costs were estimated at $28,269, $47,639, $62,066, $77,707, and $91,123 for the 20, 40, 60, 75, and 90 head per hour plants, respectively. In relative terms these investment costs, as shown in Table XI, are 10.6, 9.1, 8.3, 8.1, and 7.9 percent of the total annual costs, respectively. Although these costs can be ignored in the short-run, survival of the firm decrees that these costs be covered in the long-run.

TABLE XI

COST COMPONENTS FOR FIVE MODEL PLANTS AS A PERCENTAGE OF TOTAL ANNUAL COST AT RATED LINE SPEEDS

	Plant Size, Head per Hour				
Cost Items	20	40	60	75	90
			(Percent)		
Annual Investment	10.6	9.1	8.3	8.1	7.9
Depreciation	4.9	4.2	3.8	3.8	3.6
Interest	3.5	3.0	2.7	2.6	2.6
Taxes and Insurance	2.2	1.9	1.8	1.7	1.7
Labor	65.6	64.7	62.8	62.9	63.1
Kill Floor	19.6	16.9	18.9	18.1	18.6
Supporting Operations	21.2	22.4	18.7	19.2	20.0
Salaried Personnel	19.6	20.3	20.2	20.6	19.5
Tax and Welfare	5.2	5.1	5.0	5.0	5.0
Utilities	6.3	8.6	10.2	10.7	11.0
Other Supplies	17.4	17.6	18.6	18.2	18.0
Total[a]	100	100	100	100	100

[a]Columns may not sum to 100 because of rounding errors.

Depreciation comprised the largest component of the annual fixed investment cost and ranged from $13,064 or 4.9 percent for the smallest plant to $41,806 or 3.6 percent for the largest. Interest on the investment ranked second in importance and amounted to almost one-third of the annual fixed investment cost. Taxes and insurance on the investment formed the balance of the fixed investment costs and increased from $5,993 for the 20 head per hour plant to $19,757 for the 90 head per hour plant. The various components of the annual investment costs are presented in Table XII.

TABLE XII

ANNUAL FIXED INVESTMENT COSTS

Cost Item	Annual Costs				
	Plant Size, Head Per Hour				
	20	40	60	75	90
			(Dollars)		
Depreciation[a]	13,064.26	22,003.78	28,649.23	36,046.71	41,806.51
Interest					
Building and Equipment[b]	9,028.41	15,159.22	19,781.21	24,831.87	28,845.59
Land[c]	182.99	337.20	484.87	390.06	714.70
Insurance[d]	337.06	565.94	738.49	927.06	1,076.90
Taxes[e]	5,656.00	9,572.71	12,411.84	15,510.88	18,679.86
Total	28,268.72	47,638.85	62,065.64	77,706.58	91,123.56

[a]Column 13, Table III, and Column 13, Table IV.

[b]Column 9, Table IV.

[c]Column 6, Table II.

[d]Column 8, Table IV.

[e]Column 10, Table V.

The annual operating costs, consisting of the costs of labor, utilities and other supplies, constitute the major part of the total annual costs. Labor costs, the largest component of total operating costs, were estimated at 65.6, 64.7, 62.8, 62.9, and 63.1 percent of total annual cost, respectively, for the 20 to 90 per hour plants at rated line speed.

For each plant, labor costs increased uniformly as the level of output increased from 90 to 100 percent of rated line speed. When output levels were increased from 100 to 115 percent of rated line speed, the total labor cost increased at a greater rate, causing a kink to occur in the total cost function at an output level equivalent to 100 percent of rated line speed. The change in rate of increase in total labor costs at the larger output levels was a result of the payment of overtime wages.

An examination of the total annual costs in relation to the scale of plant provides information concerning the existence or nonexistence of scale economies. If the 20 head per hour plant is used as a basis for comparison, it can be noted that as the scale of plant is increased by multiples of 2.00, 3.00, 3.75, and 4.50, total costs are increased by multiples of 1.97, 2.80, 3.58, and 4.34, respectively. These results imply the existence of some economies of scale for the model plants.

The scale economies implied by the total cost relationships may be investigated more closely and in more familiar terms by an examination of the short-run average cost curves. Estimates of the average cost per head for each scale of plant at each of six operating levels is presented in Table XIII and plotted in Figure 9.

Short-Run Average Costs

The average cost estimates obtained for the model plants, operating at their respective rated line speeds, were \$6.96 per head for the 20 per hour plant, \$6.86 per head for the 40 per hour plant, \$6.50 per head for the 60 per hour plant, \$6.65 per head for the 75 per hour plant, and

TABLE XIII

TOTAL AND AVERAGE UNIT COSTS[a]

Plant Size Head/Hour	Percent Rated Line Speed	Total Investment[b]	Total Cost of Labor[c]	Total Cost of Utilities[d]	Total Cost of Other Supplies[e]	Total Annual Costs[f]	Average Cost/Head
				(Dollars)			
	90	28,269	163,621	15,911	41,713	249,514	7.25
	95	28,269	169,205	16,352	43,875	257,701	7.12
20	100	28,269	174,747	16,854	46,347	266,217	6.96
	105	28,269	182,997	17,357	48,819	277,442	6.89
	110	28,269	191,218	17,796	50,982	288,265	6.85
	115	28,269	199,346	18,299	53,453	299,367	6.79
	90	47,639	318,459	43,627	83,425	493,150	7.16
	95	47,639	329,059	44,496	88,060	509,254	7.01
40	100	47,639	339,585	45,323	92,695	525,242	6.86
	105	47,639	355,314	46.114	97,331	546,398	6.80
	110	47,639	370,987	46,905	101,965	567,496	6.74
	115	47,639	386,280	47,696	106,600	588,215	6.69
	90	62,066	439,903	74,078	125,138	701,185	6.79
	95	62,066	454,333	75,256	131,936	723,591	6.64
60	100	62,066	468,702	76,486	139,042	746,296	6.50
	105	62,066	490,153	77,714	146,149	776,082	6.43
	110	62,066	511,546	78,891	152,946	805,449	6.38
	115	62,066	532,569	80,102	160,053	834,790	6.32
	90	77,707	564,058	99,006	156,655	897,426	6.94
	95	77,707	582,370	100,567	165,306	925,950	6.79
75	100	77,707	600,612	102,128	173,958	954,405	6.65
	105	77,707	627,869	103,688	182,609	991,873	6.58
	110	77,707	655,037	105,250	191,260	1,029,254	6.52
	115	77,707	681,700	106,811	199,913	1,066,131	6.46
	90	91,123	683,943	123,865	187,553	1,086,484	7.02
	95	91,123	706,918	125,875	198,058	1,121,974	6.86
90	100	91,123	729,755	127,181	208,564	1,156,623	6.72
	105	91,123	763,867	129,883	219,070	1,203,943	6.66
	110	91,123	797,870	131,889	229,576	1,250,458	6.60
	115	91,123	831,230	133,851	239,849	1,295,053	6.54

[a]All cost items rounded to nearest dollar.

[b]Taken from Table XI.

[c]Taken from Table VI.

[d]Taken from Table VIII.

[e]Taken from Table X.

[f]Sum of columns 2, 3, 4, and 5.

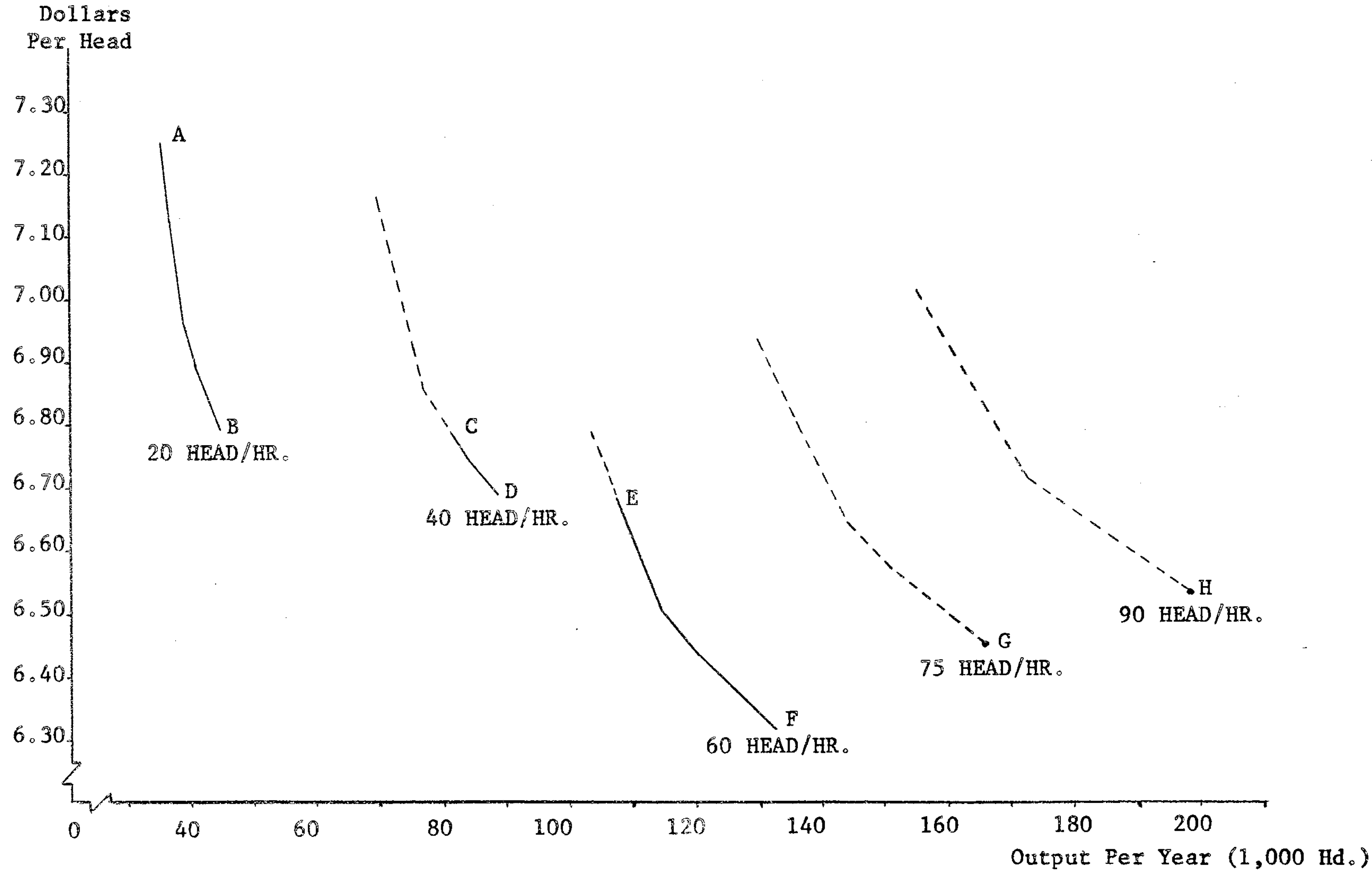

Figure 9. Short-Run and Long-Run Average Cost Curves for the Five Model Plants.

\$6.72 per head for the 90 per hour plant.

Average short-run costs decreased for each scale of plant as the output increased from 90 to 115 percent of their rated line speeds. Over the range of plants studied, the average cost decreased an average of \$.47 as plant output increased from 90 to 115 percent of rated line speed. For illustration, average cost would be reduced from \$7.25 to \$6.79 or \$0.46 per head in a 20 head per hour plant when output is increased from 90 percent to 115 percent of rated line speed. The reduction in average cost resulting from increased utilization of the fixed factors of production was least for the 20 head per hour plant. The 75 and 90 head per hour plants each showed a decrease in average cost of \$.48 per head as output increased from 90 percent to 115 percent of rated line speed, while the reduction in average cost over the operating range amounted to \$.47 for the 40 and 60 head per hour plants. For each plant, average costs declined at a slower rate as output levels were increased beyond the rated line speed, thus, producing a "kinked" relationship.

Each of the model plants attained a position of minimum average cost at 115 percent of the rated line speed, or at maximum designed cooler capacity. Since plant output was limited to the declining portion of the average cost curve by cooler capacity, the model plants are restricted to operation in Stage I of the production process.

Long-Run Average Costs

Theoretically, the long-run average cost curve is a locus of points tangent to an infinite number of short-run average cost curves. When less than an infinite number of short-run average cost curves are possible, then the minimum portions of the short-run average cost curves, as shown in Figure 4, describe the long-run average cost curve.

In the case of the model plants, the long-run average curve is described by the line segments AB, CD, EF, and points G and H in Figure 9. In the long-run, economies of scale are presented for plant sizes up to 60 head per hour. A comparsion of the minimum cost points for the 20 and 60 head per hour plants indicates economies of \$.47 per head. For the plants with rated line speeds greater than 60 head per hour and limited by cooler facilities to single shift operations, some diseconomies appear to exist. A comparison of the minimum cost points for the 60 and 90 head per hour plants indicates diseconomies of \$.22 per head.

The reduction in long-run average costs between 20 and 60 head per hour plants is the net effect of a reduction of \$.20 per head in fixed investment cost; a \$.14 per head reduction in kill floor labor cost; a \$.25 per head reduction in supporting labor cost; a \$.10 per head reduction in the combined cost of salaried personnel, taxes, and insurance; and a \$.23 per head increase in utility costs.

The apparent increase in long-run average cost between the 75 and 90 head per hour plants is the net effect of a \$.01 per head reduction in fixed investment costs; a \$.01 per head increase in kill floor labor costs; a \$.15 per head increase in supporting labor costs; and a \$.07 per head increase in utility costs.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

The objectives of this study were to: (1) estimate the average cost of constructing, equipping, and operating alternative "on-the-rail" beef slaughter plants designed for operation at rates of 20, 40, 60, 75, and 90 head per hour; (2) examine the variation in average costs of these plants at 90, 95, 100, 105, 110, and 115 percent of rated line speed; and (3) examine the relationship between average cost of dressing beef cattle and the size of plant.

The method used to estimate these costs was a modified synthetic approach; that is, the plant, equipment, labor, and other costs of the various inputs involved in the slaughtering operating were estimated separately and then combined as "building blocks" in estimating costs for the model plants. A deviation from the synthetic approach was necessary in estimating the cost of the utilities and other minor expenses. For these, the physical quantities required were estimated from accounting records obtained from plants of sizes similar to the model plants. Appropriate cost rates were combined with the quantities of physical resources to obtain the cost estimates.

In specifying the nature of the five model plants, several technologies were employed including a gravity "on-the-rail" system for the 20 head per hour plant, a powered rail system for the 40 and 60 per hour plants, and a conveyorized system for the 75 and 90 head per hour plants. These technologies were the most recent for which data were available.

Average short-run costs decreased for each scale of plant as the output increased from 90 to 115 percent of their rated line speeds. Over the range of plants studied, the average cost decreased an average of \$.47 as plant output increased from 90 to 115 percent of rated line speed. For illustration, average cost would be reduced from \$7.25 to \$6.79 or \$0.46 per head in a 20 head per hour plant when output is increased from 90 percent to 115 percent of rated line speed. The reduction in average cost resulting from increased utilization of the fixed factors of production was least for the 20 head per hour plant. The 75 and 90 head per hour plants each showed a decrease in average cost of \$.48 per head as output increased from 90 percent to 115 percent of rated line speed, while the reduction in average cost over the operating range amounted to \$.47 for the 40 and 60 head per hour plants.

Under the conditions of the study, the output of each plant is restricted, by the capacity of the coolers, to 115 percent of the rated line speed. An expansion of cooler facilities to permit employment of more than a single labor crew would increase both output and total cost. Average cost, however, may be expected to continue to decline because of greater utilization of the original plant, equipment, and fixed labor resources.

The short-run relationships derived in this study imply that the plants should be operated at maximum physical output to attain minimum cost. If output at 115 percent of rated line speed represents the maximum output possible and also the point of absolute minimum cost, then at output levels less than 115 percent of rated line speed the plant would have an incentive to import cattle to supplement local supplies. With an expansion of cooler facilities the point of minimum average cost would be expected to lie below the minimum point obtained with the original plant and equipment. Thus, given average revenues greater than average costs, output would be increased at least to the point of minimum average cost if profits are to be maximized.

In the analysis the long-run average cost curve was composed of line segments from the short-run average cost curves of the 20, 40, and 60 head per hour plants and minimum cost point of 75 and 90 head per plants. Long-run average cost decreased by $.47 per head between the 20 and 60 head per hour plants, indicating a region of economies to scale. Long-run average cost increased by $.22 per head between the 60 and 90 head per hour plants, indicating a region of diseconomies of scale. The economies which occurred between the 20 and 60 head per hour plant primarily are due to reductions in per head costs of fixed investment, kill floor labor, and supporting labor. The diseconomies which occurred between the 60 and 90 head per hour plants principally are due to increases in per head cost of supporting labor and utilities.

The results of the study indicate that the 60 head per hour plant is the most efficient of the plants designed to operate with a single shift. However, it must be re-emphasized that procurement and distribution costs were not included in the study and may materially affect the results. Also, the conclusion of the study might be altered significantly for plants designed for multiple shift operations.

Suggestions for Further Studies

The research reported in this study considered only the cost relationships associated with the in-plant operations for specialized beef slaughtering plants. The results of this research would be improved and extended if several other studies were conducted.

Knowledge concerning the long-run average cost curve would be improved considerably if an analysis of each size of plant were conducted which permitted operation with several shifts of labor. Such a study would permit more precise estimates of the economies due to scale and would shed light on the desirability and/or necessity of obtaining sufficient financial resources to construct and operate plants with multiple shifts.

Since in-plant costs constitute only a part of a slaughtering firm's operations, the in-plant costs are insufficient criteria for intelligent investment decisions. The results of this study could be extended to provide more complete information relating to investment decisions by estimating the cost relationships associated with the procurement and selling functions for each scale of plant.

In this study, changes in output were accomplished by changes in the length of the workday. Decisions regarding the optimum size of kill crew to employ at various output levels would be aided by studies of the input-output relationships for several operating levels which involve changes in the crew size.

Several other studies which would be useful to the livestock and meat industry are: (1) cost analysis of meat processing plants, (2) cost studies of full-line packing plants, (3) cost studies of breaking and boning plants, and (4) studies to determine the optimum location of each type of meat processing facility.

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A P P E N D I X E S

APPENDIX A, TABLE I

COST OF CORRAL FLOORING, FENCING, AND ROOFING

Plant Size Head Per Hour	Pens Needed[a] 10'x20'	Area in Pens[b]	Area in Alleys[c]	Total Area[d]	Cost of Pen and Alley Floor[e]	Gates[f]	Length of Fencing[g]	Cost of Gates and Fencing[h]	Area Cover by Weathertight Roof[i]	Cost of Weathertight Roof[j]	Total Cost[k]
	(Number)	(Square Feet)			(Dollars)	(Number)	(Feet)	(Dollars)	(Square Feet)	(Dollars)	(Dollars)
20	32	6,400	2,400	8,800	4,501.80	36	1,120	2,198.40	1,760	1,760.00	8,460.20
40	66	13,200	4,600	17,800	9,045.00	73	2,140	4,284.80	3,560	3,560.00	16,889.80
60	104	20,800	7,000	27,800	14,174.10	113	3,440	6,800.80	5,560	5,560.00	26,534.90
75	128	25,600	7,800	33,400	16,795.35	137	3,650	7,558.00	6,680	6,680.00	31,033.35
90	152	30,400	9,400	39,800	20,082,15	161	4,490	9,146.80	7,960	7,960.00	37,188.95

[a]Based on 11 head per pen with total capacity of approximately 2 1/2 days kill.

[b]Number of pens in Column 2, multiplied by 200 square feet.

[c]Alleys are specified to be 10 feed wide.

[d]Column 3 plus Column 4.

[e]Total area plus the linear length of fence to allow for the 12 inch curbs which separate all pens, plus 3/4 square foot per post, multiplied by $.45 per square foot.

[f]One gate is allowed for each pen, plus a number of extra ones for the alleys.

[g]Derived from pen requirements.

[h]Fencing cost estimated at $1.32 per linear foot, gates (10 foot wide) estimated at $20.00 each.

[i]One-fifth of total pen area to be covered by weathertight roof.

[j]Square feet of roof multiplied by $1.00 per square foot.

[k]Sum of Columns 6, 9, and 11.

APPENDIX B

CHILL AND HOLDING COOLERS

In estimating the refrigeration requirements for the coolers in the five model plants, it was necessary to specify several important factors involved in the design of coolers including the size, shape, orientation of the cooler, type of materials used in construction, and the daily heat load of the cooler, i.e., the number of carcasses, electric motors, men and electric lights in the coolers daily. The size, shape, and daily heat load of the coolers are specified in Appendix B, Table I. The orientation of the cooler and type of materials used in the construction of the coolers is discussed here.

The orientation of the coolers is important because of the large heat gain obtained through the west wall. In the model plants it was assumed to be possible to orient the narrow side of the chill cooler to face the west in order to minimize this heat gain. The holding cooler was specified to attach to the chill cooler on the east, thus eliminating the heat gain of the east wall of the chill cooler and the west wall of the holding cooler. The kill floor and other work areas were specified to join the coolers on the south which greatly decreases the heat gain of the south walls.

The type of materials and the thicknesses of the materials specified for the construction of the coolers and used in calculating the estimated tonnage of refrigeration presented in Appendix B, Table I are as follows:[7]

North and West walls:[8]

8" sand and gravel aggregate cement block

1/2" cement plaster

6" cork

1/2" cement plaster, smooth surface

South and East walls:

4" cement block

1/2" cement plaster

4" cork

1/2" cement plaster, smooth surface

Floor:

2" concrete slab

4" cork

4" concrete floor

Ceiling:

Asphalt roll roofing

4" concrete slab

Air space

6" cork

Asbestos cement board

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[7]Gunther, Raymond C., Refrigeration, Air Conditioning, and Cold Storage, (Philadelphia, 1957) p. 724.

[8]Materials are listed from outside to inside of wall, floor, and ceiling.

APPENDIX B, TABLE I

GENERAL COOLER SPECIFICATIONS FOR THE FIVE MODEL PLANTS

Plant Size Head Per Hour	Dimensions[a]	Cu. Ft.	Maximum Daily Heat Load: Carcasses[b]	Maximum Daily Heat Load: Electric Motors[c]	Maximum Daily Heat Load: Electric Lights[d]	Estimated Tons of Refrigeration Required[e]
Chill Coolers			Number	Horsepower	Watts per Hour	
20	45x38x13	22,230	173	15	3840	43
40	54x58x13	40,716	345	30	6480	84
60	69x68x13	60,996	518	45	9120	125
75	84x68x13	74,256	647	60	11120	157
90	90x83x13	97,110	876	75	14480	210
Holding Coolers						
20	53.5x42x13	29,211	300	5	5040	12
40	61x62x13	49,166	600	7.5	7760	22
60	76x72x13	71,136	900	10	10640	30
75	96x72x13	89,856	1126	15	14080	41
90	91x87x13	102,210	1350	20	15360	50

[a]The number of linear feet of rail space was estimated (see Appendix B, Tables II and III) and the coolers were arbitrarily shaped to allow enough area for required ~~spacing~~ of the rails.

[b]Maximum number of carcasses to be in cooler at any one time.

[c]Estimated from the equipment necessary to provide proper circulation under the peak loads.

[d]For procedure used in estimating electric light requirements, see Brown, R. H., E. E., A. E., Farm Electrification (New York, 1956), pp. 139-152.

[e]For the procedure used in estimating tons of refrigeration required see Raymond C. Gunther, Refrigeration Air Conditioning and Cold Storage, (Philadelphia, 1957), pp. 1125-1130. An alternative procedure may be found in ASHRAE Guide and Data Book 1962, Application for Heating Refrigerating Ventilating and Air Conditioning, American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., New York, pp. 341-343.

APPENDIX B, TABLE II

COST OF CHILL COOLERS

Plant Size Head/Hour	Area[a]	Exterior Wall[b]	Construction Cost of Exterior Wall[c]	Number of Floor Drains[d]	Cost of Floor Drains[e]	Number of Doors[f]	Cost of Doors[g]	Feed of Rail[h]	Cost of Rail Installed[i]	Total Cost[j]
	(Square Feet)		(Dollars)		(Dollars)		(Dollars)		(Dollars)	
20	1,710	5,084	20,336	4	96	1	546	432	2,160	23,138
40	3,132	8,422	33,688	8	192	2	1,092	862	4,310	39,282
60	4,692	12,062	48,248	12	288	2	1,092	1295	6,475	56,103
75	5,712	14,492	57,968	14	336	2	1,092	1617	8,085	67,481
90	7,470	18,359	73,436	19	456	2	1,092	2190	10,950	85,934

[a]Rail space required for one day's kill plus 15 percent excess capacity was estimated and enough area was allowed to space rails on three feet centers.

[b]Does not include wall between coolers.

[c]Column 3 times $4.00 per square feet.

[d]Approximately one floor drain per 400 square feet. Agriculture Handbook No. 191, U. S. Inspected Meat Packing Plants, Agricultural Research Service, USDA, p. 4

[e]Column 5 times $24.00 each (manufacturer's price).

[f]Number of doors assumed.

[g]Column 7 times $546.00 each (manufacturer's price).

[h]30 inches rail space per carcass, plus one foot for each switch.

[i]Column 9 times $5.00. (Estimate of rail cost installed made by contractors).

[j]Sum of columns 4, 6, 8, and 10.

APPENDIX B, TABLE III

COST OF HOLDING COOLERS

Plant Size Head/ Hour	Area[a]	Exterior Wall[b]	Construction Cost of Exterior Wall[c]	Number of Floor Drains[d]	Cost of Floor Drains[e]	Number of Doors	Cost of Doors[g]	Feet of Rail[h]	Cost of Rail Installed[i]	To- tal Cost[j]
	(Square Feet)		(Dollars)		(Dollars)		(Dollars)		(Dollars)	
20	2,247	6,483	25,932	6	144	2	1,092	600	3,000	30,168
40	3,782	9,886	39,544	9	216	2	1,092	1,200	6,000	46,852
60	5,472	13,908	55,632	14	336	2	1,092	1,800	9,000	66,060
75	6,912	16,372	65,488	17	408	2	1,092	2,250	11,250	78,238
90	7,917	19,383	77,532	20	480	2	1,092	2,700	13,500	92,604

[a]Rail space required for two days' kill was estimated and enough area was allowed to space rails on two and one-half foot centers with three feet of clearance from all walls. An alley seven feet wide for pushing offal down one side of the cooler was also included.

[b]Does not include wall between coolers.

[c]Column 3 times $4.00 per square foot.

[d]Approximately one floor drain per 400 square feet.

[e]Column 5 times $24.00 each.

[f]Number of doors assumed.

[g]Column 7 times $546.00 each.

[h]24 inches rail space per carcass.

[i]Column 9 times $5.00 per linear foot.

[j]Sum of Columns 4, 6, 8, and 10.

APPENDIX C, TABLE I

EQUIPMENT REQUIREMENTS FOR SYNTHESIZED PLANTS

Equipment	Plant Size, Head Per Hour				
	20	40	60	75	90
	(Quantity)				
Kill Floor Equipment					
Knocking pen door (revolving)	1	1	1	2	2
End gate for knocking pen	1	1	1	2	2
Electric beef hoist (7.5 hp) with automatic lander	1	1	2	2	2
Blood and water drain	1	1	1	2	2
Bleeding rail, tracking hanger	Lot	Lot	Lot	Lot	Lot
Shackle lowerator	1	1	1	1	1
Overhead bleeding conveyor system	0	0	1	1	0
Electric beef hoist (bleeding rail to dressing rail)	1	0	0	0	0
Powered cattle rail system	0	1	1	C	0
Cattle bleeding conveyor	0	0	0	0	1
Automatic shackle releasing device	0	0	0	1	1
Cattle dressing and splitting conveyor	0	0	0	1	0
Washing and shrouding conveyor	0	1	1	1	0
Brisket saw	1	1	1	1	1
Carcass splitting saw	1	1	1	1	1
Air power dehiders with regulators	7	14	14	20	20
Air shin bone saws with regulators	2	2	2	2	2
Tail puller	1	1	1	1	1
Variable speed conveyor drive for driving bleeding, skinning, dressing, spreading, and washing and shrouding conveyors and viscera inspection table	0	0	0	1	1
Beef viscera inspection table	0	1	1	1	1
Shackle return rail and hangers	0	0	0	Lot	0
Cattle head and tongue conveyor	0	0	0	1	1
Head flushing cabinet	1	1	1	1	1
Head work-up table	1	1	1	1	1
Cattle jaw puller	0	0	0	1	1
Pneudraulic cattle head splitter	0	1	1	1	1
Pluck table	1	1	0	1	1
Tongue trucks	0	0	0	3	0
Heart trucks	0	2	0	3	0
Liver trucks--99 hooks	1	0	2	3	0
Offal cooler pan trucks	0	0	0	2	0
Stainless steel sterilizing lavatories	7	10	12	16	19
Hydraulic platforms	5	0	6	2	0

APPENDIX C, TABLE I (Continued)

Equipment	Plant Size, Head Per Hour 20	40	60	75	90
	(Quantity)				
Stationary platforms	3	3	4	Lot	Lot
Saw sterilizers	2	2	2	2	2
Shroud box	1	1	1	1	1
Paunch table	1	1	1	0	0
Fatting table	0	0	0	1	0
Tripe scalder and scraper	1	1	1	0	0
Beef shackles	10	20	30	40	45
Beef trolleys	300	900	1500	1800	4000
Hydraulic leg cutter and pow-r-pak unit	0	0	0	1	0
Skip hoists	0	1	1	2	0
Track scale	1	1	1	1	1
Trolley cleaning unit	1	1	1	1	1
Cattle head trucks	2	2	2	0	0
Paunch trucks	2	0	0	0	0
Tripe inspection truck	1	2	2	0	0
Inedible Rendering Equipment					
12" prebreaker	1	1	1	1	1
Peck and entrail cutter and washer	0	1	1	0	0
12" dia. inclined screw conveyor	0	2	2	Lot	Lot
12" dia. horizontal screw conveyor	0	2	1	Lot	Lot
Inedible and blood cookers 5' x 12'	2	3	4	6	6
Crackling pan	2	1	1	1	1
Blood cooling pan	0	1	1	0	0
9" dia. inclined screw conveyor	Lot	1	1	0	0
9" dia. horizontal screw conveyor	0	1	2	0	0
6" dia. horizontal screw conveyor	0	1	1	0	0
16" dia. inclined screw conveyor	0	0	2	0	0
300 ton quick acting hydraulic press	1	1	2	0	0
Electric hydraulic pump	1	1	2	0	0
Crackling cake breaker	0	1	0	0	0
Hot well	1	1	1	1	1
Jet condensers	1	3	4	6	6
Grease pumps	1	2	0	2	2
J. B. grinder	0	1	1	1	1
Inedible paunch table with platforms and skip hoist	1	0	0	0	0
Hasher and washer	1	0	0	0	0
Grease settling tank	1	0	0	0	0
Inclined blow tank	1	0	0	2	2
Blood blow tank	1	0	0	0	0
Anderson dual expeller	0	0	0	1	1
Special crackling storage hopper	0	0	0	1	1

APPENDIX C, TABLE I (Continued)

Equipment	Plant Size, Head Per Hour 20	40	60	75	90
	(Quantity)				
Drag conveyor	0	0	1	1	1
Blood dryer 4 1/2 x 16	0	0	1	0	0
Skim tank	0	0	1	0	0
Vertical Kelly duplex feed bagger	0	0	1	0	0
By-pass assemblies for barometric condensers	0	0	1	0	0
Super silver top steam traps	0	0	1	0	0
Office Equipment					
Executives desk	1	1	1	1	1
Executives chair	1	1	1	1	1
Management desks	4	11	15	18	20
Management chairs	4	11	15	18	20
Secretaries desks	3	3	4	5	6
Secretaries chairs	3	3	4	5	6
Typewriters	3	4	5	6	7
Desk calculators	1	2	4	6	8
Adding machines	1	2	2	3	3
Check writer	1	1	1	1	1
Safe	1	1	1	1	1
Intercommunications	1	1	1	1	1
system (stations)	5	10	16	19	22
Typewriter tables	1	1	1	2	3
Duplicators	1	1	1	1	1
File cabinets	16	30	42	49	54
Guest chairs	10	18	25	30	35
Bookcases	3	6	8	10	12
Drinking fountain	1	1	1	1	2
Time clock	1	1	1	1	1
Postal scale	1	1	1	1	1
Supply cabinets	1	2	3	3	4

APPENDIX D, TABLE I

ANNUAL WAGE SCHEDULE OF HOURLY EMPLOYEES[a]

Hourly Wage Rate[b]	Vacation Pay[c]	Health & Welfare[d]	90 Percent Rated Line Speed or Below: Annual Minimum[e]	90 Percent Rated Line Speed or Below: Minimum Total Annual Wage[f]	95 Percent Rated Line Speed: Annual Wage[g]	95 Percent Rated Line Speed: Total Annual Wage[h]	Rated Line Speed: Annual Wage[i]	Rated Line Speed: Total Annual Wage[j]
				(Dollars)				
1.82	145.60	120.00	3,407.04	3,672.64	3,596.32	3,861.92	3,785.60	4,051.20
1.85	148.00	120.00	3,463.20	3,731.20	3,655.60	3,923.60	3,848.00	4,116.00
1.91	152.80	120.00	3,575.52	3,848.32	3,774.16	4,046.96	3,972.80	4,245.60
1.92	153.60	120.00	3,594.24	3,867.84	3,793.92	4,067,52	3,993.60	4,267.20
1.95	156.00	120.00	3,650.40	3,926.40	3,853.20	4,129.20	4,056.00	4,332.00
1.96	156.80	120.00	3,669.12	3,945.92	3,872.96	4,149.76	4,076.80	4,353.60
1.98	158.40	120.00	3,706.56	3,984.96	3,912.48	4,190.88	4,118.40	4,396.80
2.01	160.80	120.00	3,762.72	4,043.32	3,971.76	4,252.56	4,180.80	4,461.60
2.09	167.20	120.00	3,912.48	4,199.68	4,129.84	4,417.04	4,347.20	4,634.40
2.12	169.60	120.00	3,968.64	4,258.24	4,189.12	4,478.72	4,409.60	4,699.20
2.17	173.60	120.00	4,062.24	4,355.84	4,287.92	4,581.52	4,513.60	4,807.20
2.20	176.00	120.00	4,118.40	4,414.40	4,347.20	4,643.20	4,576.00	4,872.00
2.28	182.40	120.00	4,268.16	4,570.56	4,505.28	4,807.68	4,742.40	5,044.80
2.36	188.80	120.00	4,417.92	4,726.72	4,663.36	4,972.16	4,908.80	5,217.60
2.50	200.00	120.00	4,680.00	5,000.00	4,940.00	5,260.00	5,200.00	5,520.00

[a]Wage practices (vacation pay, holidays, health and welfare, and overtime) based on an agreement between Texas Meat Packers, Inc., and Amalgamated Meat Cutters and Butcher Workers of North America, AFL-CIO, Local No. 540.

APPENDIX D, TABLE I (Continued)

[b]Wage rates vary considerably from location to location. These rates were selected after comparing the wage rates of several plants with up-dated wage rates taken from Wage Structure Series II, No. 59.

[c]Based on two weeks' vacation with full pay (full pay based on 40-hour week).

[d]A sum of $10.00 a month or $120.00 a year per employee is paid into a trust by the employer for the purpose of providing Health and Welfare benefits to the employees.

[e]Hourly wage times 1872 hours.

[f]Sum of columns 2, 3, and 4.

[g]Hourly wage times 1976 hours.

[h]Sum of columns 2, 3, and 6.

[i]Hourly wage times 2080 hours.

[j]Sum of columns 2, 3, and 8.

APPENDIX D, TABLE I.a

ANNUAL WAGE SCHEDULE OF HOURLY EMPLOYEES

Hourly Wage Rate	Total Annual Wage[a]	Over-time Wage Rage[b]	105% Rated Line Speed: Annual Overtime[c]	105% Rated Line Speed: Annual Wage plus over-time[d]	110% Rated Line Speed: Annual Over-time[e]	110% Rated Line Speed: Annual Wage plus over-time[f]	115% Rated Line Speed: Annual Over-time[g]	115% Rated Line Speed: Annual Wage plus Over-time[h]
				(Dollars)				
1.82	4,051.20	2.73	283.92	4,335.12	567.84	4,619.04	851.76	4,902.96
1.85	4,116.00	2.78	289.12	4,405.12	578.24	4,694.24	867.36	4,983.36
1.91	4,245.60	2.87	298.48	4,544.08	596.96	4,842.56	895.44	5,141.04
1.92	4,267.20	2.88	299.52	4,566.72	599.04	4,866.24	898.56	5,165.76
1.95	4,332.00	2.93	304.72	4,636.72	609.44	4,941.44	914.16	5,246.16
1.96	4,353.60	2.94	305.76	4,659.36	611.52	4,965.12	917.28	5,270.88
1.98	4,396.80	2.97	308.88	4,705.68	617.76	5,014.56	926.64	5,323.44
2.01	4,461.60	3.02	314.08	4,765.68	628.16	5,089.76	942.24	5,403.84
2.09	4,634.40	3.14	326.56	4,960.96	653.12	5,287.52	979.68	5,614.08
2.12	4,699.20	3.18	330.72	5,029.92	661.44	5,360.64	992.16	5,691.36
2.17	4,807.20	3.26	339.04	5,146.24	678.08	5,485.28	1,017.12	5,824.32
2.20	4,872.00	3.30	343.20	5,215.20	686.40	5,558.40	1,029.60	5,901.60
2.28	5,044.80	3.42	355.68	5,400.48	711.36	5,756.16	1,067.04	6,111.84
2.36	5,217.60	3.54	368.16	5,585.76	736.32	5,953.92	1,104.48	6,322.08
2.50	5,520.00	3.75	390.00	5,910.00	780.00	6,300.00	1,170.00	6,690.00

[a]Column 9 Appendix D, Table I.

[b]Based on one and one-half times the employee's basic straight time wage. Paid for all hours over 40 hours in any one work week.

[c]Overtime hourly wage times 104 hours.

[d]Sum of columns 2 and 4.

APPENDIX D, TABLE I.a (Continued)

[e]Overtime hourly wage times 208 hours.

[f]Sum of columns 2 and 6.

[g]Overtime hourly wage times 312 hours.

[h]Sum of columns 2 and 8.

APPENDIX D, TABLE II

SYNTHESIZED SALARIED PERSONNEL REQUIREMENTS AND ANNUAL PERSONNEL COSTS OF THE FIVE MODEL PLANTS

Position	Item	Output per Hour 20	40	60	75	90
		(Number of Head)				
General Manager	Wage	9,500	11,500	14,500	17,500	25,000
	Number	(1)	(1)	(1)	(1)	(1)
Senior Buyer	Wage	--	9,000	9,000	11,500	11,500
	Number	--	(1)	(1)	(1)	(1)
Sales Manager	Wage	--	9,000	9,000	11,500	11,500
	Number	--	(1)	(1)	(1)	(1)
Plant Superintendent	Wage	--	7,500	9,000	11,500	11,500
	Number	--	(1)	(1)	(1)	(1)
Assistant Plant Superintendent	Wage	--	--	5,200	5,600	6,000
	Number	--	--	(1)	(1)	(1)
Buyers	Wage	7,500	7,500	7,500	8,500	8,500
	Number	(2)	(3)	(5)	(6)	(7)
Sellers	Wage	7,500	7,500	7,500	8,500	8,500
	Number	(2)	(3)	(5)	(6)	(7)
Officer Manager	Wage	--	9,000	9,000	11,500	11,500
	Number	--	(1)	(1)	(1)	(1)
Switch Board	Wage	--	3,000	3,000	3,000	3,000
	Number	--	(1)	(1)	(1)	(1)
Secretary	Wage	3,000	3,000	3,600	3,600	3,600
	Number	(1)	(1)	(2)	(2)	(3)
Bookkeeper	Wage	6,000	6,000	6,000	6,000	6,000
	Number	(1)	(1)	(1)	(2)	(2)
Payroll and Billing Clerk	Wage	3,600	3,600	3,600	3,600	3,600
	Number	(1)	(1)	(1)	(1)	(1)
Total	Wage	52,100	106,600	150,500	196,900	226,000
	Number	(8)	(15)	(21)	(24)	(27)

APPENDIX D, TABLE III

SYNTHESIZED KILL FLOOR CREWS AND ANNUAL LABOR COSTS FOR THE FIVE MODEL PLANTS

Operation	Hourly Wages (Dollars)	Output per Hour, in Number of Head: 20 — Number of Workers[a]	20 — Annual Cost Per Worker[b] (Dollars)	40 — Number of Workers[a]	40 — Annual Cost Per Worker[b] (Dollars)	60 — Number of Workers[a]	60 — Annual Cost Per Worker[b] (Dollars)	75 — Number of Workers[a]	75 — Annual Cost Per Worker[b] (Dollars)	90 — Number of Workers[a]	90 — Annual Cost Per Worker[b] (Dollars)
Kill Floor Labor											
Drive	1.85			1	4,116.00	1	4,116.00	1	4,116.00	1	4,116.00
Pen	1.85					1	4,353.60	1	4,353.60	1	4,353.60
Knock	1.96	1	4,634.40								
Shackle & Hoist	1.95			1	4,634.40	1	4,332.00	2	4,332.00	2	4,332.00
Sticking	2.09					2	4,634.40	3	4,634.40	4	4,634.40
Scalping	2.09	1 (1)	4,634.40	2 (1)	4,634.40						
Remove Right Hind Leg	1.98					1	4,396.80	1	4,396.80	2	4,396.80
Open Right Butt	1.98					1	4,396.80	1	4,396.80	1	4,396.80
Transfer	1.98	2 (2)		2	4,396.80			1	4,396.80	1	4,396.80
Remove Left Hind Leg	1.98					1	4,396.80	1	4,396.80	1	4,396.80
Open Left Butt	1.98					1	4,396.80	1	4,396.80	1	4,396.80
Remove Front Legs	1.98	1 (1)		2 (1)		1	4,396.80	2	4,396.80	2	4,396.80
Rim Over	2.20			1 (2)	4,872.00	2	4,872.00			3	4,872.00
Open shanks, Clear out	2.20	1 (3)	4,872.00					3	4,872.00		
Skin pit of shanks	2.20			2 (3)		1	4,872.00			3	4,872.00
Clear Rosette	2.12							1	4,699.20		
Clear Flanks	2.12	2 (2)	4,699.20	1	4,699.20	1	4,699.20	1	4,699.20	1	4,699.20
Open Aitch Bone	2.12									1	4,699.20
Rump	2.28			1(4)	5,044.80			1	5,044.80	1	5,044.80
Drop Bungs	2.12			1 (5)	4,872.00	2	5,044.80	1	4,872.00	1	4,699.20
Open & Pull Tails	2.20	1	5,044.80	1 (4)						1	4,872.00
Pull Hide	2.20			1	4,872.00	1 (1)	4,872.00				
Pull Fells	2.20			1 (5)		1 (2)		1	4,872.00	2 (1)	5,217.60
Saw Brisket	1.92	1 (3)		1 (2)		1 (1)					
Back	2.36	1 (4)	5,217.60	2 (3)	5,217.60	1 (2)	5,217.60	2	5,217.60	2(1) 1(2)	5,217.60
Drop Hides	2.17									1 (2)	
Eviscerate	2.01	1(5)	4,461.60	1(6)	4,461.60	2	4,461.60	2	4,461.60	3	4,461.60
Saw or Split Carcass	2.50	1	5,520.00	1	5,520.00	2	5,520.00	2	5,520.00	2	5,520.00

APPENDIX D, TABLE III (Continued)

Operation	Hourly Wages	20 Number of Workers[a]	20 Annual Cost Per Worker[b]	40 Number of Workers[a]	40 Annual Cost Per Worker[b]	60 Number of Workers[a]	60 Annual Cost Per Worker[b]	75 Number of Workers[a]	75 Annual Cost Per Worker[b]	90 Number of Workers[a]	90 Annual Cost Per Worker[b]
	Output per Hour, in Number of Head										
	(Dollars)		(Dollars)		(Dollars)		(Dollars)		(Dollars)		(Dollars)
Kill Floor Labor											
Trim Bruises	1.95	1(4)		1(6)1(7)		2	4,332.00	3	4,332.00	3	4,332.00
Scribe & trim neck	1.92	1(5)		1(7)	4,332.00						
Scale	1.92	1(6)	4,267.20			1	4,267.20	1	4,267.20	1	4,267.20
High Wash	1.82					1	4,051.20	1	4,051.20	2	4,051.20
Low Wash	1.82	1	4,245.60			1	4,051.20	1	4,051.20	1	4,051.20
High Shroud	1.91			3	4,245.60	1	4,245.60	1	4,245.60	1	4,245.60
Low Shroud	1.91	1(6)				1	4,245.60	1	4,245.60	2	4,245.60
Push into Cooler	1.85					2	4,116.00	2	4,116.00	2	4,116.00
TOTAL		11	52,296.00	19	88,658.40	31	141,268.80	38	173,104.80	47	214,555.20

[a]Similar figures in parentheses indicate that the operations are being performed by the same man or men.

[b]The worker will always be paid the wage rate of the highest skill he is performing.

Source: Labor requirements were taken from specifications supplied by Allbright-Nell Co., Chicago, and selected slaughter plants in the Southwest. These were used to synthesize the kill floor crews with the help of Donald R. Hammons, Industrial Research Engineer, of the Handling and Facilities Research Branch, Transportation and Facilities Research Division, Agricultural Marketing Service, U. S. Department of Agriculture.

APPENDIX D, TABLE IV

SYNTHESIZED CREWS AND ANNUAL LABOR COSTS FOR THE SUPPORTING OPERATIONS IN THE FIVE MODEL PLANTS

		Output per Hour, in Number of Head									
		20		40		60		75		90	
Operation	Hourly Wages (Dollars)	Number of Workers[a]	Annual Cost Per Worker[b] (Dollars)	Number of Workers[a]	Annual Cost Per Worker[b] (Dollars)	Number of Workers[a]	Annual Cost Per Worker[b] (Dollars)	Number of Workers[a]	Annual Cost Per Worker[b] (Dollars)	Number of Workers[a]	Annual Cost Per Worker[b] (Dollars)
Hot Offal Labor											
Foreman[c]	2.28			1	5,044.80	1	5,044.80	1	5,044.80	2	5,044.80
Separate, open & flush paunches	1.95	1	5,044.80								4,332.00
Bone heads, save brains	1.95			1	4,332.00	3	4,332.00	3	4,332.00	3	4,332.00
Trim plucks, hang offal	1.95	1	4,332.00	1	4,332.00			2	4,332.00	3	4,332.00
Wash hang, brand edible offal, inedible trucks	1.95			1	4,332.00	1	4,332.00	1	4,332.00	1	4,332.00
Cold Offal Labor											
Foreman[c]	2.28		5,044.80	1(1)	5,044.80	1	5,044.80	1	5,044.80	2	5,044.80
Truck edible offal, trim tongues spread offal to chill, assist inedible trucker	1.95	2(1)	4,332.00								4,332.00
Pack offal	1.95			2	4,332.00	3	4,332.00	5	4,332.00	6	4,332.00
Assemble local orders, load trucks	1.95	1	4,332.00	2	4,332.00	3	4,332.00	4	4,332.00	4	4,332.00
Wash barrels, hook trucks, Tub trucks, shelf trucks, & buckets	1.95	2(1)		1(1)		1	4,332.00	1	4,332.00	1	4,332.00
Cooler Labor											
Foreman[c]	2.28	1	5,044.80	1	5,044.80	1	5,044.80	1	5,044.80	1	5,044.80
Remove shrouds, push carcasses	1.95			3	4,332.00	3	4,332.00	4	4,332.00	6	4,332.00
Dock Labor											
Foreman[c]	2.28			1	5,044.80	1	5,044.80	1	5,044.80	2	5,044.80
Roll beef, hook cars and trucks	1.95	1	5,044.80								4,332.00
Push to scale	1.95			1	4,332.00	1	4,332.00	1	4,332.00	2	4,332.00
Scale	1.95			1	4,332.00	1	4,332.00	1	4,332.00	1	4,332.00

APPENDIX D, TABLE IV (Continued)

		Output per Hour, in Number of Head									
		20		40		60				90	
Operation	Hourly Wages	Number of Workers[a]	Annual Cost Per Worker[b]	Number of Workers[a]	Annual Cost Per Worker[b]	Number of Workers[a]	Annual Cost Per Worker[b]	Number of Workers[a]	Annual Cost Per Worker[b]	Number of Workers[a]	Annual Cost Per Worker[b]
	(Dollars)		(Dollars)		(Dollars)		(Dollars)		(Dollars)		(Dollars)
Dock pusher	1,95										
Luggers	1.95	3	4,332.00	6	4,332.00	6	4,332.00	8	4,332.00	10	4,332.00
Rendering Labor											
Foreman[c]	2.28	1	5,044.80	1	5,044.80	1	5,044.80	1	5,044.80	1	5,044.80
Helper	1.92			1	4,267.20	1	4,267.20	2	4,267.20	2	4,267.20
Maintenance Labor											
Foreman[c]	2.36	1	5,217.60	1	5,217.60	1	5,217.60	1	5,217.60	1	5,217.60
Helper	2.17			1	4,807.20	2	4,807.20	3	4,807.20	4	4,807.20
TOTAL		12	56,433.60	26	117,492.00	31	139,627.20	41	183,357.60	52	231,484.80

[a]Similar figures in parentheses indicate that the operations are being performed by the same man or men.

[b]The worker will always be paid the wage rate of the highest skill he is performing.

[c]The operations performed by the foreman were arbitrarily designated, since they would vary greatly in actual plants.

Source: Labor requirements were taken from specifications supplied by Allbright-Nell Co., Chicago, and selected slaughter plants in the Southwest. These were used to synthesize the kill floor crews with the help of Donald R. Hammons, Industrial Research Engineer, of the Handling and Facilities Research Branch, Transportation and Facilities Research Division, Agricultural Marketing Service, U. S. Department of Agriculture.

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