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# Relationships Between Market Price Signals and Production Management: The Case of Fed Beef

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ABSTRACT

The beef industry in the United States consists of several distinct production levels ranging from the cow-calf producer at the lowest level to the final consumer. These sectors face varying levels of profitability, degrees of market power, conflicting goals, and price signals. Environmental regulations involve questions of what costs are involved, who is in a position to pay these costs, and whether market prices are capable of signaling different environmental practices. Understanding the relationships within the beef industry may allow researchers to fine-tune analyses of environmental issues in the beef industry.

**Key Words:** beef, BMP, cattle, environment, pricing.

The beef industry in the United States consists of several distinct production levels ranging from the cow-calf producer at the lowest level to the final consumer. Each of these levels has varying degrees of market power. The degree of market power has a substantial influence on the ability or, in some cases, the inability of the players in the different production levels to adopt and use alternative production management practices. Simply put, some producers may not be in a sound enough financial position to adopt alternative management practices, or the market price does not clearly signal the desires of players at the higher production levels. While the title of this paper indicates that fed beef will be the focus, the authors have chosen to broaden the discussion to the entire beef production sector. This paper will focus on the relationships between market power and price signals and the incentives or disincentives that are created for environmental stewardship for cow-calf producers, backgrounding or stocker operations, and feedlots.

Several types of pollution are caused by agriculture (e.g., water, air, etc.). For simplicity, this discussion will focus on water pollution. Agriculture is the leading source of water pollution in the United States [National Research Council (NRC); U.S. Environmental Protection Agency (U.S. EPA) 1993]. In recent years, animal agriculture has been targeted as a major source of pollution of rivers, lakes, and aquifers (U.S. EPA 1992). For example, animal agriculture is responsible for 13% of the impairments to rivers; this figure is higher than impairments from either industrial sources or storm sewers, at 9% and 11%, respectively (U.S. EPA 1993).

Livestock pollution has generally been controlled by utilizing appropriate best management practices (BMPs). Both unconfined or range/pasture management representative of cow-calf and stocker operations, and confined

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management representative of feedlots utilize alternative BMPs to control water pollution (Sweeten and Melvin). The levels of management and costs associated with these BMPs are considerably different for unconfined and confined operations. Feedlots have far greater potential to cause water quality problems than pasture operations, unless properly designed water pollution abatement systems are installed (Sweeten). This stems from the sheer numbers of animals that are confined in relatively small areas.

The remainder of this paper offers a discussion of environmental regulations and costs for livestock operations, the structure of the cattle industry, and cattle production and pricing issues, and the relationships within these issues are summarized. The interaction between market and environmental issues may suggest some future methodological adjustments in environmental research.

## Environmental Regulations and Costs Associated with Confined and Unconfined Operations

Under the 1972 Clean Water Act, feedlots with greater than 1,000 head are designated point sources of pollution and are required to manage manure in accord with a National Pollution Discharge Elimination System (NPDES) permit (Outlaw et al.). This designation results in significant costs and levels of management required to maintain the permit. Every permitted operation must have a pollution prevention plan that includes a retention facility or basin designed to capture and hold all contaminated runoff and process water for a minimum of 21 days, a waste management plan, an erosion control plan, an employee training plan, a regular inspection program, and a record keeping system. In addition, any existing retention facility must be certified by a professional engineer or ground water scientist to have no hydrologic connection to nearby waterways (Smolen and Caldwell).

Feedlots with fewer than 1,000 head are designated as nonpoint sources of pollution (Outlaw et al.). In general, the waste management options available to this type operation are less costly and management intensive. As reported by Sweeten and Melvin, BMPs that could be utilized by smaller feedlots include:

- Locating the feeding facility away from a stream or drainage channel.
- Diverting outside runoff away from the feedlot surface by using diversion terraces and roof gutters.
- Collecting solids carried off the feedlot surface by runoff water.
- Installing a grass filter strip at least twice as large as the feedlot where the feedlot is close to a water body.
- Installing a runoff holding pond if the water quality risk is high.

Unconfined cattle production is also treated as a nonpoint source of pollution. This type of production accounts for one-half of the almost 109 million metric tons of animal manure generated each year in the United States (Sweeten and Melvin). In unconfined livestock operations, manure and sediment runoff can be significant particularly where livestock are free to trample and defecate in and along streams and ponds (U.S. EPA 1992). BMPs that help control pollution from these sources include:

- Installing electric wire fences along streams and providing environmentally sound stream crossings.
- Rotating cattle among several smaller-sized loafing areas to allow vegetative cover to regenerate.
- Providing adequate storage for manure supplies.
- Applying manure nutrients to land only as needed by crops (U.S. EPA 1992).

Animal numbers, dispersion, and location have a significant influence on the costs of environmental compliance for confined and unconfined cattle operations. The question becomes more complex—i.e., not only what costs are to be borne, but also, who is in the best position to pay the costs and are prices capable of signaling the need for better environmental management? To answer these que-

ries, it is helpful to understand more about the beef production system.

## The Beef Production System

Perhaps the best way to begin discussion of the interplay between the beef industry and the environment is to define and discuss in general terms the different sectors of the industry and their relation to each other.

The basic beef production unit is the cow-calf operation. The operation has a cow herd and calves are produced. Although calves may be sold at any time, it is generally done after weaning. Depending on the area of the country, calves may weigh between 450 and 650 pounds at sale. From the cow-calf operation, calves may go to stocker/backgrounding operations, or directly into feedlots. Of course, the cow-calf operator may retain ownership of the calves or sell them to others.

Backgrounding or stocker operations may be thought of as including rye grass winter pastures in the Southeast, wheat pasture in the Southern Plains, and other backgrounding programs in the West, Midwest, and Northern Plains. In these operations, calves are overwintered on a feed source to be sold at heavier weights in the spring. In some areas, these "feeders" may be held into the summer to take advantage of additional spring and summer grasses. In these cases, the feeders are then sold, off grass, as yearlings.

Feeder cattle and/or calves then move into feedlots. The feedlot sector involves drylot, concentrate (grain) feeding of steers and heifers to slaughter weight. For all practical purposes, all steers and heifers are fed in the United States. The only nonfed components of beef production are cull cows and bulls. The length of feeding period will vary due to the weather and the type of cattle, but predominantly the feeding period will be from 100 to 240 days.

Beyond the cattle production sectors are the packers and the wholesale and retail markets. Packers purchase fed animals to slaughter and process and sell beef in the wholesale market. Grocery stores and hotel, restaurant, and institutional (HRI) buyers purchase beef for sale to consumers in the retail market.

## Production and Pricing Issues

There are many important cattle price and pricing issues that may play a role in the industry's ability to practice sound environmental stewardship. Among these are cattle prices and the cattle cycle, competing goals and price signals of each sector of the industry, and several market concentration issues. While this is not an all-inclusive list, it does provide a starting place for identifying important issues relating to environmental quality and the beef industry.

### *The Cattle Cycle*

The history of the cattle industry has been one of cycles as cow-calf producers expand inventories in response to profits and, ultimately, contract their herd size in response to losses. While no two cattle inventory cycles have been exactly the same, there have been a number of repetitive patterns occurring across cycles which can be used to judge where the industry is and where it is headed within a given cattle cycle (Anderson, Robb, and Mintert).

Cycles are measured from one trough to the next trough. The average length of the six full cycles in cattle inventories since 1928 has been about 10 years. On average, inventories increased about six years during each cycle; during the last full cycle, however, cattle inventories increased just three years before producers began to liquidate their herds. Historically, periods of declining cattle inventories have averaged about four years. Liquidation during the 1980s was a dramatic exception; lasting eight years, this was the longest liquidation phase on record. The cattle herd liquidation of the 1980s was apparently caused by an extended period of low prices attributable not only to cattle and beef supplies, but also to large year-to-year declines in beef demand. Relatively low prices of competing meats, and other factors related to changing consumer

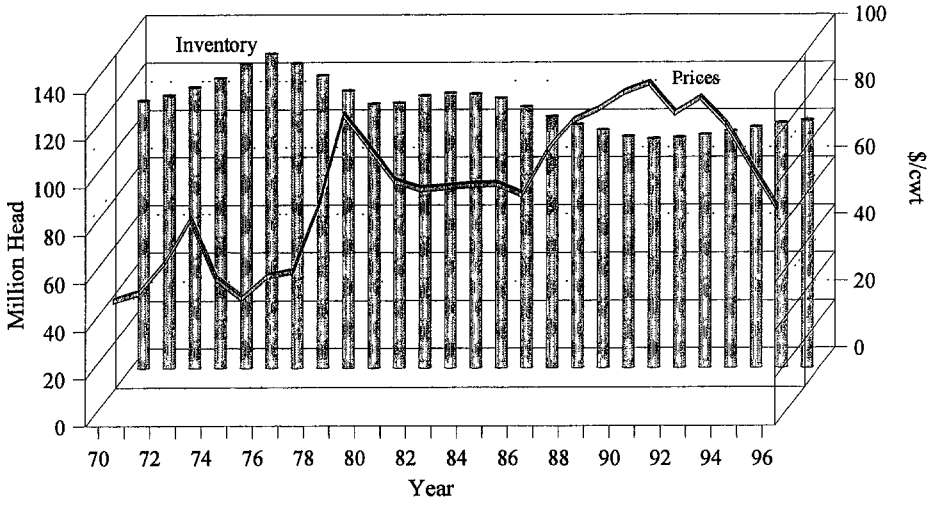


**Figure 1.** U.S. cattle inventory and Amarillo 500–600 pound steer prices, 1970–96

tastes and preferences for beef, led to the decline in beef demand.

Prior to 1979, the long-term trend in the U.S. cattle sector was for inventories to increase. At each cycle's trough, the cattle and calves inventory was larger than the lowest inventory during the previous cycle, and each successive inventory peak was greater than the previous cycle's peak. The cattle inventory peak during the 1979–90 cycle was the first time the cycle's peak failed to establish a record high. In addition, the 1990 cattle inventory estimate marked the first time an inventory trough fell below the previous cycle's trough.

Cattle cycles occur in large part because of the biological nature of production. Cow-calf producers respond to profitable calf prices by holding back more replacement heifers and not culling as many cows. The increase in cow numbers leads to more calves for the next year. But additional heifers held back for entry in the cow herd won't increase beef production for at least three years. Eventually, the increase in the cattle inventory, and subsequently beef supplies, leads to lower prices. Ultimately, prices decline below many cow-calf producers' break-even level, prompting higher-cost firms to start liquidating their herds. Herd liquidation continues until prices return to profitable levels.

The amount of time it takes production to respond to higher or lower prices creates a lag between price peaks (troughs) and subsequent inventory peaks (troughs). For example, annual average prices for 500–600 pound steers in western Kansas reached a cycle high of $87.97 per cwt in 1979, but the cattle and calves inventory didn't peak until three years later in 1982 (figure 1). Similarly, in the current cycle, the same weight steers averaged $100.19 per cwt in 1991, and it appears the cattle and calves inventory peaked about five years later.

In summary, profitability in the cattle industry is heavily influenced by the stage of cattle cycle. Some understanding of the cycle itself and where the industry currently is in the cycle should add insight into the ability of the industry to adopt and practice production management techniques that are thought to be good environmental stewardship.

### *Competing Goals and Price Signals*

Each sector of the industry has a different set of goals, i.e., different cattle characteristics are paid for and valued in the market by each segment of the industry. These competing values can cloud price signals and potentially confuse market signals related to environmental quality.

The cow-calf producer is paid on the pounds of calves produced. The most important factor in ranch profit is producing and

selling a live calf (Melton, Colette, and Willham). For example, one more 500-pound steer calf to sell at $80 per cwt represents an additional $400 to the producer. A short list of other important factors would include weaning weight, birth weight, cow milk production, and calving ease.

The stocker-backgrounder has a different set of goals. Characteristics of the mother cow have much less significance, while rate of weight gain and feed conversion rates increase in importance. At sale, some characteristics will command a premium (or at least a smaller discount), including the number of head sold at the same time, breed type, and (related to breed) the color of the animal. Note that some of these premium characteristics also apply to calves being sold.

Cattle feeders may consider fed cattle prices, feed costs, and feed conversion and rate of gain in the decision to purchase feeder cattle. In addition, pens of cattle expected to have more Choice grade animals may attract higher prices. Packers pay an average price for cattle—the same price is paid for both good and bad cattle in a pen. In an attempt to solve this problem, there is a move toward more value-based marketing in the form of pricing grids. With pricing grids, there is a schedule of premiums and discounts for quality characteristics. The result should be more quality-based market information to producers.

Finally, throw into this mix of competing goals, values, and price signals some characteristics identified as being important to consumers. In particular, price, flavor, tenderness, and juiciness have been identified as being of importance to consumers.

*Pricing Issues*

The sharp decline in cattle and calf prices in 1994–96 brought to the forefront an ongoing debate about pricing in the cattle industry. Among those pricing issues are packer concentration (market power), captive supplies, market price determination, and the differentiation of consumer food products and retail price behavior. There is a large body of literature on these issues, and this discussion is not meant to be comprehensive. The following is intended to briefly introduce some of the issues involved. While it is a favorite theme of classic economics that prices direct all of the activities from producer to consumer, in reality, there are many influences which tend to complicate and confuse price information.

The belief appears to be widespread among producers that concentration in the beef packing sector has allowed packers to exercise market power to hold down cattle prices. In 1980, the four-firm concentration in the beef packing sector represented 36% of steer and heifer slaughter, increasing to 82% by 1994 [U.S. Department of Agriculture/Agricultural Marketing Service (USDA/AMS) 1996b]. The impacts of market concentration generally have been difficult to identify. Studies have indicated that packers have been able to exercise a small degree of market power (Ward and Schroeder). But concentration has also led to increased plant and industry efficiency that may allow packers to bid more for cattle than they could otherwise.

Captive supplies are cattle committed to buyers more than two weeks in advance. Captive supply arrangements may include forward contracts and packer feeding. The concern is over the impact of captive supplies on the cash market price of cattle. On one hand, a packer having locked-up cattle supplies may bid less aggressively in the cash market, potentially reducing cash prices. On the other hand, fewer cattle on the cash market may also mean higher cash prices as packers without captive supplies bid for the reduced number of cattle available. Research has shown that in some cases, captive supplies have a small negative impact on cash cattle prices (Ward et al.).

The concern over these marketing issues grew to such a high level that the USDA formed the Advisory Committee on Agricultural Concentration. The committee reviewed information and research, and heard comments from the public on a wide range of issues. Three general recommendations of the committee are briefly summarized as follows (USDA/AMS 1996a):

- Antitrust enforcement of current regulations

under the Packer and Stockyards Act should be stepped up.
- The degree of price and quantity reporting and information timeliness in all livestock sectors should be increased.
- The amount of information available to all parties in the vertically integrated food industry needs to be increased.

Product differentiation—the development of product brands which are important to consumer choice—is an important factor in food marketing. This type of marketing activity is developed to a much greater extent in food than in most consumer products. It puts emphasis on the development of new and different product attributes, rather than emphasizing traditional product values. This activity also invites the introduction of private-label products by food retailing firms, with frequently as much as a 30% price discount. It is not known how much this "battle of the brands" affects the system's ability to transmit accurate information from consumer to producer with prices.

Food retailers are very sensitive to retail prices of their competitors. It is argued that they are more sensitive to "horizontal competition" than to "vertical competition" (Padberg, Knutson, and Jafri). If retailers are pricing 20,000 to 30,000 items, it may not be feasible or important for them to be sensitive to all of the vertical relationships (which transmit price information). Clearly it is important to their survival to pay attention to prices of other stores. This emphasis may reduce the ability of the food system to accurately transmit price information.

In summary, there are a host of issues of concern in today's cattle market. The cattle cycle, and the nature of cattle production in general, is an important indicator of profitability. The competing goals of each sector of the industry also may cloud price signals between sectors. The general areas of market power, as shown in the packers and stockyards concentration studies and the USDA concentration committee report, also indicate a significant level of distrust between producers and other industry segments. Since each affects the profitability of the sector, they consequently affect the ability to pay for environmental practices.

## Getting the Right Signal

In some respects, the relationship between market price signals and production management in the cattle industry is fairly straightforward. Take, for example, consumers' desire for leaner beef. This message is communicated through retail demand to packers who, in turn, bid the price of fed cattle that are not over-finished to a relative premium compared to over-finished cattle. Cattle feeders then may pay a premium for the type (size and/or breeds) of feeder cattle that produce leaner meat or finish cattle to Select instead of Choice grade. Hopefully, then, this information may be passed on to producers in the form of premiums (discounts) for calves of the desired (undesired) breed. Producers can then react to this price signal by purchasing breeding stock of the desired breed. This example, although fairly simple, serves to illustrate how the demand for measurable or distinguishable traits may be signaled throughout the production system.

It is also clear from the previous discussion on the cattle cycle that players in this industry are geared toward reacting to price signals. Due to the biological nature of beef production, it takes time for management changes to correct the market imbalance, but producers do respond rather quickly by either liquidating or expanding their herds.

Consider a cow-calf producer who adopts the BMP of fencing off his cattle from direct access to a nearby stream. It is fairly clear that the amount of market power or influence the various players have declines significantly from packer to cow-calf producer. This producer does not have the ability to pass on the costs associated with this BMP, and therefore must internalize these costs. Not all the players face this same dilemma. As market power increases, so does the ability to pass on costs associated with waste management—which is fortunate, because the costs associated with BMPs increase with the movement from cow-calf producer to the feedlots.

As Thurow and Holt aptly pointed out in the previous paper, firms may be able to "improve their efficiency through adopting cost-saving or *quality-improving* technologies" [emphasis added]. Fencing cattle out of riparian areas neither improves nor degrades the quality of beef produced. Accordingly, there would not be a cattle price premium due to enhanced beef quality.

## The Green Beef Example

Now take the case of consumers preferring beef that was produced under a production management regime that included sound environmental stewardship utilizing the appropriate BMPs. There is almost no way to determine whether the animals (e.g., fed and feeder cattle, stockers, and/or calves) were produced under this type of management because there is no identifiable trait or characteristic that distinguishes the production system under which the animal was raised. This is not just a hypothetical situation. There are studies which show that consumers are willing to pay for environmental protection (Carson and Mitchell). But how would consumers know they were getting what they paid for? On the other hand, there are also studies reporting that cattle producers think they are doing a good job as stewards of the land (Smith). If so, are they being rewarded by the market?

Thus far, our experience with environmental quality problems has shown that it is far easier to have the government create legislation to "attempt" to handle a problem than to wait for markets to solve it. There have been surveys of the general public that indicate a majority have preferences for environmental improvement in agriculture, and expect more regulation of the sector rather than less (USDA/Natural Resources Conservation Service 1995). However, the current political trends favor increased reliance on private stewardship directed by market signals (Ervin and Graffy).

Will market signals do the job of directing producers toward sound environmental production practices? The answer is probably no—because of differences in what the market values. The market has not assigned a value to environmentally sound management of animal wastes (Manale and Narrod). The pollution caused by these farms is generally treated as an externality (Ervin and Graffy; Manale and Narrod), which means that the cost associated with pollution is borne by someone other than the person who caused it to arise (Portney).

There is an example (and probably countless others) of market price signals that are changing beef production practices toward different environmental stewardship. The fly fishing boom and the dollars spent for quality fly fishing opportunities on private land adjacent to rivers and streams may enable some producers to pay for management changes. Hunting and fishing leases, and even bird watching activities, may provide additional income for producers in the right location and who can manage accordingly. But it is important to recognize that producers are responding to "environmental" market price signals rather than to cattle or beef market price signals.

## Conclusions

In this paper we have attempted to identify and address the relationship between market price signals and production management in the beef production sector. It is clear that market price signals work, and work well for traits that are distinguishable. Also, the ups and downs of the cattle cycle have been signaling production management changes to producers throughout the cattle industry's history. A problem arises when animals raised under one production management practice are indistinguishable from animals raised under more preferred alternative practices. This is the case for cattle produced utilizing the appropriate BMPs to control environmental pollution. It is difficult, if not impossible, to tell the difference.

There are several issues at work in today's beef industry including profitability, market power in different production sectors, and market signals that affect the industry's role in the environment and its ability to cope with regulations. Understanding the relationships within the beef industry may allow researchers

to fine-tune analyses of environmental issues in this sector.

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