Cost Structures of Pork Slaughter and Processing Firms: Behavioral and Performance Implications

by

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ABSTRACT: The cost structure of pork slaughter and processing plants and firms has significant behavioral and competitive implications. A survey of selected large slaughter and processing firms probed into fixed and variable costs for single and double shift plants, and capacity utilization and multiplant effects on cost levels. Behavioral implications are considered.

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The pork slaughter and processing industry is rapidly becoming more concentrated. Packers are more closely linked to producers via production and marketing contracts or vertical integration into hog production. The USDA reports that the number of plants with over a half million dollars in sales fell 42 percent from 1984 to 1994. The top four firms accounted for 34 percent of hog slaughter volume in 1980, rising to 48 percent in 1994. The share held by the largest firms has climbed more since then as IBP and Smithfield, the two largest firms, have expanded their plant numbers or size, and corresponding market shares. In 1976, the number of plants slaughtering one million hogs per year accounted for less than 28 percent of U.S. slaughter; it rose to 87 percent in 1994 (USDA). The slaughter and processing industry is populated by smaller number of firms, but an increasing number of multiplant companies. Double shift plants processing 12-17 thousand hogs per day are commonplace, and the largest plant now processes over 26 thousand head per day. Costs of slaughtering and processing livestock are seldom analyzed by economists. Yet costs are important considerations in a number of issues in the livestock industry. These include market power and profitability links with economies

of size, farm-wholesale-retail margins, short term market price behavior, competitive advantage among competing firms and countries, and the standards to be able to meet or beat if entry into the packing industry is being contemplated. In addition, cost structures for packers may be a contributing factor to their stronger linkages with hog producers, or their entry into hog production enterprises.

While some aspects of the cost structure of the beef packing industry have been the focus of economic studies in recent years, the cost structure of the pork slaughter and processing industry has received very little attention. The U.S. pork packing industry is perceived to be much more efficient than slaughter and processing industries in many competing countries (because of the larger number of animals handled per hour and lower relative labor costs per hour in the U.S.), but this has not been confirmed. In this paper, the results of a survey of eight large pork packers are reported, and factors influencing cost structures are described. This should provide some useful insights into one factor influencing dynamic competitive behavior among firms in acquiring hogs, and changing industry structure and coordination systems.

Previous Research

Little research on pork processing costs has been published. Melton and Huffman recently analyzed costs for beef and pork packers derived from American Meat Institute surveys of their members during 1963-1988, and concluded that the real costs of pork

processing had changed dramatically , and were less than half their peak 1971 levels in 1988 (at $.12-13 per pound slaughter weight, in 1980 dollars).

The beef packing industry has had more attention. Kambhampaty, et al. analyzed short term beef packer variable costs and conduct, and concluded that plants were not short term profit maximizers. Sersland's study of beef packing economies of size involved surveys of managers asking their estimates of average cost changes under specified changes in plant size and capacity utilization (summarized in Ward, 1988). They found double shift plants were lower cost per unit than single shift plants, and costs declined as capacity increased and capacity utilization increased. But they found adding an extra day of operation reduced costs for large plants, but not small ones. The USDA Economic Research Service has modeled beef packing and processing plants, providing a computer-assisted cost analysis tool. Earlier studies by Logan and King and Cothern in the 1960s and 1970s found economies of size in beef slaughter plants on the West Coast.

Pork Industry Trends

The pork sector continues to exhibit substantial seasonal and cyclical fluctuations in production, despite increasing concentration of production in the hands of fewer, larger hog producers. Five percent of all hog producers had 51 percent of the inventory in 1996, and those with over 2,000 sows now produce over 20 percent of the hogs. From 1984-94, the number of plants involved in hog slaughter has continued to decline (from 439 to 254). Industry capacity has increased as many plants were transformed from single to double

shift plants, and operating rates per hour have gradually increased to spread the fixed cost of plant and equipment over more output. More value-added processing has been an aspiration of virtually all pork slaughter firms in the last 20 years, as that is perceived to be more profitable than selling fresh “commodity products”. Further processing (especially closer trimming of external fat, and deboning operations for retail, food service and export customers) is very labor intensive. In addition, the average weight of slaughter hogs has been increasing steadily in the last 20 years, as processors recognized that the genetic improvements in hogs led to much less low-value fat per pig, and the labor and other out of pocket costs involved in slaughtering and processing an animal did not change significantly if the animal was 10 or 20 pounds heavier. Short term market price variability remains quite high, with strong seasonal patterns. Packers have been dramatically increasing their use of long term contracts with hog suppliers in the last decade, and several packers are producing part or all of their own hog supply. Consistency of supply and increased volume of hogs supplied to plants are among the top three reasons most frequently cited for packers’ use of long term marketing contracts or production contracts (Lawrence, et al.). The cost structures in the pork slaughter and processing industry are likely to have a strong influence on the growth of larger plants and larger firms, short term packer procurement strategy, market price behavior, and the shift away from the spot market as the primary coordination mechanism linking producers and packers.

Survey Procedures

In this paper, the focus is on cross sectional estimates of current slaughtering and processing costs. In late 1996 and early 1997, personal interviews were conducted with managers of eight firms responsible for over 70 percent of industry slaughter volume, including the six largest firms and two firms with the newest plants. While these data are usually considered highly proprietary, their own costs were directly provided in most cases; in others, their own costs served as reference points for their estimates of representative industry cost structures. Since many plants are now double shift plants, managers were asked to estimate typical costs in plants operating either one or two shifts near sustainable full capacity (approximately 95% of rated capacity) at the approximately 1000 head per hour rate typical in the industry today (or their own operating rate).

Fixed costs were typically defined narrowly as plant and equipment costs amortized over their useful economic life, plus interest on that investment, and any other related costs (e.g. property tax, insurance , etc.). Variable costs were defined as all other costs associated with operating a pork slaughter and processing plant, <u>except</u> the cost of the market hog, including shared administrative costs from corporate headquarters in multiplant firms. The extent of processing built into their cost estimates was either what the firms actually did recently, if they supplied their own costs, or what they considered typical in the industry if they were estimating representative cost levels. Accounting practices and the functions performed and included in the plant variable costs will vary somewhat across firms. Individual firm or manager estimates are not disclosed to

preserve confidentiality. Some additional questions to a few respondents probed the cost impacts of additional plants under common centralized management, and short run cost structures. Subsequently, all survey respondents were given an opportunity to point out errors of interpretation or measurement.

Survey Results

Pork slaughter and processing costs are incurred in several stages. First, the slaughter occurs followed by evisceration and the initial separating the split carcass into several untrimmed primal cuts. This is followed by further processing of fresh wholesale cuts into closely trimmed or boneless primal cuts. These may be transformed into cured, sliced, or ground product, closely trimmed bone-in products (like pork chops), or boneless products for food service, retail or export customers. These products are cut according to customer or packer specifications, sometimes vacuum packed to enhance shelf life, and shipped to the customer. Typically, in the largest firms sampled, approximately 50% of fresh bone-in product like loins and hams are being deboned, most bone-in loins and butts are being further trimmed, and a majority of bellies are skinned within the plant where the hogs are initially slaughtered, though the extent of further processing varies widely by plant and company.

Variable Costs

The focus on costs in this paper is on the costs other than livestock costs. Livestock costs will vary cyclically and seasonally, averaging around 70 percent of all costs. We focus on the other variable costs per hog processed for single shift and double shift plants, which often did not vary much for firms with both types of plants. Where differences were noted, the two shift plants were lower due to less than proportional increases in administrative costs (e.g. corporate headquarters top management and some staff changed slightly, but still only one plant manager required) in moving from one to two shifts. For all respondents, the extreme range in variable cost estimates was from $16-32 per animal processed for plants involved in the typical range of pork slaughter and processing functions. The typical single shift costs were mostly in the $20-25 range compared to $16-25 for double shift plants (Table 1). Most two shift estimates were near $20, while the single shift estimates averaged $22 per head. These estimates included all

Table 1. Pork slaughter and processing costs 1996-97

	Variable costs, $ per head	Fixed costs, $ per head
Single shift		
Average	22	6
Range	20-25	3-10
Double shift		
Average	20	3
Range	16-25	1-6

in-plant costs and allocation of administrative costs from corporate headquarters in multiplant operations. Technology differences do not appear to be the basis for the cost differences between single and double shift plants, as some of the newest plants were single shift. A stylistic graphical representation of the variable cost structure is shown in Figure 1.

The biggest variable cost differences among plants were usually attributable to the extent of further processing and fabrication of pork products in a plant -- more deboning and further processing involves much higher labor costs. Labor costs typically comprise approximately 50 percent of in-plant and administrative costs, with approximately 50-60 percent of those labor costs for production workers in the plant. Further processing adds significantly to variable costs; deboning 50 percent of hams, loins and shoulders was estimated to cost about $3-5 per head, primarily incremental labor costs. Labor costs per animal also vary related to the degree of automation (increasing automation increases fixed costs, and reduces variable costs), experience level and turnover rate of the labor force (acquiring and keeping a quality labor force is a significant and increasing problem for plant management), and wage and fringe benefit levels. Base wages are now in the $6-10 per hour range for plant production workers, plus fringe benefits, substantially lower than the peak wages paid historically ($9 per hour average wages in meat packing plants in 1982, plus higher fringe benefits).

While less influential, packaging is another significant cost factor, comprising approximately 10 percent of variable costs in the mid-1990s. Cryovac or similar vacuum

packaging of most pork products can cost $1.50-2.00 per head.

Fixed Costs

Annual amortization rates of fixed costs per head differ for one and two shift plants, and at varying capacity utilization rates. Estimates of fixed costs per animal for single shift plants operating near full capacity ranged from $3-10 per head, while double shift plant fixed cost estimates ranged from $1-6 per head. Average fixed cost figures varied widely, as expected. The plants covered in the survey varied from new ones with varying degrees of financial assistance from local economic development authorities, to plants which had been closed, then bought at very low cost relative to building a new plant, and refurbished extensively, often with assistance from local or state agencies. Mean estimates were $6 per head for single shift plants, $3 for double shift plants. Replacement costs sometimes would be higher than the fixed cost estimates provided here.

One industry expert suggested that adding a double shift usually would add 20 percent to building and equipment costs (for extra cooler capacity, etc.), but volume would increase approximately 95 percent. This would suggest that double shift fixed costs are approximately 60 percent of single shift costs per head processed (close to the survey results). A graphical depiction of fixed cost differences in single and double shift plants is shown in Figure 2.

Capacity Utilization

Fixed costs per head for plant and equipment will also vary dramatically in direct relation to the percent of capacity utilization. The pork sector exhibits both significant seasonal and cyclical variation in hog production and slaughter, and typically has excess capacity even at times of peak industry slaughter (although the practical capacity limit temporarily was reached in late 1994).

Because pork packers typically guarantee to pay their unionized plant labor force for 32 or 36 hours work per week, this cost is essentially fixed in the short run once a plant begins operating in a week. Even if union contracts did not require this, several packers considered it highly likely that they would lose production workers if they provided less than 32 or 36 hours pay for a week or two. This would lead to significant costs of finding and training replacement workers which might offset any savings from lower plant labor costs achieved by operating fewer days per week in the short run. In addition, plants require janitorial and maintenance services, electricity for lights and coolers, sales people, accounting clerks, and quality control labs; these costs often change very little with incremental volume changes in the short run. Approximately 60-70 percent of what are variable costs in the medium run are essentially fixed within the first 32-36 hours of operations in a week. These short run costs are depicted in Figure 3.

When the number of hogs purchased is below the number necessary to fully employ their workers for the guaranteed hours, packers often are more willing to bid

significantly higher prices to increase their capacity and labor force utilization. The marginal costs of purchasing, slaughtering and processing additional animals, even at sharply higher purchase prices, can still be lower than the expected prices for the end products. Packers bidding higher prices to more fully utilize fixed labor commitments can optimize profitability in the short run, with revenues covering all marginal costs and part of the fixed cost in the short run. In so doing, they also maintain long term customer and supplier relationships, and reduce labor force turnover.

Since industry capacity has to be large enough to handle seasonal and cyclical peaks of production, this is not unusual behavior in the meat packing industry. Market prices sometimes surge when hog supplies are less than expected in mid-week[1], and extended periods of poor returns for packers are symptoms of the frequent periods of excess capacity and the marginal cost structure found in this industry.

After the volume necessary to satisfy in-plant labor guarantees is reached, the marginal cost of in-plant labor ratchets up sharply for higher volumes of hogs processed. When livestock numbers are quite large, running a plant on Saturdays usually involves overtime time and a half wage rates for hourly production workers. In Figure 3, this is the reason for the ratcheting up of marginal costs shown for Saturday operations. Some

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[1]An examination of short term changes in 1990-96 USDA reported hog prices indicates that daily price changes of $1 per cwt. or more occurred over 10 percent of the time, and two day price changes over $1 per cwt. occurred over 18 percent of the time (average prices were $47).

managers indicate that the incremental increase in variable cost per head on Saturday is approximately equivalent to the reduction in fixed cost per head associated with the larger volume processed.

When hog supplies are low, firms have to choose among bidding higher prices for a larger share of the hogs, closing one shift at double shift plants, or closing an entire plant and shipping some hogs longer distances to their other plants. These tradeoffs are part of the daily calculus in complex operations management in the pork sector. Temporary shut downs or plant closings happen under conditions of financial duress which often occur when inadequate supplies of hogs occur seasonally and cyclically, with higher cost plants feeling more pain more quickly, or when major necessary capital expenditures cannot be justified. The plants and firms with the most variable sources of hog supplies are most vulnerable in the low volume stage of the hog cycle, especially in fringe areas of hog production. The growth in production contracts, self production or long term contracts has been much faster in areas like North Carolina and Oklahoma, where uncertain hog supplies have a much greater opportunity cost than in the Midwest. But long term marketing contracts with producers are rapidly increasing in the Midwest now, in competitive response to some packers locking up high quality hogs and high volume producers via marketing contracts, which forces other packers bear more of the brunt of cyclical and seasonal supply downturns if they do not follow similar purchasing strategies.

Multiplant Incremental Costs

If you add another plant to an existing operation, the primary factors which usually do not change are the number of top executives at corporate headquarters (CEO, CFO, Director of Operations, Director of Quality Control, etc.). Activities and related expenses which may not change proportionately with the volume increase include accounting, sales and marketing, research, and advertising and promotion. Intangible items like quality control and operational procedures, computer programs, etc., are readily transferrable to a new plant at a small incremental cost relative to the cost of developing them in the first place. In addition, building and energy costs for administrative support staff will not change proportionately. Variable costs per animal which might rise include transport costs for inputs and output in some situations if customers or suppliers are more distant, or prices paid for animals if competition is more fierce in the new location. Building and equipment and "approval" costs by regulators and local authorities may go up if the most desirable sites are already taken. Labor costs per unit may rise temporarily until the labor force acquisition and training phase is completed, and productivity reaches the level of existing plants. Acquiring an ongoing plant operation avoids many of these start up costs, though the purchase price likely will be higher to reflect that. The extent to which fixed and variable costs per head for a firm will drop as plants increase depends on the number of plants already in operation, the extent of unutilized capacity in the administrative and staff functions, and the how many initial start up costs are avoided. Adding a plant to a firm with two or three plants would reduce variable costs for each plant by approximately

$1 per head, while adding a plant to a single plant firm would reduce costs slightly more than that. This is clearly an incentive to continue increasing the size of firms in the pork slaughter and processing industry.

Other Size Influences

As plant and firm volume increase, the ability of these operations to serve the largest volume export and domestic customers is enhanced. There is a larger population of hogs from which to select products to meet demanding customer specifications, and provide high volumes with fewer transaction costs. Having more plants reduces the risk of supply interruptions for the customer, as a storm, strike or fire at one plant can be offset by volume changes at other plants. Increased research and development becomes more feasible, and advertising and promotion costs per unit decline. More further processing or byproduct salvage operations become feasible with larger volume at a plant. However, transport costs may rise to serve more distant locations, additional sites may be more difficult to purchase and get approved for use as a meat packing plant, etc. But once a site is found and approved, doubling volumes by double-shifting a plant is much less expensive than building another at a different site, if inadequate hog production density or labor supply, and low cost, excess competitive slaughter capacity in the area do not make expansion prohibitive.

Summary and Implications

The expansion in slaughter plant size, firm size and concentration, and stronger vertical coordination linkages between packer and producer in the pork sector in the last 20 years has been dramatic. Personal interviews of managers of the six largest firms and those firms with the newest plants (eight firms accounting for 70 percent of industry volume) offers some useful insights into the influence of cost structures in these developments.

For all respondents, the range in variable cost estimates was from $16-32 per head for plants involved in the typical range of pork slaughter and processing activities. Most two shift estimates were near $20, while the single shift estimates averaged $22 per head. Labor costs typically comprise approximately 50 percent of in-plant and overhead costs. An important variable cost difference among plants was the extent of further processing and fabrication of pork products in a plant--more deboning and further processing involves much higher labor costs.

Mean estimates of fixed plant and equipment costs were $6 per head for single shift, $3 for double shift plants. Consequently, there is a clear rationale for double shift plants where other factors do not offset these economies of size.

Capacity utilization rates can have a significant effect on costs per head and pricing behavior in the market for hogs. Approximately 60-70 percent of variable costs in the

medium run are essentially fixed within the first four days of the week. When the number of hogs purchased is below 80-90 percent of plant capacity, packers often are more willing to bid significantly higher prices for hogs, since the marginal costs of killing and processing them are quite low relative to expected prices for the end products. Since packer capacity has to be large enough to handle the seasonal and cyclical peaks of hog production, this leads to occasional periods when packers' hog procurement behavior appears to be destructive competition, with bid prices surging and farm-wholesale margins dropping sharply. This also is a significant incentive for vertical integration into hog production or long term supply contracts with hog producers, to reduce a packer's susceptibility to the seasonal and cyclical vagaries of spot market hog supplies.

If you add another plant to an existing operation, costs of administrative overhead typically increase less than volume increases, though the cost impact will vary depending on the number of plants and the extent of unutilized capacity in the administrative and staff functions. Costs do decline as volume and market shares of the largest firms increase, though market concentration and potential market power also may increase. However, the excess capacity usually found in this industry, in combination with the small marginal costs of processing more hogs in that environment, provides a strong incentive to each firm to bid a larger share of hogs available away from its competitors. For firms slaughtering and processing hogs into relatively undifferentiated fresh wholesale pork products, and into processed products in which few firms have successfully differentiated a large proportion of their products, this makes it very difficult to consistently reap high

profit levels.

In conclusion, the cost structures outlined here are significant influences to the changing structure and coordination systems employed in the pork sector. Increased market concentration seems likely in response to the economies of size, both within plants and in multiplant operations. Stronger long term vertical linkages between packer and hog producer (or vertical integration) will continue to increase in importance to reduce quality and quantity risks which are quite costly to packers. Overall efficiency is likely to be enhanced, but market power issues will become more frequently raised if current trends continue.

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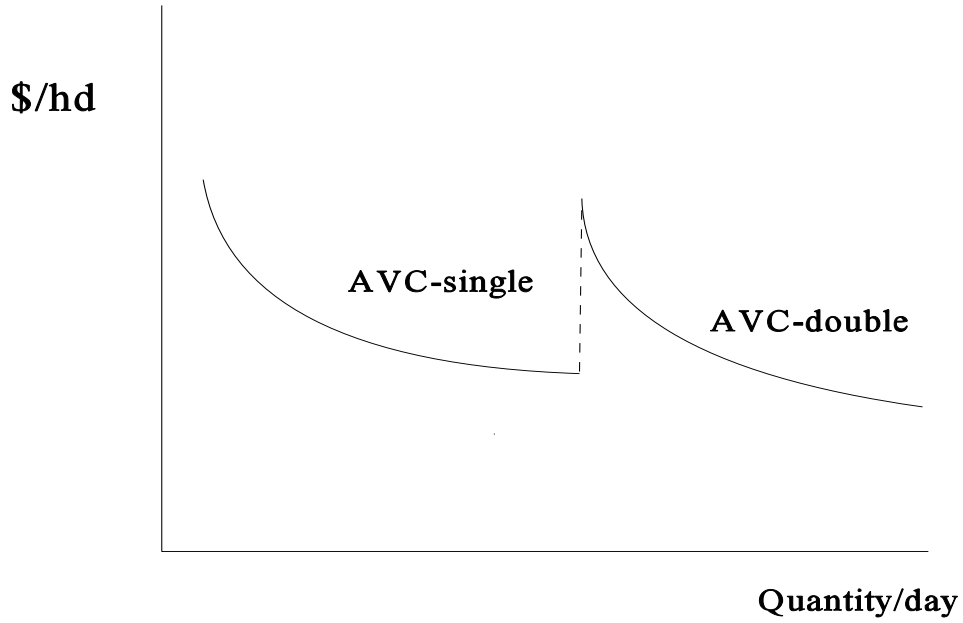

FIGURE 1. Medium Run Average Variable Costs - Single and Double Shifts

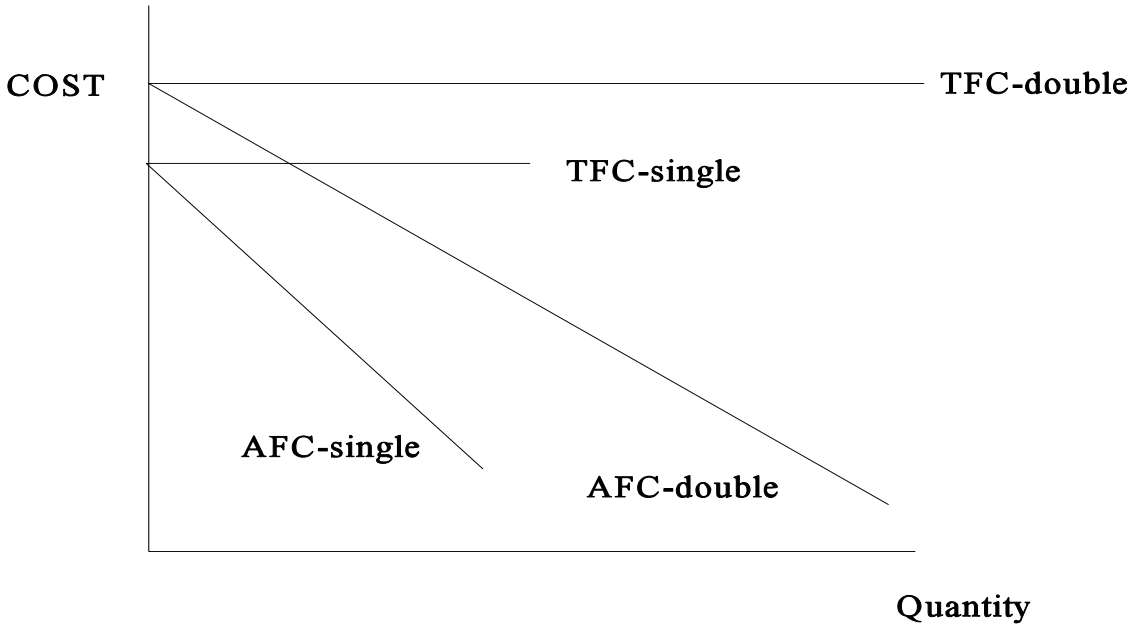

FIGURE 2. Fixed Cost Structure -
Single vs. Double Shift

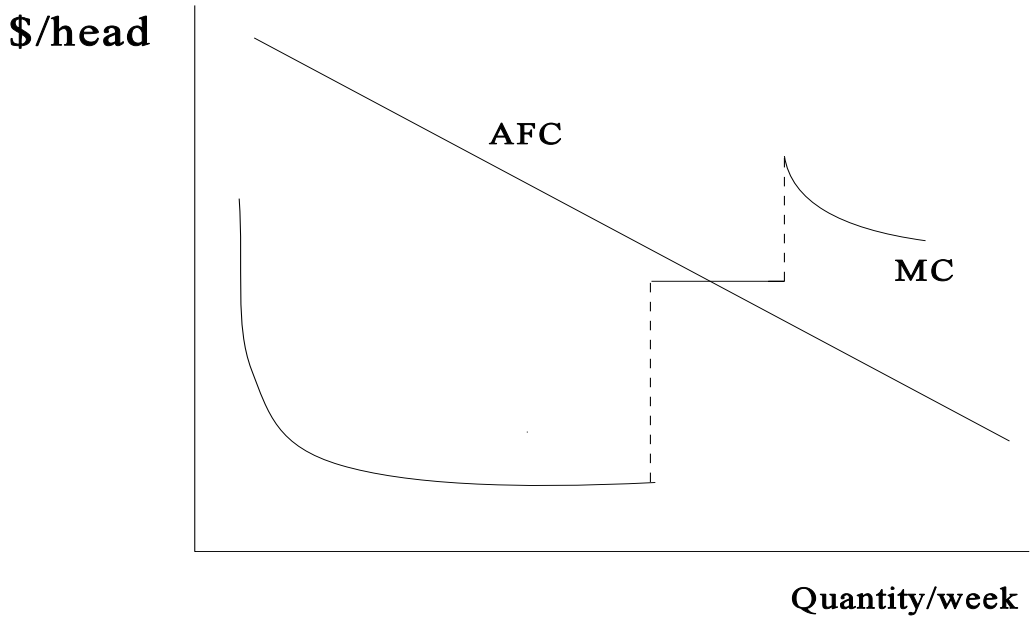

FIGURE 3. Weekly Short Run Fixed and Marginal Costs