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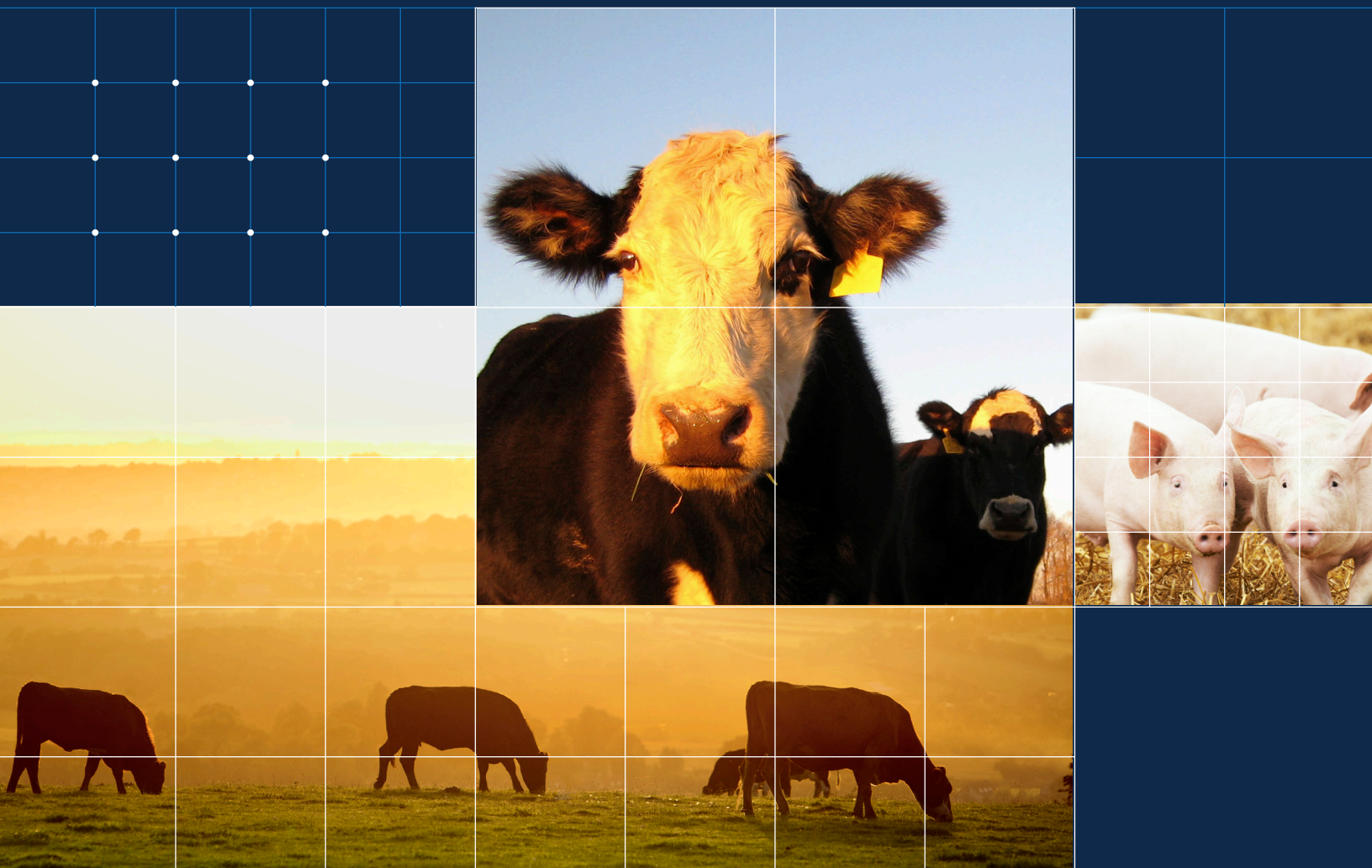
Livestock Futures and Options: Introduction to Underlying Market Fundamentals



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Introduction

For many decades CME Group has provided participants in the livestock industry with valuable tools to manage risk. Futures and options on Live Cattle, Feeder Cattle and Lean Hogs serve livestock producers and processors, as well as traders seeking to capitalize on the extraordinary opportunities these markets offer.

Market participants should gain an understanding of the underlying cash markets before entering into the futures and options markets. *CME Group Livestock Futures and Options: Introduction to Underlying Market Fundamentals* provides basic information regarding the cattle and hog industries, as well as a fundamental economic framework for analyzing prices.

The information is divided into two main sections. The first section provides general information on the cattle and hog industries, highlighting the life cycle of each species from birth to slaughter. It also describes the different pricing mechanisms in each respective industry, and how prices are realized in the cash markets. The second section provides information on analytical tools used in price forecasts and discusses economic factors affecting the livestock industry. This section also assists the market participant in locating and understanding the various government livestock reports used in price forecasts.

This publication provides a starting point for the potential trader to amass knowledge about the underlying industries. Each market participant must learn about other types and sources of pertinent information and how to use the information available. The emphasis here is on fundamental analysis; however, the novice trader may also want to explore technical analysis and discover the benefits it could add to trading. Some market participants prefer one technique over the other, while others utilize both types of analysis to enhance trading skills. The type or combination of techniques used is solely the preference of the individual.

A useful publication to complement this one is the *Self Study Guide to Hedging with Livestock Futures and Options* which provides a comprehensive overview of using futures and options for risk management in the livestock markets. Visit cmegroup.com/livestock for additional resources.

The Pork Industry

The pork industry can be divided into several basic phases that correspond to the animals' life cycle: 1) the production of young animals (pigs), 2) feeding the pigs to slaughter weight and 3) slaughter and fabrication.

The Hog Production Facility

Hogs originate from several types of hog farms: farrow-to-finish, finish-only, farrow-to-feeder, and farrow-to-wean. Farrow-to-finish operations handle all stages of a pig's life, from birth to sale of a market-ready hog, while farrow-to-feeder operations raise pigs from birth to the feeder pig stage, when they weigh about 40 to 60 pounds, and are ready to be sold to finishing farms. Farrow-to-wean farms raise pigs from birth to only about 10 to 15 pounds, when they are then sold to another operation and fed to market weight. The swine industry has seen dramatic change over the last decade due to a move to contract and vertically coordinated hog production.

At present, most hog operations involve finishing and are located in the Western Corn Belt (principally Iowa) and North Carolina. Newly emerging hog regions are developing, however, in Oklahoma, Utah, and other non-traditional pork producing states. Table 1 shows the total inventory numbers in each state as of March 1, 2017; from the USDA Quarterly Hogs and Pigs report.

Table 1 – Total Hog Inventory by State (in Thousands)

State	Total Inventory ('000)	% of U.S. Total
Iowa	21,800	31%
North Carolina	9,200	13%
Minnesota	8,300	12%
Illinois	5,250	7%
Indiana	4,050	6%
Nebraska	3,350	5%
Missouri	3,100	4%
All other US States	3,071	4%
Ohio	2,650	4%
Oklahoma	2,110	3%
Kansas	1,990	3%
South Dakota	1,450	2%
Pennsylvania	1,160	2%
Michigan	1,110	2%
Texas	920	1%
Colorado	710	1%
Utah	700	1%
United States Total	**70,921**	

**as of March 1, 2017*

(USDA Quarterly Hogs and Pigs)

Hog facilities have grown dramatically larger, evolving from small hog farms to large corporate and private operations. According to the last "Overview of the United States Hog Industry" published on October 29, 2015, 93 percent of the annual pig crop is produced on operations with at least 5,000 head, up from 88 percent in 2008 and up from 27 percent in 1994. The 2012 Census of Agriculture indicated that only 5 percent of hog and pig operations had 5,000 or more head, but accounted for 68 percent of the nation's inventory. Conversely, 95 percent of operations had fewer than 5,000 head, but accounted for only 32 percent of the inventory.

The driving force behind this shift is the benefits stemming from economies of scale. Production costs per hog decline on large farms, in part, because of improved feed efficiency and labor productivity. As annual marketings increase to 1,000 head, production costs drop sharply, and continue to decline as the marketings increase above 1,000 head, albeit at a slower rate. Larger operations also are better able to negotiate long-term contracts with packers because the operators can assure them of a constant supply of hogs.

Stages of Hog Production

The life cycle begins with the baby piglet. Each gilt (young female that has not given birth) and sow (mature female that has given birth) is generally bred twice a year, on a schedule to provide a continuous flow of pigs for the operation. To obtain the breeding stock, operators retain gilts that show superior growth, leanness, and reproductive potential as seen in their mothers. Boars (sexually mature males) used for breeding are generally purchased from breeding farms and have a working life of approximately two years

There are three main types of hog breeding. The first is pen mating, in which one or more boars are placed with a group of sows or gilts. The second and most common method is hand mating, where one boar is placed with only one sow or gilt at a time and they are monitored to be sure mating occurs. This method is more labor intensive than pen mating but there is more assurance that the female will reproduce. The third method is artificial insemination. This method allows for new genetics to be introduced quickly, but it is the most labor intensive of the three alternatives.

The gestation period for a bred female is approximately 4 months, at which point the female will give birth to an average of nine to 10 pigs. The number of pigs per litter has seen steady increases in recent years, due to improved herd health, genetics, and production efficiencies. This trend has been an important factor in increasing the US hog inventory. Accordingly, the pig per litter number is very important in estimating the supply of market hogs and is closely watched in the USDA's Quarterly Hogs and Pigs report.

After these baby pigs are weaned, at around three to four weeks of age, the sows will either be re-bred or sent to market. Females are generally kept in the breeding herd for two to three years until they are sold for slaughter, but depending on their genetics, health, and weight, they may be sold earlier.

Between farrowing and weaning, death loss accounts for approximately five percent of the pigs. Death can occur from suffocation by the sow laying on the baby pig, disease, weather conditions, and other external factors. Depending on the facilities used for farrowing, death loss due to weather conditions can be higher in severe winters.

As the young pigs grow, they are fed various diets to meet their specific nutritional needs at different predetermined weights. These diets must be high in grains because hogs cannot efficiently convert forages to muscle. Also, many times barrows (castrated males) and gilts are fed separately due to their differing nutritional needs. By separating these two groups, each sex can be fed more efficiently because their nutritional needs are different. The diet generally consists of corn, barley, milo, oats, distiller's grains or sometimes wheat. The protein comes from oilseed meals and vitamin and mineral additives.

Most of the feed is mixed on the site of the hog operation and some farms grow the feed that is used. However, sometimes complete rations are purchased from feed manufacturers and can be fed directly without further processing. On average, a barrow or gilt in the finishing stage will gain approximately one pound per day with a feed conversion of 3.5 pounds of feed.

Typically, it takes six months to raise a pig from birth to slaughter. Hogs are generally ready for market when they reach a weight of approximately 270 pounds. According to the USDA (LM_HG201), the average federally inspected slaughter weight (or live weight) was 275 pounds with an average carcass weight of 208 pounds in 2016. The weight at which hogs are marketed is affected by feed and hog prices. High feed prices and low hog prices may cause producers to sell hogs at a lighter weight while low feed prices and high hog prices might induce producers to feed hogs to a heavier weight before they are sold.

Generally, market-ready hogs are sold directly to the packer; however, some are sold through buying stations and auctions, and a small number are sold through terminal markets.

In 2015, 93 percent of the annual pig crop is produced on operations with at least 5,000 head. The 2012 US Ag Census indicated that only 5 percent of hog and pig operations had 5,000 or more head, but accounted for 68 percent of the nation's inventory. Conversely, 95 percent of operations had fewer than 5,000 head, but accounted for 32 percent of the inventory.

In 2016, about 67.4 percent of hog production was from independent producers with the remainder from packer-owned facilities. Hog producers sell their hogs either as a negotiated transaction for a particular day or as part of a formula price. Formula pricing may be used when a large number of hogs are forward contracted with a packer or another producer over an extended time period. The formula price is derived from a "price determining market" such as the Iowa-Southern Minnesota weighted average price of 51-52 percent lean hogs. There also may be a price differential subtracted or added based on different factors such as location or overall quality of the hogs.

It is important to mention that when hogs are priced, generally, it is with regard to the actual percent lean of their carcasses, since this percentage determines the actual amount of meat the carcass will yield. When live hogs are sold at an auction, however, the price is based on an expected lean figure, typically 51-52 percent.

Pork Packing and Processing

After hogs are sold, they are shipped to a packer and slaughtered. The carcasses are cut into wholesale cuts and sold to retailers. A market hog with a live weight of 270 pounds will typically result in a 200 pound carcass with an average of 25 percent ham, 25 percent loin, 16 percent belly, 11 percent picnic, 5 percent spareribs and 10 percent butt. The rest goes into jowl, lean trim, fat (lard) and miscellaneous cuts and trimmings.

A large portion of pork is further processed and becomes storable for considerable periods of time. Hams and picnics (a ham-like cut from the front leg of the hog) can be smoked, canned, or frozen. Pork bellies (the raw cut of meat used for bacon) can be frozen and stored for up to a year prior to processing. The pork belly is the meat from the underside of the hog. This section is cut to produce two pieces. Belly pieces vary in size depending on the size of the animal and are divided into two-pound weight ranges. The bulk of bellies fall into the 12-14, 14-16 and 16-18 pound weight ranges. Almost all bellies are treated in a preservative process (cured) and sliced into bacon.

The Beef Industry

The Cow/Calf Operation

Cattle production begins with a cow-calf producer or rancher who breeds cows to produce calves using natural service with a bull or an artificial insemination (A.I.) program. Although the size of cow-calf operations varies considerably, 91 percent of beef cow farms have less than 100 head as of 2012. Operations with 100 or more beef cows comprise 9 percent of all beef operations and 54 percent of the beef cow inventory. If using a natural service breeding program, each producer commonly runs one mature bull per 20-25 cows for breeding purposes. However, some cow-calf operators choose to breed their herd with an A.I. program in order to better control the genetics of any resulting calves. Genetics have grown in importance with the movement to produce higher quality beef and heavier weight animals.

A producer, with or without the use of bulls, requires a certain number of acres of pasture or grazing land to support each cow-calf unit. The acres of grazing land required per cow-calf unit is referred to as the stocking rate, and it differs among regions across the U.S. due to weather conditions and management practices. In high rainfall areas of the East and Midwest, for example, the stocking rate can be as low as five acres per cow-calf unit, while in the West and Southwest it can be as many as 150 acres.

The ranches themselves vary in size from less than 100 acres to many thousands of acres. In western states, ranches often lease summer grazing rights on public lands (particularly the US Forest Service and Bureau of Land Management). These grazing leases allow ranchers to graze cattle through the summer without the costs of land ownership.

Most herds are bred in late summer and after a 9 month gestation period, produce a spring calf crop. Most producers breed their herd to calve in the spring to avoid the harsh weather of winter and to assure abundant forage for the new calves during their first few months. This spring calving cycle creates strong seasonal supply effects which ripple across the entire cattle industry.

Each cow in a herd generally gives birth to one calf; however, twins are born on rare occasions. Not all cows in a herd will conceive and the conception rate (the percentage of cows bred that actually produce a calf) can be adversely affected by disease, harsh weather, and poor nutrition. A cow that misses its annual pregnancy is referred to as "open" and is usually culled from the herd and sent to slaughter, even if she is still young.

Typically 15 to 25 percent of the cows in a herd are culled each year. Cows can be culled for several reasons: failure to become pregnant, old age, bad teeth, drought or market conditions such as high feed costs. The cows that are culled must be replaced in order to maintain herd size. To accomplish this, a certain number of females from the calf crop must be held back to use as replacement heifers. If the calf crop does not contain enough suitable heifer calves to maintain the size of the herd, replacement heifers must be purchased from another source. During the expansion phase of the cattle cycle when producers are building their herds, the retention rate is higher than average and the rate is lower during the liquidation phase.

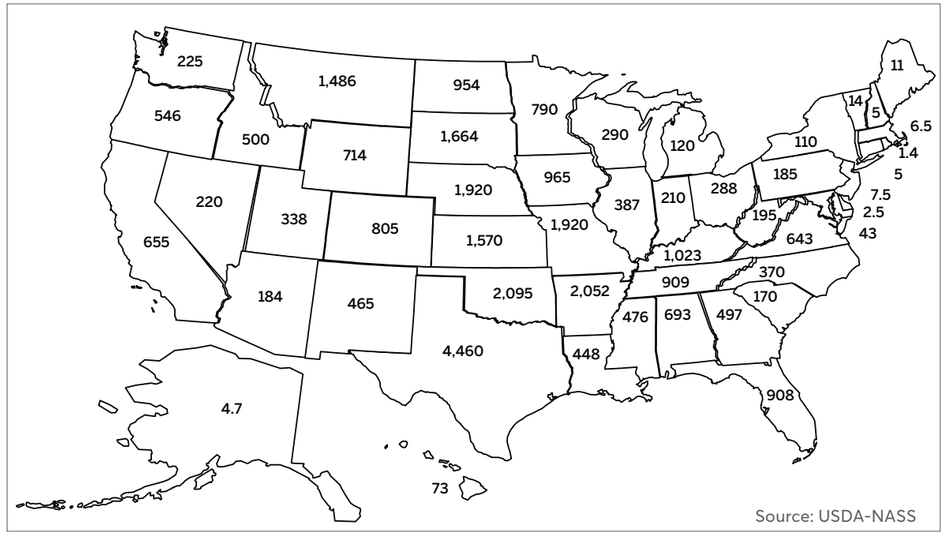
Calves, whether being retained for replacement heifers or being sold for eventual slaughter, remain with the cow for at least the first six months of their lives. At birth, calves receive their nourishment exclusively from nursing. Over time, however, their diet is supplemented with grass and eventually grain. When calves reach six to eight months of age, they are weaned from the cow. The average weight of a beef calf at weaning is between 500 and 600 pounds. Some heavier weight calves are then put directly into feedlots, but most pass through an intermediate stage called the "stocker operation."

The Stocker Operation

Stocker or "backgrounding" operations place weaned calves on summer grass, winter wheat, or some type of harvest roughage, depending upon the area and the time of year. The cow-calf operator may pay a stocker operator for providing these services or may sell the calves to a stocker operator. Either way, the stocker phase of the calf's life may last from six to ten months, until the animal reaches feedlot weight of about 600 to 800 pounds. When the cattle are ready to be placed in feedlots, they are referred to as feeder cattle. Again, as they pass from the stocker operation to the feedlot, the animals may or may not change ownership. Many of the feedlots that stocker calves are sent to are located in the Great Plains, specifically Colorado, Nebraska, Kansas, Oklahoma, and Texas.

Map 1 shows where the nation's beef cattle are raised according to the United States Department of Agriculture (USDA) National Agriculture Statistics Service (NASS). There were about 728,000 ranches with beef cattle in 2012[1] but 74 percent of the value of US sales came from 46,000 operations.

Map 1 – January 2017 Total Beef Cattle Inventory by State (in Thousands)



1 The USDA Census of Agriculture is performed every five years. The results of the 2017 census will be released in February, 2019.

The Feedlot

Cattle producers, or backgrounders, have three options when their cattle reach the feeder stage. They can 1) feed the cattle at a home operation, 2) place the cattle in a commercial feedlot to be custom fed while retaining ownership or 3) sell the cattle to another cattle feeder or feedlot. Regardless of the option selected, when cattle reach this stage, they are fed a mix of high energy feed to promote rapid weight gain. Most feeder cattle are steers (castrated males) and heifers (females that have not yet calved). However, there are generally more steers than heifers in a feedlot at any given time since cow-calf operators usually retain some heifers for herd maintenance. Cows (females that have had a calf) and bulls (sexually intact males) are not commonly placed in feedlots.

Cattle feeding is concentrated in the Great Plains, but is also important in parts of the Corn Belt, Southwest, and Pacific Northwest. Cattle feedlots produce high-quality beef, grade Select or higher, by feeding grain and other concentrates. Depending on weight at placement, feeding conditions and desired finish, the feeding period can be from 90 to as long as 300 days. The feeding period typically lasts around 140 days. While most of a calf's nutrient inputs until it is weaned are from grass, feedlot rations are generally 70 to 90 percent grain and protein concentrates.

Feedlots vary in capacity from less than 100 head to more than 50,000 head. Generally, the small feedlots, also called farmer feedlots, are owned and run by individuals, as part of a family operation, or with a few partners. Generally, small feedlots are part of a diversified farming operation and they usually do not feed cattle for others outside the business. Small operations are defined in this publication as having a one-time capacity of less than 1,000 head.

Feedlots with less than 1,000 head of capacity compose the vast majority of U.S. feedlots, but market a relatively small share of fed cattle. In contrast, lots with 1,000 head or more of capacity compose less than 5 percent of total feedlots, but market 80- to 90-percent of fed cattle. Feedlots with 32,000 head or more of capacity market around 40-percent of fed cattle. The industry continues to shift toward a small number of very large specialized feedlots, which are increasingly vertically integrated with the cow-calf and processing sectors to produce high-quality fed beef.

Some commercial feedlots may sell their services to outsiders in an arrangement known as custom feeding. Commercial feedlots can offer several services to producers who choose to have their cattle custom fed, particularly in regard to marketing and risk management. Commercial feedlots usually have a greater ability to market cattle because they have contacts with many packing plants that small farmer feeders may not have. Commercial operations can also sell large lots of cattle by combining cattle from several different owners, and packers prefer this to buying numerous small individual lots. In addition, commercial feedlots can offer different methods of risk management and various types of financing.

Once a feeder calf enters a feedlot, whether it is a farmer feedlot or a commercial lot, there is intense focus on feeding the calf for slaughter. The rations fed promote low feed-to- meat conversion and high daily rate of gain. An average daily gain for steers in feedlots in the Great Plains is 2.5 to 4 pounds per day and the average feed conversion is 6 pounds of feed for every one pound of gain. Generally, average daily gain for a heifer is lower and feed conversion is higher. However, the averages, for both steers and heifers, can be greatly affected by management practices and weather. Extremely hot weather can depress appetites, resulting in lower daily weight gains, and extended feeding periods. Unusually cold weather can cause food energy to be diverted from growth to the maintenance of body heat. This also results in lower daily gains and longer feeding periods, as well as higher feed conversion ratios.

The efficiency and ability of the feed yard also strongly influences feeding statistics. Many lots, especially larger ones, have a full-time nutritionist, equipment to monitor feed intake and an on-site mill to manufacture feed for the animals' dietary requirements. These and other facilities and services create higher efficiencies in feeding and therefore, higher daily gains, lower feed conversions, and fewer days on feed.

Pharmaceutical products also greatly influence cattle feeding performance. Antibiotics and other disease prevention or prescription products keep cattle healthier and reduce the effect of lost weight gain due to sickness. Cattle are not fed daily regimens of antibiotics and receive these products only when illness is detected.

Cattle often do receive daily dosages of pharmaceutical products called β-agonists (beta-agonists). These products promote lean muscle growth and feed efficiency, making finished cattle heavier with a higher lean content (muscle to fat ratio). β-agonists are typically fed during the last 30 to 45 days on feed.

Whether the cattle are fed in a farmer or commercial feedlot, they usually receive a ration consisting of grain, protein supplement and roughage. The grain portion is usually corn, milo, or, when the price is low enough, wheat. The protein supplement is soybean meal, cottonseed meal or distillers grains. The roughage portion is alfalfa, silage, prairie hay, or some other agricultural by-product such as sugar beet pulp. The choice of feed depends upon its price relative to the price of other alternatives.

Feeding continues until the animal is "finished" or has reached some optimum combination of weight, muscling and fat and is ready for slaughter. In 2016, the average live, federally inspected slaughter weight was approximately 1,384 pounds and the average federally inspected dressed (carcass) weight was about 895 pounds. However, these feeding weights will vary with market conditions. If feed prices fall or slaughter cattle prices rise, animals will be kept on feed longer to bring them to a heavier weight. There is a limit to the extension of the feeding period, though, because over-fattened cattle can be discounted substantially when sold. Starting the feeding period earlier with lighter weight feeder calves can also extend the length of time cattle are on feed.

Once the cattle reach slaughter weight and the owner is ready to sell, there are two main marketing routes through which the animals pass: 1) direct sale to a packer, or 2) sale through an auction.

Beef Packing and Processing

A packer buys cattle, slaughters them, and then sells virtually every item that comes from the slaughtered animals. The two major sources of revenue for packers are sales of meat (either in carcass or boxed form, or the most recent trend, case ready) and sales of the hide and offal, or "drop" (hide, trimmed fat, variety meats, bones, blood, glands, and so on). Packers generally sell meat in boxed form, with the carcass divided into major cuts and vacuum-packed. When these boxes reach a retailer they are further fabricated. However, there is a move in the beef industry towards selling case-ready beef which has been cut into retail cuts by the packer and sent to the retailer ready to be placed directly in the meat case and sold. For case ready beef, there is no further fabrication necessary on the part of the retailer.

Although boxed and case-ready meats are packaged differently, all carcasses, regardless of packaging, are split down the middle and then cut into quarters. The hindquarter is about half of the carcass and includes the round and rump (22%), loin (17%), and flank (5%). The remaining half of the carcass is the forequarter and is comprised of the rib (10%), chuck (27%), plate (8%), brisket (4%), and fore shank (3%). Most of the meat is fabricated into steaks and other cuts and the remainder is used for ground beef and stew meat.

Salaried employees, known as packer buyers, purchase many of the packers' cattle directly from feedlots. Based upon current meat prices and other economic factors, the buyers bid on desirable cattle. If a bid is accepted, the cattle are generally delivered to the packer within seven to 14 days for slaughter, depending on the pricing method. This delivery schedule allows the packers some flexibility and enables them to schedule their kills several days in advance.

Fed cattle prices may be expressed as either a live- or dressed-weight basis. Live-weight pricing is based on estimated carcass weights and quality (generally, Prime, Choice, Select, and Standard) and yield grades (1 through 5, with the higher numbers representing a lower proportion of salable retail cuts from the carcass). The price determined by these estimates is then averaged across the entire pen of cattle. Dressed-weight prices are based on estimated quality and yield grades and known carcass weights. This price is not averaged across the pen as in live-weight pricing, but is calculated for each individual carcass. Live weight pricing is more common than dressed weight or "in the beef" pricing in some regions, especially in the southern plains.

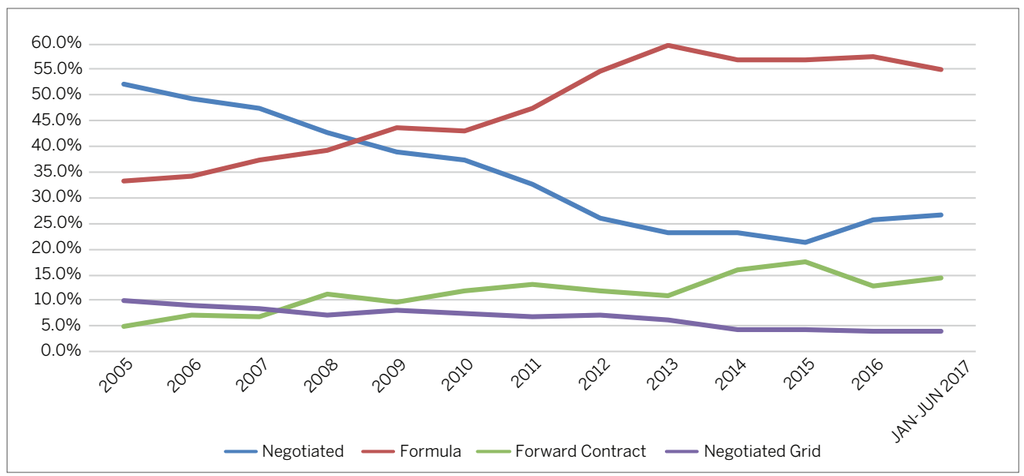
Price determination is either done via a formula or frequent negotiation. Formula pricing involves using a mathematical formula that includes some other price as a reference, such as the average price of the cattle purchased by the plant for the week prior to the week of slaughter. A portion of cattle prices are arrived at by negotiating a price on the cash market. The cattle are sold at the current market price. Cash market sales include selling at terminal markets (which are generally located close to slaughter facilities), auction sales, and direct sales to packers at the cash price (spot bid). Frequently, pricing grids are used to arrive at a final price.

A price grid establishes a base price (either negotiated or via a formula) and then specifies premiums and discounts above and below the base for different carcass attributes, such as quality and yield grade and whether the carcasses are light or heavy. The base price is set differently depending on each packer and can be based on several different prices. Some of these prices include the futures price, boxed beef cutout value, or average price of the cattle purchased by the plant the week prior to the week of slaughter. Grid pricing is also known as value-based pricing because prices are based on the known weight of the carcass, and the quality and yield grade of each individual carcass.

Figure 1 shows the relative popularity of negotiated, formula, negotiated grid, and forward contract marketing arrangements for fed cattle. Most significant is the dramatic decline of negotiated transactions. The decrease in negotiated transactions has been largely offset by increases in formula transactions. This phenomenon may be driven by the added economic "costs" of negotiated transactions and by the appeal of using an easily observable, transparent outside market to determine prices.

There is a high amount of industry concentration amongst the beef packers. The four largest packing firms make up slightly more than 80% of the Federally Inspected slaughter.

Figure 1 – Percent of Cattle Sold by Marketing Arrangement



Source: USDA AMS

Economic Factors

After gaining an understanding of the production cycles of hogs and cattle, it is important to recognize how that knowledge combines with economic factors that affect each industry. The following sections will examine the relationship between economic conditions and livestock prices. These sections will discuss the pipeline approach to the livestock industry, provide information on supply and demand factors and explain livestock cycle and seasonality issues.

The Pipeline Approach

The pipeline approach is a forecasting technique that estimates the quantity of a commodity at a specific point in the future based on observation at various points during the production cycle. At birth, livestock enter into a production pipeline beginning on the farm and terminating at the supermarket. The assumption is that what goes into the pipeline must eventually come out, barring minor "leakage" due to death, loss and exports.

The forecasting technique requires: 1) an estimate of current supplies at various stages in the pipeline; 2) knowledge of the average time it takes for the commodity to move from one stage to the next; and 3) information about any important leakages, infusions (imports) or feedback loops (diversion of animals from slaughter back into the breeding herd). Much of this information is available through United States Department of Agriculture (USDA) publications.

Hog Pipeline

One of the first pieces of information needed to study the hog pipeline is the size of the hog inventory. Hog inventory data can be obtained from the Hogs and Pigs report published by USDA's National Agricultural Statistics Service (NASS). On a quarterly basis, this report provides information for all fifty U.S. states on the pig crop and total inventory as well as other relevant information regarding hogs and pigs. It also publishes a report on the litter size, breeding herd size, and the number of sows and gilts bred on a monthly basis.

Quarterly data for total United States inventory of market hogs (those not being kept for breeding purposes), total commercial hog slaughter and commercial pork production, are provided in Table 1.

Obtaining Data

Market participants may also need additional information regarding hog slaughter, depending on the stage in the pipeline they are studying. This data can be obtained from the monthly Livestock Slaughter report. Also published by NASS, it presents statistics on total hog slaughter by head, average live and dressed weight in commercial plants by state and in the U.S., information about federally inspected hogs, and additional slaughter data.

Table 2 – US Market Hog Inventory, Hog Slaughter and Pork Production

Market Hogs (1,000 head)	Quarter I	Quarter II	Quarter III	Quarter IV
2008	60,518	60,969	62,135	60,987
2009	59,528	60,742	60,842	58,837
2010	57,858	58,862	60,201	58,947
2011	57,971	59,517	61,428	60,456
2012	58,957	60,607	62,244	60,405
2013	59,236	59,304	61,090	59,018
2014	55,643	55,713	60,059	61,838
2015	61,418	61,240	63,200	62,917
2016	62,144	63,302	65,870	65,435
2017	64,853	65,581	–	–

Commercial Pork Production (million pounds)	Quarter I	Quarter II	Quarter III	Quarter IV
2008	6,024	5,593	5,632	6,098
2009	5,814	5,490	5,700	5,996
2010	5,607	5,302	5,401	6,126
2011	5,719	5,370	5,484	6,186
2012	5,858	5,519	5,631	6,244
2013	5,775	5,516	5,622	6,274
2014	5,784	5,504	5,424	6,131
2015	6,162	5,925	5,958	6,457
2016	6,230	5,963	6,100	6,648
2017	6,409	6,137	–	–

Commercial Hog Slaughter (1,000 head)	Quarter I	Quarter II	Quarter III	Quarter IV
2008	29,601	27,941	28,696	30,214
2009	28,503	27,072	28,428	29,615
2010	27,630	26,074	26,931	29,626
2011	27,483	26,110	27,379	29,888
2012	28,105	26,661	27,965	30,433
2013	27,864	26,765	27,657	29,792
2014	27,131	25,575	25,558	28,612
2015	28,724	27,850	28,477	30,375
2016	29,262	28,116	29,323	31,539
2017	30,176	29,163	–	–

Source: USDA–NASS

Finally, hog pipeline analysts need information regarding leakages, infusions, and feedback loops. Several reports published by USDA's Economic Research Service (ERS), including *Livestock, Dairy and Poultry Situation and Outlook*, provide data on imports and exports, offering monthly, quarterly, and yearly statistics separated out by selected countries on a carcass weight and live animal basis.

For feedback data or data regarding retention for breeding purposes, market participants can consult the Hogs and Pigs report, particularly the "Hogs Kept for Breeding" and "Monthly Sows and Gilts Bred" sections. This, however, this does vary over time depending on whether the industry is in an expansion or contraction phase. Although gilts may be retained for breeding, they do eventually go back into the pipeline and become part of the slaughter and pork production numbers.

Estimating Slaughter

Using data from the USDA Hogs and Pigs Report, it is possible to estimate the levels of hog slaughter. For example, calculating the past ratio of hog slaughter to market hog numbers can be useful in predicting future slaughter levels. The first quarter 2017 market hog inventory was reported at 64,853,000 (Table 2). These hogs were slaughtered during the first and second quarters of 2017. To forecast hog slaughter during these quarters, the ratio of combined first and second quarter slaughter to first quarter market hog inventory was calculated. The five year average (from 2012 to 2016) of this ratio is 0.930. Multiplying this number by the first quarter 2017 market hog inventory, the predicted first and second quarter combined hog slaughter in 2017 is 60,313,000.

The actual first and second quarter slaughter in 2017 was 59,339,000 hogs. Thus, the forecasted slaughter was within 1.6% of the realized slaughter. Forecasting the slaughter numbers helps in predicting hog prices by giving some insight into the supply of animals that will be marketed.

Speed of Commodity Flows

Recall that the pipeline approach requires knowledge of the speed of the commodity flow. While the average time between birth and slaughter is roughly six months, the actual period can vary with economic conditions as well as with the season and unexpected changes in the weather. For example, a decline in the cost of feed makes livestock feeding more profitable, so producers will feed the animals to heavier weights and therefore, increase the time the animals are in the pipeline. A rise in the cost of feed can result in earlier marketing at lighter weights. If livestock prices decline temporarily, producers may delay marketing in hopes of a price increase.

Market participants also need to remember that the number of females withheld from slaughter for breeding purposes will vary over time. When producers are expanding, they increase the number of gilts withheld for breeding. During a contraction phase, however, producers cull females from the breeding herd and increase the number of sows and gilts slaughtered. Although no public data provides exact figures on gilt slaughter in comparison to total hog slaughter, some inferences can be made from data in the Hogs and Pigs report. When producers are putting more hogs into the breeding herd, they are therefore slaughtering fewer females. These estimates can then be considered when forecasting hog slaughter using the pipeline approach.

Effects of Imports and Exports

Market participants also need to account for exports and imports into the hog pipeline to accurately forecast hog slaughter numbers. They can consult USDA data to determine the number of exports and imports that enter and exit the pipeline, apply these numbers to the pipeline forecast, and then estimate the total slaughter.

However, when considering import and export data in the pipeline approach, it is important to remember the stage in which the hogs will enter and exit the pipeline. For example, exports of hogs will only affect the slaughter forecast if they are exported as live animals, not pork. Pork exports are subtracted after the U.S. production number is calculated. However, live animals will "disappear" between the pig crop stage and the slaughter stage and this loss must be accounted for to compute an accurate forecast.

Similarly, only imports of live animals will affect U.S. slaughter and production numbers because these animals are slaughtered in the U.S. However, imports of pork are not counted in U.S. slaughter and production numbers because these animals were not slaughtered in this country.

Table 3 shows import and export data provided by the USDA's Economic Research Service (ERS). As can be readily seen, the levels of trade have varied widely on an annual basis for pork exports and hog imports. The U.S. is a net exporter of pork, sending the bulk of it to Japan, Mexico, Canada, South Korea, and mainland China. The U.S. is a net importer of hogs, primarily from Canada, although the number of imports has declined significantly over the last ten years.

Other Factors Affecting Production

One final consideration to account for in the pipeline forecast is death loss. A percentage can be applied to the final total slaughter estimate to account for death loss. Average death loss from birth to finished hog is between three and six percent.

Table 3 – US Hog and Pork Trade

	US Pork Trade (million pounds)		US Hog Trade (1,000 head)	
	Imports	Exports	Imports	Exports
2007	968	3,141	10,004	137
2008	832	4,651	9,348	97
2009	834	4,094	6,365	21
2010	859	4,223	5,749	15
2011	803	5,196	5,795	30
2012	802	5,379	5,656	56
2013	880	4,986	4,948	34
2014	1,011	5,092	4,947	19
2015	1,116	5,009	5,740	41
2016	1,092	5,233	5,656	48

Source: USDA–ERS

Reviewing the factors that can affect the final number of hogs slaughtered demonstrates why the two-quarter prior pig crop is not a perfect predictor of hog slaughter. Other factors not discussed here and not easily quantifiable, such as producer behavior or weather, also influence hog slaughter.

Beyond estimating hog slaughter numbers, there is one further step a market participant can take in forecasting movements along the hog pipeline. This step is to translate the hog slaughter forecast into a pork production forecast. For example the average hog carcass weight in 2017 was 208 pounds (USDA, NASS). Referring back to the 29,163,000 hogs slaughtered in the second quarter of 2017, and multiplying this number by the average carcass weight of 208 pounds, yields a forecast for the second quarter of 2017 of approximately 6,066 million pounds of pork (29,163,00 head × 208 lbs. per head). The actual second quarter pork production for 2017 was 6,137 million pounds (Table 2), which almost equals the forecast (actual production was 1.1% higher than the forecast). Again, in this pork production forecast, the market participant must take into consideration other factors, similar to those noted previously, that may affect production.

Cattle Pipeline

Market participants calculate numbers of animals in the cattle pipeline in much the same manner as the hog pipeline. They consider the same factors and, similarly study USDA publications. Like hog pipeline analysts, cattle analysts must determine at which stage in the pipeline to initiate their forecasts. There is a difference between the two pipelines, however. The hog pipeline starts with the birth stage, or pig crop estimates. But since there is so much variation in the time it takes to get a calf to the feeder calf stage, a more accurate forecast of cattle slaughter can be made if the estimation begins with cattle placements into or marketings from the feedlot.

Estimating Slaughter

Each month, USDA provides estimates of the cattle placed on feed, which are cattle put into a feedlot and fed a high energy, grain-based ration that will get them ready for slaughter. Data on placements can be obtained from the monthly Cattle on Feed report published by NASS of USDA. This report also provides information on the number of cattle already on feed and marketings of fed cattle, or the number of cattle shipped out of feedlots to slaughter, for the month.

Table 4 provides data on placements from 2008 to 2017. Using this data, with appropriate adjustment factors, a market participant can use the information to forecast total commercial slaughter and beef production approximately four to five months later. The forecast is several months in the future because the typical feeding period to bring an animal to an average live weight of 1,305 pounds, as discussed in the previous Feedlot section, is between four and five months.

For example, in January 2017, 1.981 million head of cattle were placed on feed in the United States in feedlots with 1,000 head or greater capacity (Table 4). In theory, this same number of cattle would be slaughtered in or around May 2017. However, the market participant must remember that this figure accounts for only 85 percent of the total fed-cattle marketings since cattle that are fed in small feedlots with less than 1,000 head are not included in this number. Total marketings for May 2017, including both small and large capacity feedlots, can then be estimated at 2,330,000 head (1,981,000 head ÷ 0.85). This estimate then can be used as the forecast for May slaughter. However, commercial slaughter in May 2013 was 2,119,000 head or 9 percent less than the forecast (Table 5).

Table 4 – Total U.S. Placement of Cattle on Feed (1000+ Capacity Feedlots; 1,000 head)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
January	1,787	1,858	1,822	1,904	1,788	1,869	2,014	1,789	1,779	1,981
February	1,723	1,678	1,677	1,662	1,694	1,436	1,658	1,551	1,710	1,694
March	1,736	1,808	1,868	1,904	1,752	1,889	1,801	1,809	1,892	2,117
April	1,536	1,600	1,647	1,770	1,431	1,738	1,623	1,548	1,664	1,848
May	1,900	1,638	2,070	1,755	2,064	2,051	1,909	1,719	1,889	2,119
June	1,518	1,391	1,631	1,673	1,634	1,532	1,468	1,481	1,525	1,770
July	1,656	1,863	1,798	2,070	1,892	1,698	1,559	1,547	1,572	–
August	2,061	2,109	2,283	2,191	2,007	1,777	1,725	1,632	1,879	–
September	2,281	2,398	2,476	2,415	2,014	1,988	2,014	1,941	1,895	–
October	2,438	2,474	2,521	2,407	2,130	2,379	2,368	2,286	2,171	–
November	2,016	1,844	1,969	1,984	1,918	1,853	1,794	1,602	1,843	–
December	1,647	1,526	1,814	1,665	1,576	1,654	1,537	1,527	1,785	–

Source: USDA–NASS

One inherent weakness in this cattle pipeline approach is that cattle slaughter can be under forecast or over forecast depending on the month in which the placements occur. Weather affects cattle performance significantly. If it is cold and wet or hot and dry, cattle do not gain as efficiently and it takes longer for them to reach slaughter weight. The result is a backlog of cattle and eventually, slaughter will be larger than normally expected. Weather does not affect overall hog slaughter as much because many hogs are raised in confinement where they are protected from extreme weather.

Imports and Exports

Other difficulties in forecasting the cattle slaughter include leakages, infusions, and feedback loops. Information regarding exports (leakages) and imports (infusions) of beef can be gained from Livestock, Dairy and Poultry Situation and Outlook published by the ERS. The information is provided monthly, quarterly, and yearly, and separated out by select countries on a carcass weight and live animal basis. The export and import numbers gathered from these sources can be applied to the pipeline forecast and then entered into the final calculation of total slaughter estimate.

It is important to remember the stage in which cattle imports and exports will enter and exit the pipeline. Exports of beef will not affect total slaughter or production numbers because the reported figure is the total slaughter and production in the United States. Even though the beef is exported, the cattle were slaughtered in the U.S. and therefore counted in the total slaughter and production number. The pounds of beef exported are subtracted from production after the total is calculated and thus affect only the total U.S. beef supply number. However, if live animals are exported, they will affect the slaughter forecast because they will "leak" out of the pipeline at some stage in the life cycle. The market participant should account for this leakage by utilizing data on exports.

Imports of cattle or beef have the same influence on slaughter and production numbers. Only imports of live animals affect the U.S. slaughter and production numbers because they are slaughtered in the United States. However, imports of beef will influence only the total U.S. supply number and not U.S. production because the cattle were not slaughtered in the United States.

Table 5 – US Commercial Cattle Slaughter (1,000 head)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
January	2,704	3,200	3,610	3,355	2,824	2,464	2,406	2,326	2,314	2,009
February	2,423	2,433	2,468	2,482	2,383	2,237	1,976	1,801	1,789	2,024
March	3,025	2,304	2,553	2,417	2,788	2,887	2,634	1,720	1,799	2,016
April	2,557	2,282	2,679	3,298	2,183	2,535	2,070	1,732	2,355	2,593
May	3,551	3,094	3,665	2,815	2,351	2,782	2,657	2,132	1,986	2,123
June	2,901	2,337	2,729	2,775	3,103	3,209	2,012	1,643	1,905	2,210
July	2,720	2,457	3,255	3,669	2,619	2,407	1,745	1,525	2,318	–
August	3,483	3,106	2,563	3,113	2,491	2,751	2,161	1,800	1,827	–
September	2,745	2,443	2,790	3,311	3,171	2,162	1,706	1,678	1,922	–
October	3,007	3,590	3,764	4,173	2,839	2,330	1,871	2,228	2,697	–
November	3,802	3,118	3,215	3,323	3,021	3,190	2,550	1,907	2,254	–
December	2,535	2,700	2,946	3,831	3,529	2,227	1,834	1,797	2,603	–

Source: USDA–NASS

Table 6 shows import and export data provided by the USDA's Economic Research Service (ERS). As can be readily seen, the levels of trade have varied widely on an annual basis for beef exports and cattle imports.

Table 6 – US Beef and Cattle Trade

	US Beef Trade (million pounds)		US Cattle Trade (1,000 head)	
	Imports	Exports	Imports	Exports
2007	3,052	1,434	2,495	66
2008	2,538	1,996	2,284	107
2009	2,626	1,935	2,002	58
2010	2,298	2,300	2,284	91
2011	2,057	2,785	2,107	194
2012	2,220	2,452	2,283	191
2013	2,250	2,588	2,033	161
2014	2,947	2,572	2,358	108
2015	3,371	2,265	1,984	73
2016	3,016	2,550	1,708	69

Source: USDA–ERS

Other Factors Affecting Production

Besides exports and imports, other weaknesses in the cattle pipeline include death loss and feedback loops. Heifers retained for breeding purposes are not a concern in the cattle pipeline, however, if the market participant begins with placements or other data after this point in the life cycle. This is because heifers retained for breeding are not placed in a feedlot and therefore do not affect the forecast. They do become a concern after the animal is no longer able to reproduce and is culled from the herd, which is where the cattle feedback loop begins. At this point cows, as well as bulls and stags (males castrated after maturity) enter the pipeline and are accounted for in the slaughter number. While these animals are included in the slaughter and production numbers, they are not accounted for in placements, cattle on feed, or marketings. Data regarding this type of animal slaughter is available in Livestock, Dairy and Poultry Situation and Outlook, as well as Livestock Slaughter. An estimate can be made regarding cow, bull, and stag slaughter and applied to the final slaughter and production pipeline forecasts.

Table 7 – Commercial Beef Production (million pounds)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
January	2,233	2,118	2,083	2,123	2,114	2,260	2,141	1,964	1,954	2,118
February	2,039	1,986	1,956	2,021	2,009	1,874	1,788	1,769	1,885	1,934
March	2,101	2,144	2,212	2,266	2,160	2,039	1,938	1,933	2,097	2,248
April	2,255	2,133	2,140	2,055	1,991	2,127	2,043	1,929	1,964	1,963
May	2,380	2,179	2,088	2,131	2,232	2,228	2,072	1,926	2,030	2,162
June	2,263	2,289	2,321	2,375	2,251	2,166	2,069	2,002	2,193	2,279
July	2,372	2,271	2,230	2,135	2,201	2,294	2,087	2,047	2,024	–
August	2,267	2,184	2,287	2,387	2,369	2,242	2,024	1,935	2,264	–
September	2,270	2,234	2,252	2,215	2,016	2,074	2,068	2,087	2,179	–
October	2,341	2,276	2,235	2,215	2,345	2,318	2,171	2,126	2,210	–
November	1,959	2,016	2,236	2,149	2,208	2,058	1,850	1,936	2,239	–
December	2,082	2,134	4,353	2,127	2,020	2,047	2,000	2,046	2,173	–

Source: USDA–NASS

Market participants must also consider death loss in a cattle pipeline slaughter forecast. When researching a death loss percentage, the analyst must consider at which stage the cattle are in the life cycle. If using placements, the cattle are in the finishing phase and an average death loss percentage for this stage for both steers and heifers is about 1 percent. However, the death loss percentage increases when the cattle are heifers or if they are placed on feed at a lighter weight.

To forecast beef production (see Table 7), slaughter (in number of head) must be multiplied by an average weight per head. From the previous "Feedlot" section, the average dressed carcass weight in 2016 was 895 pounds. Using this number and multiplying it by the actual May 2017 slaughter number of 2,123,000 head, the May 2017 commercial beef production forecast would be 1,900 million pounds of beef (2,123,000 head × 895 lbs.). The actual production number for this month was 2,162 million pounds (Table 7). A portion of the error originates from using an average carcass weight. Some carcasses weigh more, while others weigh less than this average weight.

Both the slaughter and production forecasts could be improved by using marketing data rather than cattle placement data. In the pipeline, marketings are one stage beyond placements. Using marketings would increase the accuracy of the forecast by decreasing the error due to death loss in the feedlot. Marketing data would also improve the forecast because there would no longer be a question as to how long it took the cattle from when they were placed on feed to the time they were marketed because once cattle are marketed, they go directly to slaughter. One final improvement would be the decreased error from not having the impact of exports and imports. Cattle are generally not exported or imported at the marketing stage but are moved at the feeder cattle stage or before.

The Economics of Supply

Although the forecasting tools provided in the pipeline approach offer an estimation of slaughter and production, the projection will not be accurate if the market participant fails to monitor the basic economic forces affecting supply.

Many factors can influence supply. However, it is important to distinguish between the factors changing the quantity supplied and factors causing a change in supply. These two circumstances have different influences on the supply curve. Theoretically, a supply curve is upward sloping because as price for the output increases (decreases), the quantity supplied increases (decreases). When the price of the specific output changes, this creates a change in the quantity supplied or, more importantly, a movement along the existing supply curve. A change in the quantity supplied refers only to changes that result from changes in the price of the product itself. Also, a change in the quantity supplied is a short-term or immediate concept.

In contrast, external factors can cause a change in supply, which is a shift in the entire supply curve. These factors include: 1) change in the price of inputs, 2) change in the price of substitute goods, 3) change in the price of joint products, 4) change in technology, and 5) institutional factors. Any of these factors can shift the supply curve either to the right or the left, depending on whether the influence on the product is positive (shift to the right) or negative (shift to the left), all other factors being held constant.

It is important to note that the effect of these factors on the supply curve may not be seen immediately. Generally, the expected effect, either positive or negative, is a long-run effect and is not realized until the next production cycle.

For example, if there is an incentive for producers to raise more livestock for slaughter, they will increase their herd size by either buying females to increase the number of young born or they will buy younger animals. If livestock feeders choose the first alternative, more females are held out of slaughter and put into the breeding herd. When these animals reproduce, the offspring have to be fed to slaughter weight. If the feeders choose to buy younger animals, these animals will have to be fed for a certain time period before they reach slaughter weight. Once the feeding period for the animals in both alternatives is complete, the final increase in supply will be noted.

If the incentive is for producers to cut the size of their herds, the full response will not be immediate because animals in the middle of a feeding period will be fed until they reach an appropriate slaughter weight. The full change is not felt until after the youngest group of animals has been slaughtered.

Input Price

Inputs are products and factors that produce a final output. Two significant inputs in the livestock industry are feed and feeder animals. The costs of these two inputs are highly influential in shifting the supply curve. If the price of feed or the price of feeder animals increases and all other variables are held constant, the supply curve will shift to the left, resulting in a lower quantity supplied at the same output price. However, if the prices of the inputs decrease and all else stays constant, the curve shifts right and a larger quantity is supplied at the same output price.

A change in an input price may not immediately affect supply but may instead have an effect over the long run that is not evident for a certain amount of time. For example, if the price of feed declines, there may be a short-run, or immediate, reduction in the supply of cattle and hogs, the opposite of what one would expect. The boost in supply usually does not occur until later. Why? Because at the time the price of feed declines, animals almost ready for market have been fed to the point where the cost of the last pound of gain is almost as much as the price per pound of animals sold for slaughter.

If feed prices decline, it costs less to feed the hogs or cattle for each additional pound of gain. This lower cost makes it more profitable to continue feeding animals longer and thus creates a short-run reduction in supply. The expected long-run increase in supply will not appear for a time equal to the length of the feeding period for each animal. When feed prices decline, livestock feeders buy more young animals to increase their feeding herd size. Not until these animals are fed to slaughter weight is the increase in supply realized.

Substitute Price

Substitutes, or competing products, are different goods that can be exchanged for a specific product and produced with the same resources. For example, beef may be considered a substitute for pork and conversely, pork may be a substitute for beef. Substitutes affect supply because if the price of a competing product (product B) changes relative to the price of the product in question (product A), the supply curve will shift. If the price of product B decreases relative to product A, the supply curve for product A will shift to the right and there will be a greater supply of product A. The opposite occurs if the price of product B increases relative to product A. The price of product B can increase (decrease) relative to product A because of an increase (decrease) in the price received for the product or a decrease (increase) in the cost of production for the product.

Joint Product Price

Joint products are goods derived from a single commodity and produced in proportion to the quantity of this commodity, such as pork bellies from a pork carcass or spare ribs from a beef carcass. If the price of one of these joint products increases, it can shift the supply curve of the other joint product to the right. However, if price decreases, the opposite occurs.

Technology

Improvements in technology can make it more economical to produce a certain product and thereby also shift the supply curve to the right. This occurs when technology increases the output of a certain product while the level of inputs remains constant. In livestock production, examples of technological improvements would include new breeds, improvements in reproduction advances in the understanding of genetics, and a better understanding of what types of feed animals can most efficiently convert into gain. With improvements in technology, hog and cattle producers can increase profitability by increasing the yield of lean meat on a carcass without increasing their costs of production. This in turn shifts the supply curve to the right, if all other factors are held constant.

Institutional Factors

Institutional factors generally relate to government programs or restrictions such as land-use or waste disposal regulations. These factors can shift the supply curve for the product to the left or right, depending on the industry. For example, stricter waste management regulations may result in decreased livestock production and shift the supply curve to the left, if the guidelines make it less profitable to produce livestock.

Interest rates are another important institutional factor. Significant movements in interest rates can affect production decisions and thus, supply. Capital is an input just like feed and feeder animals. The magnitude of the effect is greater for industries with larger up-front costs than for industries whose costs are spread more evenly throughout the production period. An increase in interest rates may lead producers to not expand herds, improve facilities, or adopt new technology because of the additional cost of financing. However, in times of decreasing interest rates, the livestock industry may expand due in part to more economical borrowing costs.

Short-Run Supply Impacts

Although the factors discussed so far generally impact the supply of a commodity over time, there are other factors that can create an immediate response in an industry. In the livestock industry, for example, severe weather and disease or pest outbreaks can immediately shift the supply curve to the left, assuming all other factors are held constant. In feeding livestock, extremely hot or cold weather slows the rate of gain. When this happens, the supply curve immediately shifts to the left because animals expected to be ready for slaughter at a certain time are not available.

Disease outbreaks affect the supply curve in much the same way. If an outbreak occurs in which animals must be destroyed, the supply curve immediately shifts to the left because supply is drastically reduced. In an outbreak where livestock can be treated but the medication used requires a withdrawal period before slaughter, again the immediate response is for the supply curve to shift to the left.

The Economics of Demand

In addition to understanding supply factors, market participants must also have a solid knowledge of factors affecting demand and recognize that these factors are often related to consumer attitudes and decisions. Although many factors can affect demand, it is again important to distinguish between factors that change the quantity demanded and factors that cause a change in demand (demand curve shift). A change in the quantity demanded is a movement along the existing demand curve. Opposite of a supply curve, a demand curve is theoretically downward sloping. As the price of a product increases, the quantity demanded decreases, creating a change in the quantity demanded. A change in the price of the specific product is the only factor adjustment that can create a change in the quantity demanded.

However, other demand factors can cause the demand curve to shift either to the right or the left, depending on whether the factor creating the change is viewed as positive (right or outward shift) or negative (left or inward shift), all other factors being held constant. The main factors that may cause a demand curve to shift include: 1) changes in population size and its distribution, 2) change in income, 3) change in the price of substitutes, 4) change in the price of complements, and 5) change in consumer preferences.

Change in Population Size and Distribution

Population growth can increase demand, and population reduction can decrease it. A shift in demand can also result from a change in population distribution, such as a growing number of elderly versus children, because preferences and/or needs of the larger population group dominate. For example, more baby food is sold during a population boom (increased demand for baby food) while other food products are sold after those babies have grown (decreased demand for baby food). However, it is also important to remember that changes in population occur over many years and therefore, do not have much of an impact on short-term analysis.

Change in Income

Increasing or decreasing income levels can also shift the demand curve. When income grows, people tend to spend a large proportion of the increase on additional goods and services and put a small proportion into savings. However, the response of the demand curve to an increase or decrease in income depends on the specific product. Generally, the benefits of an increase in income are not usually seen in food items but in other nonessential items such as cars and electronics. However, demand for meat has traditionally responded positively to increased income. This response is limited, however, by the fact that people can only consume a certain amount of meat no matter how much income increases.

Although meat demand generally has a positive relationship with income growth, not all meats respond in that manner. For example, if income increases, the demand for more expensive cuts of meat, such as steaks, may increase and the demand for less expensive products, such as ground beef, may decrease. When income decreases, there is usually a decrease in demand, or a leftward shift of the curve, for more expensive cuts and an increased demand, or outward shift, for the less expensive types of meat.

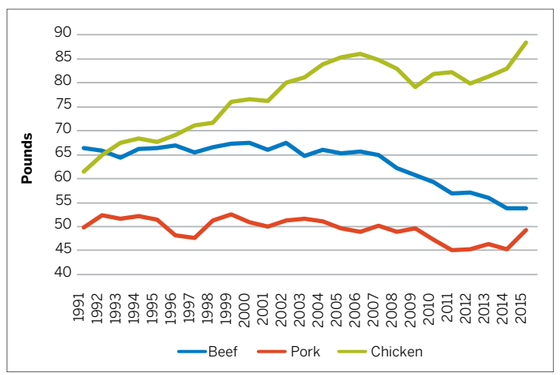
Change in the Price of Substitutes

Substitutes are goods that can be used instead of another good. For example, chicken can be a substitute for either pork or beef. When the price of a substitute good (product B) increases, demand typically increases for another good (product A). When users of product B switch to product A because they consider the price of product B too high, demand for product A increases. Similarly, when the price of a substitute good decreases, users of product A are likely to switch to the substitute, product B. Thus, demand for product A decreases and the demand curve shifts to the left.

Change in the Price of Complements

Complements are items that enhance, but are not a necessity to, a good in question. Barbecue sauce and beef or pork may be considered by some as complementary products. When the price of one of the complementary items increases, in this case, beef or pork, demand for another item, the barbecue sauce, decreases and shifts left. The opposite is true for a price decrease: demand would shift to the right, all other factors being held constant. For example, if the price of pork or beef decreases, demand for barbecue sauce may increase.

Chart 1 – Per Capita Meat Consumption



Source: USDA–ERS

Change in Consumer Preferences

Consumer preferences are constantly changing. There are many different reasons, such as age, increased awareness, and advertising. Increased consumer awareness may be related to increased health consciousness or exposure to new types of foods or preparation methods. Advertising can also sway a consumer's preferences for one item or another. Sometimes, there is a general shift in preferences for a large group of the population, such as a move toward a lower fat diet. It is extremely difficult, however, to measure demand curve shifts in response to changing preferences because they are not directly observable. Many times, preference changes are tied to an additional demand shifter, such as increased consumer income, which makes additional money available to buy different items.

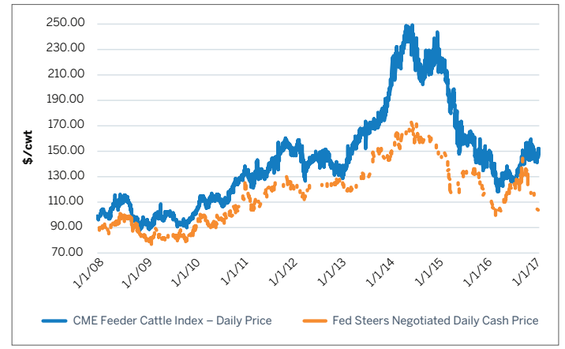
Seasonal periods can clearly and predictably result in changes in tastes and preferences. For example, there is increased demand for certain cuts of meat during the summer because many people enjoy grilling outside. Similarly, at Thanksgiving the demand for turkey increases while the demand for pork and beef decreases.

Chart 1 provides a graph of yearly per capita meat consumption for beef, pork and chicken in the United States from 1991 through 2015. The graph shows decreasing trends for beef consumption for the last ten years and an increasing trend for chicken consumption. It is important to note, however, that per capita consumption alone is not a measure of demand. Market participants must also consider relative prices and income when studying demand for meat.

Lagged Demand Impacts

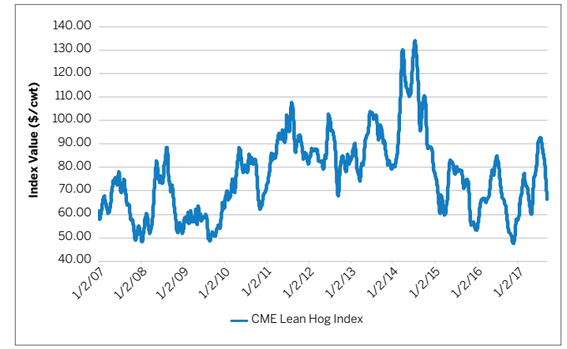
Changes in the demand curve may not be seen immediately, for several reasons. First, consumers do not have perfect knowledge of what is happening to the price of the goods and services they use. For example, they may not immediately know that the price of pork is falling relative to the price of chicken, which could change their purchasing and eating habits. Consumers are also uncertain about what is going to happen to the price of a good. They may not purchase pork the first time they realize price is decreasing because they might be waiting to see if the price is reduced further. A third reason for the lack of an immediate impact on the demand curve may be a barrier restricting consumers from purchasing a good. For example, a consumer may have purchased several cuts of meat the previous week and even with the price decrease of the current week, the consumer has no room in the refrigerator or freezer for additional purchases. Or, the consumer's food budget may not allow for additional purchases, no matter how attractive the price. A final reason demand changes may be lagged is that consumers tend to be restricted by their habits. If they have always bought a certain type of meat, they will generally continue with that meat even if its price increases relative to a substitute meat. Although each of these factors may cause a lagged response in demand, it is difficult to predict the exact length of the delay.

Chart 2 – Fed Steer Futures and Feeder Steer Index Prices



Source: USDA–AMS and CME

Chart 3 – CME Lean Hog Index Prices



Source: CME

Historic Price Responses to Changing Market Fundamentals

Chart 2 provides a graph of fed steer cash prices and the CME feeder steer price index, and Chart 3 provides a graph of the CME Lean Hog Index price. Cash prices for livestock in numerous locations are provided by the USDA's Agricultural Marketing Service (AMS). Several of these USDA reports are aggregated in the CME cash price indexes. The combined forces of supply and demand create movement in the prices of each respective commodity.

Livestock Cycles and Seasonality

In addition to knowledge of supply and demand factors, as well as pipeline production forecasts, market participants may also want to consider livestock cycles and seasonality when forecasting prices.

Livestock Cycles

Historically, livestock inventories and production have followed predictable cycles. These cycles have been useful tools in both cattle and hog markets for predicting expansion and contraction phases and thus, the directional movement of price. In the past, hog cycles have lasted an average of four years while cattle cycles generally have lasted 10 to 12 years. An actual cycle consists of the time between a trough (low point in inventory) and the next trough or the time between a peak (high point in inventory) and the next peak. The expansion phase of a cycle is constrained by the time it takes to raise female animals to breeding age and to produce offspring.

Increasing prices spur producers to retain female animals to increase the breeding herd. This initially reduces slaughter numbers and as a result, prices increase even further. However, once these female animals begin producing offspring and the offspring in turn reach slaughter weight, there may be an oversupply of livestock. Prices begin to decline and it eventually becomes unprofitable to raise and feed young animals. Producers begin culling the breeding herd and sending them to slaughter, adding additional numbers to supply and causing prices to decrease even further.

This is the contraction or downward phase, which can be long or short in duration depending on the incentives or disincentives provided by the price.

Although hogs and cattle have different average cycle lengths, the dynamics of the cycles are the same. Recently, there have been arguments about the reliability of the hog cycle. One claim is that the hog cycle is becoming more erratic due to changes in hog industry management strategies and structure, making it a less useful guide to understanding producer response to prices. The other side of the argument is that although the variation in hog production is decreasing over time, the large variations in price that accompany hog cycles are still present. Therefore, even though the industry may be going through structural changes, the hog cycle still exists and can be a useful tool in providing indications about the directional movement of price.

Currently, there are no similar arguments regarding the cattle cycle. This may be because the cattle industry has not seen the dramatic changes in structure that the hog industry has experienced. Nonetheless, anyone using either the hog or cattle cycles must remember that both need to be considered as long-run factors and are most useful when used in longer term price analysis.

Seasonality

Seasonality trends refer to ways that both the supply and demand for a commodity can be affected by factors that change with reasonable regularity during the year.

These changes include such factors as calving and farrowing seasons, summer consumer demand for grilling meats, and different seasonal holiday demands. For example, sales of feeder cattle tend to increase in the fall when grazing season ends and again in the spring when they are pulled off winter wheat. In the pork industry, there is a strong demand for ham and other cuts of pork during the winter holiday season and again around Easter. These and other seasonal trends can help in an analysis of the respective commodity.

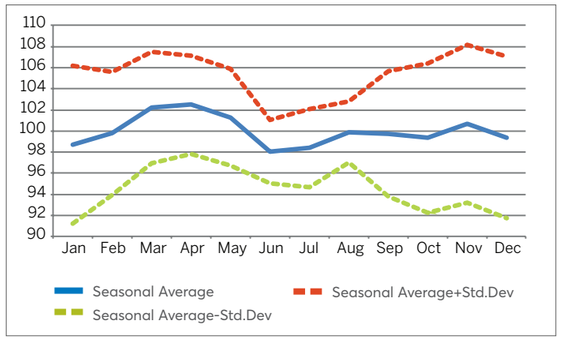
Seasonal tendencies reflect a repeated, measurable change in the level of some variable. Although there may be a sound reason to suggest such a shift, it must be detectable in historical data or it is of little use.

Charts 4, 5 and 6 present seasonality indexes for fed steer prices, feeder steer prices and commercial cattle slaughter, respectively. The respective indexes were derived by first calculating a yearly average for each year included. Each monthly number (price or commercial slaughter number) was then divided by the yearly average and multiplied by 100 to convert it into a percentage. Next, a monthly percentage average across years was calculated, providing the seasonal index number. Further calculations were completed to compute a monthly standard deviation. The standard deviation was then added to and subtracted from each monthly seasonal index number to provide a range in which prices or production numbers could fall.

A closer look at Chart 4 reveals that fed steer prices do show seasonal trends. In May through August and January through February, fed steer prices are generally below the yearly average. This is clear in the graph because the solid index line is below the 100-percent level for these months. These seasonal lows for fed cattle prices are driven by supplies of slaughter-ready cattle that are at their highest levels of the year. However, in the other months of the year, tightened fed cattle supplies push prices above the average yearly price.

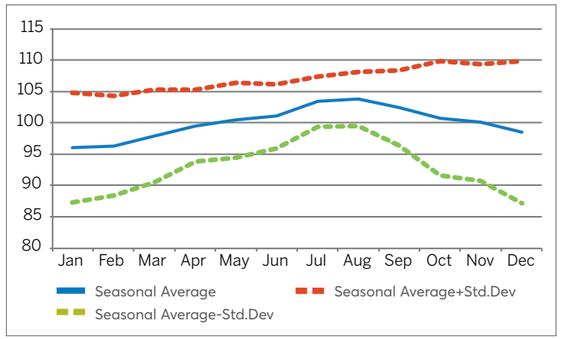
Towards the beginning of May and again towards the end of August, where the solid line touches the 100-percent level, price is equal to the average yearly price. The dotted lines on either side of the solid index line create a confidence interval, or a range in which prices are likely to fall. For a given average monthly price, there is a 68 percent chance that the price will fall within this range. Chart 5 shows the seasonal pattern for feeder steers (700-800 pounds in this chart) sold at Oklahoma City. Seasonal lows occur in the late winter-early spring period and again in the late fall when there are large amounts of cattle moving from grazing land to feedlots.

Chart 4 – Seasonal Index of Fed Steer Prices (2007-16)



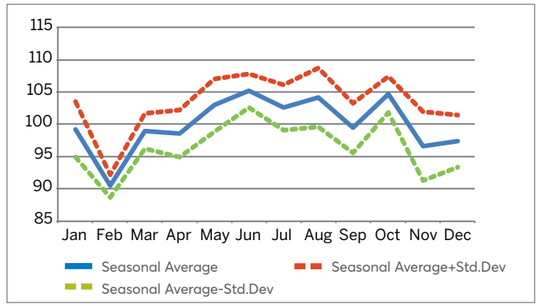
Source: USDA–AMS

Chart 5 – Seasonal Index of Oklahoma City Feeder Steer Prices (2007–16)



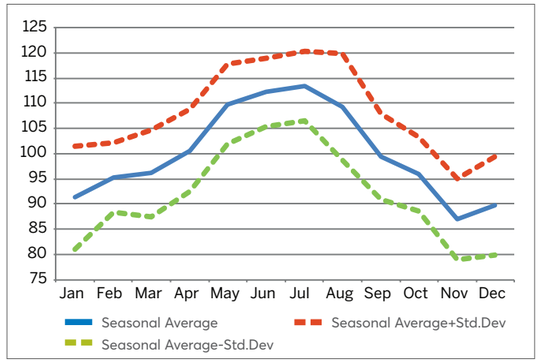
Source: USDA–AMS

Chart 6 – Seasonal Index of Cattle Slaughter (2007-16)



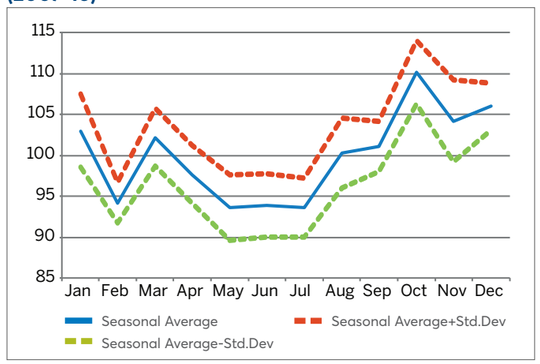
Source: USDA–NASS

Chart 7 – Seasonal Index of Lean Hog Prices (2007-16)



Source: USDA–NASS

Chart 8 – Seasonal Index of Hog Slaughter Head (2007-16)



Source: USDA–NASS

Chart 6 helps explain some of these seasonal price movements by plotting the seasonal trends in cattle slaughter. The dotted lines on either side of the index line again provide a confidence interval. When slaughter numbers in Chart 6 are above the yearly average, prices in Chart 4 tend to be below the yearly average. This is due in large part to the increased supply of cattle. The opposite is true when slaughter numbers are below the yearly average. During these months, price tends to be above the yearly average. These data support the previous discussion that there is a negative correlation between cattle price and slaughter numbers (quantity).

Although these figures depict seasonal trends for cattle, some seasonality is also leveled out. This is due in part because cattle are fed for different lengths of time depending on economic factors during that period and the genetic makeup of the animal. If feeding lengths did not differ, there would be an extremely large supply of cattle two times a year, correlating to the fall and spring calving seasons and a very small supply during other times of the year.

The seasonality of the hog industry is conceptually similar to that of the cattle industry. Seasonal indexes for lean hog prices and commercial hog slaughter were calculated (see Charts 7 and 8). Again, these indexes were created using the same methodology as the cattle seasonality indexes.

Chart 7 reveals that hog prices are higher than the yearly average during spring through early fall as the seasonal index line lies above the 100-percent mark. During most of this time period, monthly commercial hog slaughter, Figure 8, is lower than the yearly average. Prices are higher when the quantity of slaughter animals is lower and vice versa.

Seasonal indexes can also be used to distinguish when price and slaughter numbers have the greatest probability of being near the yearly average. This time period is observed in September for both price, Chart 7, and commercial slaughter, Chart 8. The confidence interval lines show the variation in the monthly average price or monthly average slaughter level. When the interval is narrow, the variation in the monthly average is low. Conversely, when the interval is wide, the variation in the monthly average is high.

Although seasonal trends are evident in these figures, it is again important to note that some of the variance in the movements has been muted due to production and management practices in the hog industry. For example, farrowing seasons are not as dictated by the weather as they once were because many hogs are raised in confinement with climate control. In the past, many producers would avoid farrowing during the winter due to the harsh conditions the baby pigs would have to survive. This is no longer such a strict practice and there is now a flatter, year-round production cycle. Although many production and management methods can help to keep a constant, year-round supply of hogs, demand factors still play an important role in the hog industry. For example, there is an increased demand for pork around the winter holiday season and no matter what production practices are used, this seasonal demand by consumers will still exist.

Sound price forecasting should be based on analyzing all factors that may affect seasonal supply and demand of beef and pork. Market participants must distinguish between one-time occurrences and actual trends, which are movements that occur in the same direction and roughly during the same time each year for several years. Once a trend has been identified, the indexes can then be used to help monitor and analyze the specific commodity in question.

One final caveat in the use of seasonal indexes is that although an overall average price or slaughter number for a particular month may be higher or lower than the overall yearly average, the specific monthly price or slaughter number in a specific year may not be higher or lower than that respective year's average number. These figures provide information for prices and slaughter numbers averaged over a period of years and data from each individual year cannot be singled out in the graphs.

Time Horizon

In any fundamental analysis, the time horizon is important to keep in mind. The factors that will affect prices over the next few weeks are often different from those that will affect prices over longer periods.

Take the following situation, for example: suppose the number of market hogs, as indicated by the USDA Hogs and Pigs Report, turns out to be much higher than the industry expectation. At the same time, there is a legislative proposal to increase the percentage of renewable fuels (such as ethanol made from corn) in gasoline content. There is also a forecast that unfavorable weather will reduce the expected yield of the current domestic corn crop.

What does all of this imply for the price of hogs? One interpretation would be an immediate price decline followed a few months later by a price decrease. The reasoning here is that in the next few weeks large supplies of hogs must be marketed and packers will only be willing to purchase them at discounted prices. However, the other news suggests that corn prices will begin rising immediately, raising the cost of feeding hogs. This should motivate hog finishers to reduce feeding periods and market their animals at lighter weights. After more time passes, the number of hogs on feed will be decreased resulting in a rise in prices.

Of course, the particular combination of news items here is unusual. But frequently factors may have both an immediate and a delayed influence on the available quantity of a commodity. As a consequence, livestock futures prices for different delivery months may not move in the same magnitude and may even move in opposite directions.

Conclusion

Becoming a successful livestock trader (whether a hedger or speculator) or livestock market analyst requires a basic understanding of the production and life cycles of cattle and hogs. This publication has attempted to provide an overview of those cycles to aid in building the skill set needed to begin trading in these commodities. Although this booklet introduces analytical techniques and information on the economics of each industry, it provides only a portion of what is needed to become successful in trading these commodities. In addition to understanding the livestock futures and options products, one must also become familiar with the actual procedures of trading, such as the different types of buy and sell orders, performance bond (margin) requirements, position limits, and the rule language for each commodity. It may also be helpful for the trader to study technical factors to assist in proper timing of entry into and exit out of the market. This additional knowledge, combined with the information provided in this publication, will help to create a successful hog and/or cattle commodity trader.

Sources of Information

Daily National Carlot Meat Report (USDA-AMS)
ams.usda.gov/mnreports/lsddb.pdf

Daily Cattle and Beef Summary (USDA-AMS)
ams.usda.gov/mnreports/lsddcbs.pdf

Daily Hog and Pork Summary (USDA-AMS)
ams.usda.gov/mnreports/lsddhps.pdf

Weekly Feeder and Stocker Summary (USDA-AMS)
ams.usda.gov/mnreports/lswnfss.pdf

Weekly National Feeder Pig Report (USDA-AMS)
ams.usda.gov/mnreports/nw_ls255.txt

Monthly Cattle on Feed Report (USDA-NASS)
usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1020

Monthly Livestock Slaughter (USDA-NASS)
usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1096

Monthly Cold Storage Report (USDA-NASS)
usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1034

Monthly Livestock, Dairy and Poultry Outlook (USDA-ERS)
usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1350

Quarterly Hogs and Pigs Report (USDA-NASS)
usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1086

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