Asymmetric Information in Cattle Auction: The Problem of Revaccinations

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Abstract: The paper analyzes the problem of asymmetric information between buyers and sellers in cattle auctions. An illustration is made regarding the vaccinations that the animals receive. Buyers do not know and cannot verify if sellers have vaccinated their animals forcing them to consider revaccination. Revaccination is only a part of the broader problem of information asymmetry that includes other quality issues and costs that can be saved, thereby increasing the welfare of both buyers and sellers. Structural characteristics of ranching, traditions and consumers' preferences are taken into account and a wider approach is attempted to explain the persistence of the problem in light of potential institutional solutions. We argue for a comprehensive empirical study of the incidence and impacts of buyer revaccination.

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Asymmetric Information in Cattle Auction: The Problem of Revaccinations

Introduction

Market failure, or inefficient exchange, in the beef cattle industry can occur when cattle are sold in live or public cattle auctions. In these auctions, sellers typically report the general protocol that was followed in their handling of their cattle, particularly with respect to vaccinations. In many cases, sellers will simply report, “these cattle have had their shots.” However, buyers will often revaccinate the cattle they purchase to be sure the cattle are, in fact, vaccinated. Although revaccination costs are typically small – between $0.50 and $5.00 per head – these costs can accumulate, especially when herds of hundreds or even thousands of cattle are revaccinated. In addition to the direct costs associated with revaccination, there are also indirect costs. For example, revaccination takes time, and revaccination can produce injection site lesions that lower the quality of a carcass.

The purpose of this paper is to examine the problem of asymmetric information in live cattle auctions. Our analysis is motivated by the problem of revaccination – why do buyers revaccinate if sellers report that their cattle have had their shots? This question embodies issues arising from institutional characteristics of the cattle auction system in which cattle are priced on weight and knowledge of upstream production practices is not costlessly transparent to downstream users. Although asymmetric information has been studied in other livestock systems (e.g., Allen, 1993), to date there has been no systematic study examining asymmetric information and its implications in the context of the live cattle auction system. This paper is a first step in that direction. We begin the paper by discussing the nature of asymmetric information generally. We also provide a brief overview of the beef cattle food chain and a discussion of the development of the live cattle auction system. We then show how asymmetric information could be an important problem in the live cattle auction system, as illustrated by the propensity of buyers to revaccinate the cattle they purchase when told the cattle have already been vaccinated. Given the significance of the beef cattle industry to U.S. agriculture as a whole, we argue for a more comprehensive empirical investigation of the asymmetric problem. Simply, are there potential cost reductions that could be obtained from a recognition, understanding, and resolution of the asymmetric information problem in live cattle auctions? We also argue that, although solutions to the asymmetric information problem have been proposed or are in the process of being implemented, structural characteristics of U.S. ranching may impede the application of these institutional measures on a large scale.

Information, Asymmetric Information and Market Failure

The classical economic model underestimates the importance of information in the economy. To be more accurate, it simply ignores information. This is due to one of the main assumptions of the classical model: Actors interact in a frictionless economic system where information is available to everybody instantly and at no cost. Although information costs were widely apparent in economic activities, it was years before economists began to incorporate them within their models. This was due in part to the convenience that the classical assumptions provided. This changed following Stigler's 1961 paper on the "Economics of Information" and the corresponding development of the research field of New Institutional Economics (NIE).

Within the NIE framework, information is central, impacting issues of risk, uncertainty, opportunism, adverse selection and moral hazard, as well as institutions generally. According to North (1990), the role of institutions is "to reduce uncertainty by providing a structure to everyday life." In order to interact with others we must know the rules of the game, otherwise uncertainty will be high and value-creating transactions may not occur. In order to acquire the needed information, human economic actors form institutions that come at a cost. Information is costly because actors have to spend time acquiring it and measuring the attributes of the goods (quality). Harold Demsetz (1993) refers to information-knowledge as a fundamental feature of firms, and he characterizes the firm as a repository of knowledge. Oliver Williamson (1985) analyzed the implications of incomplete information among economic actors. Opportunism coupled with information that only one party has (i.e. asymmetric information between parties) may result in adverse selection and moral hazard.

George Akerlof (1970) was an early pioneer by examining the consequences of asymmetric information. He used the example of a used car market in which sellers know the quality of the cars they sell but buyers do not. This drives the prices of good cars down. The reason is that buyers know that sellers of both good and bad cars have an incentive to claim that their cars are good in order to sell them at higher prices. If it is costly or difficult for buyers to find the true quality of cars, they are, at best, willing to pay an "average" price, thus driving good cars (or cars valued higher than the average) out of the market or resulting in an inefficient allocation of good (and bad) cars. We claim that this describes live cattle auctions in this sense: Determining whether cattle auctioned at live cattle auctions have been vaccinated is difficult for buyers. Thus, buyers are either not informed of the quality of cattle – in which vaccinated cattle are assumed to be of higher quality than unvaccinated cattle – or they do not trust the statements of sellers indicating that cattle are vaccinated. Thus, buyers vaccinate cattle, some of which have already been vaccinated and, perhaps, drive the average price paid for all cattle lower as in the case of the used cars.

The determination of quality in the face of asymmetric information is directly related to the issue of measurement costs. If a low cost method of determining whether cattle have been vaccinated can exist, then the live cattle auction system could segment the market into vaccinated cattle and unvaccinated cattle, thus resolving the problem of asymmetric information. Allen (1993) shows this in an analysis of veal calf auctions in British Columbia. While breed does not play any significant role in the sales of feeder cattle where usually Angus and Hereford dominate as pure beef breeds, it is not the case in veal calf where Holstein (although a dairy breed) dominate in live auction sales. The reason, according to Allen, lies in a unique characteristic of Holstein, which is used as an easy and low cost signal for quality measurement. Holstein calves develop a "pot belly" when fed hay (low quality veal) instead of milk and grain (high quality veal). The pot belly is a low cost signal of quality. The ability of buyers to identify at low cost good from poor quality veal allows the market to segment and differentially price veal, resulting in a (relatively more) efficient allocation of veal.

The beef food chain and the development of the live cattle auction system

Prior to the development of railroad and telegraph, livestock as well as other agricultural commodity markets were inefficient and unorganized (see Olson, 2001a, 2001b, 2001c, 2001d). This was because of the existence of extremely high transaction (transportation) costs. The traditional mercantile firm was responsible for marketing and distribution of goods. Once the telegraph and the railroad made their appearance transaction costs were considerably reduced. Large-scale markets could emerge, as well as a type of intermediary (drovers) who "arranged the purchase, transport and delivery of products across the nation and brought an organizational revolution to agriculture" (Olson, 2001a, p. 3). The problem with the drovers was the price markup they received because ranchers were depending on them to sell their livestock. The ongoing development of railways, however, gave ranchers access to markets directly, thus reducing their dependency, and ultimately eliminating the need for drovers. Major terminals were created in Kansas City and Chicago, where many buyers and sellers met to trade, thereby creating a competitive market. "The railroads created a national market for beef, pork and mutton when they opened the Great Plains and the Southwest to trade" (Olson, 2001a, p. 3). One other problem appeared. "As the size and scale of terminal stockyards increased it was difficult for individual ranchers to market their own animals effectively due to lack of market savvy and familiarity with stockyards personnel. This reduced the likelihood of a suitable financial return" (Olson, 2001b, p. 7). The commission merchant emerged as a necessary intermediary. Their cost of operation was relatively small, and so they quickly replaced the institution of drovers.

Price discovery at these terminal markets is more efficient than in direct sales. This is because sales at terminal markets are made under nearly standard conditions and are based on a measurable attribute – for instance, the weight of cattle. The ability of buyers and sellers to discover prices at markets allows them to calculate readily net returns from price quotations. Many livestock buyers and sellers consider terminal market prices the only accurate barometer of cattle prices (Greene, 1969).

Improvements in transportation technologies, which produce savings in shrinkage and marketing costs, resulted in a gradual replacement of terminal markets by regional live cattle auction markets. "The invention of the motor truck brought a second organizational revolution to the livestock trade" (Olson, 2001d, p. 20). The dense web of roads created an opportunity for many ranchers who resided far from railroads to sell their cattle quickly and easily. It also allowed ranchers near railroads to sell in nearby places rather than going to distant terminals.

The regional cattle auction institution emerged in the Great Plains by 1940s and 1950s. Terminal markets declined until they had nearly disappeared by early 1970s.

The direct marketing of cattle is an alternative to regional live cattle auctions, and its use has increased due to continued improvements in transportation facilities. In direct marketing, each sale is a private agreement between individual buyers and sellers. Therefore, sales are more geographically scattered than sales from live cattle auctions. Additionally, the amount of shrink charged, weighing conditions, terms of delivery, and terms of payment tend to vary from ranch to ranch. There is scope for inefficient price discovery through direct marketing, however, as less than purely competitive conditions of price formation are prevalent. According to St. Clair (1976, p. 1), the "direct method of marketing is high in technical efficiency (i.e. savings in shrinkage and marketing costs) but it may be low in pricing efficiency."

Cattle auctions and information

The beef food chain can be represented as a pyramid. At the base of the pyramid lie the cow-calf producers, who maintain an average herd size of approximately 40 cows.[1] They sell to auctions once or twice a year and usually keep the calves for about eight months to a year. In the second stage are the backgrounders, who maintain herds with average size of about 1000 head. There are fewer backgrounders than cow-calf producers, but still enough to produce competitive conditions in auctions in most cases. Backgrounders patronize cattle auctions five to six times a year and keep the calves for around three to nine months. The third level players are the feedlots. Approximately 98 percent of US feedlots have capacities of less than 1,000 head of cattle, although the few maintaining herds with an average size in excess of 30,000 head market 40 percent of fed cattle (USDA, 2003). Feedlots usually buy cattle through direct sales from backgrounders, although they may also purchase through auctions from either backgrounders or cow-calf producers. Feedlots keep cattle for approximately four to five months. The apex of the pyramid is occupied by only a few meat processors, who often have a flow of 1000 or more head per day.[2] The vast majority of their cattle come through direct sales from feedlots, but small numbers come from large ranchers or groups of ranchers (cooperatives) by way of auctions.

Live cattle auction sales are ubiquitous at the cow-calf producer to backgrounder stage of the beef food chain. They are less common, or even rarely used, at higher levels of the beef food chain (i.e. between backgrounders and feedlots and between feedlots and processors), in which direct marketing of cattle is the norm. Live cattle auctions have many characteristics of a competitive market in the classical model. A small seller (i.e., having 25-40 head) who wants to sell a few calves can notify an auction house asking them to pick his calves for auctioning. Such auctions lower the cost of price discovery for these ranchers, which Coase (1937) argued is the principal source of transaction costs in a market. For example, Crase and Dollery (1999) used the Travel Cost Method to evaluate the importance of the market information provided to sellers. They wanted "to quantify the value of market information gained by sale yard users through direct visits to livestock selling complexes." They estimate the cost at $160.50, which "represents the annual value of market information derived by a single producer directly visiting the sale yard venue" (p. 205). The value of price discovery is a principal advantage to ranchers who have relatively small herds and who frequent markets only a few times a year. However, as we show below, a problem with cattle auctions is the asymmetric information problem. The asymmetric information problem also will have a bearing on the negotiation aspects between the players in the market. Another disadvantage with auctions is that there is much scope for the spread of diseases due to the co-mingling of various cattle from different areas and the resulting animal stress, which demands that auction operators take costly measures to minimize the risk of disease spread.

Direct cattle sales overcome the problem of asymmetric information, because buyers are more likely to buy from sellers they know (or who have an established reputation, particularly with respect to statements regarding protocol, such as vaccination histories). However, price discovery is costly in direct sales, thus making them attractive only to large buyers and sellers who have more frequent interactions with markets than small-scale ranchers.

Asymmetric information in cattle auctions

We argue that asymmetric information might be an important problem in live cattle auctions, as manifested in part by the revaccination problem in which buyers of cattle that are reported to have had their vaccinations repeat the vaccinations after purchase. Why do buyers revaccinate, if auction runners (or sellers) announce that the herd has been vaccinated? There are two possible answers. The first is that buyers do not trust the statements of sellers. The reason is reflected in the fact that buyers cannot distinguish at low cost cattle that have been vaccinated from cattle that have not been vaccinated. This results in a pooled price for cattle in which cattle that have been vaccinated and cattle that have not been vaccinated are sold at the same price, usually with price determined by cattle weight and, perhaps, by other measurable attributes. Such pricing could provide less incentives for sellers to vaccinate their cattle resulting in an even greater number of cattle offered for sale that are not vaccinated, thus giving buyers greater reasons to vaccinate cattle they purchase. This problem is exacerbated when sellers might not place a high priority on reputation building or if the sale is blind with respect to the parties involved as is the case using order buyers. Furthermore, vaccination in cattle purchased might not be a high priority for buyers, who focus primarily on price, weight, breed, external appearance (signals for good condition). The second answer is that buyers might trust the reported protocol but revaccinate for other reasons. For example, many buyers buy cattle from many sellers and thus co-mingle cattle from different herds. Different regions throughout North America might have slightly different protocols for vaccination, because some diseases are more common in some parts of the country than others, and vaccinations occur on different schedules. Therefore, buyers might revaccinate in order to have a homogeneous treatment of their animals. Furthermore, some buyers might prefer a particular brand or type of vaccine. In the absence of definitive empirical evidence, we are unable to distinguish between vaccinations by buyers occurring for either of these two reasons. However, as we show below, both reasons represent an inefficiency that has its roots in the asymmetric information problem and which are perpetuated by structural conditions inherent within the U.S. beef industry.

Historically, problems derived from the information asymmetry were recognized and attempts have been made to solve them. For instance, in the 1950s sellers used to "accompany their livestock to market and remain until they are sold" and "prospective buyers were often able to discuss the merits and faults of a specific animal with the owner" (Johnson, 1954, p. 1). Johnson continues: "Generally, buyers will pay higher prices for animals consigned by reputable producers who assure them privately that the animals are clean and O.K." However, over time there has been a change in the livelihood of sellers. Traditionally, most farmers were full-time farmers who accompanied their herds to the auctions and were willing to establish a relationship with buyers. Today, many cow-calf producers are part-time ranchers; thus, the opportunity costs of their time are much greater than traditional farmers, resulting in their spending less time at the auctions.

The problem of asymmetric information may also be associated with the consumer demand in the market. If consumers do not care about differences in quality or about health and safety aspects of the foods they consume, then asymmetric information would not be an issue in that no signal would be transmitted downwards in the beef chain for price differentiation. However, quality is important for consumers, who are often willing to pay more for better quality (Melton, Huffman, Shogren, and Fox, 1996; Jensem, 1986; see also Smith, 1986). Moreover, in the last 10-15 years there was a dramatic increase in consumers' concern about food safety issues because of series of problems like presence of dioxins in chicken and mad cow disease (i.e., BSE) in Europe, as well as issues related to genetically modified organisms. Consumers have also become sensitive to environmental issues, the well-being of animals and labor issues. Therefore, shifting consumer sentiments might suggest a greater need to understand the nature and extent of asymmetric problems in cattle markets, resulting, perhaps, in opportunities for the cattle industry to lower costs or increase value added.

Market inefficiency illustration

We illustrate the inefficiency of revaccinations resulting from asymmetric information using a simplified game theory framework. We assume that there are sellers and buyers of cattle. A particular seller will either vaccinate (v) or not vaccinate (n). Similarly, a particular buyer will either vaccinate or not vaccinate depending on his belief of whether the seller has vaccinated or not. We use the following variables (with definitions provided):

- e Expected value of a healthy animal
- c Cost of vaccinating an animal
- s Cost of treating a sick animal

- p_s^v Probability that an animal gets sick if vaccinated
- p_s^n Probability that an animal gets sick if not vaccinated
- p_d^v Probability that an animal dies if vaccinated
- p_d^n Probability that an animal dies if not vaccinated

We assume that $p_s^n > p_s^v$ and $p_d^n > p_d^v$; the probability that an animal gets sick or dies when not vaccinated exceeds the probability the animal gets sick or dies if vaccinated. For simplicity, we also assume that the loss of an animal that dies is *e* (there is no salvage value to the animal carcass). We first examine the incentives for sellers to vaccinate and then examine the incentives for buyers to vaccinate.

Vaccination by Sellers

Given the assumptions of the model, vaccination by sellers is efficient if the cost of vaccinating cattle is not greater than the cost of not vaccinating cattle. This is true if

$$c + p_s^v s + p_d^v e \leq p_s^n s + p_d^n e \qquad (1)$$

or if

$$c \leq s(p_s^n - p_s^v) + e(p_d^n - p_d^v) \equiv c^s. \qquad (2)$$

The left hand side of equation (1) is the expected cost to the seller from vaccination, while the right hand side of (1) is the expected cost to the seller from not vaccinating the animal. Equation (2) says that sellers will find it in their interest to vaccinate if the cost of vaccination is not too high – that is, if the per unit cost of vaccination does not exceed a maximum per unit value, c^s. An increase in c^s means that it is more efficient for sellers to vaccinate, other things being equal. The maximum per unit cost, c^s, increases in *s*, *e*, p_s^n and p_d^n; it decreases in p_s^v

and p_d^v. That is, it is efficient for sellers to vaccinate if the cost of treating a sick animal increases, the overall value of the animal increases, and the probabilities of an unvaccinated animal getting sick or dying increase. Sellers have a diminished incentive to vaccinate if the probability that a vaccinated animal gets sick or dies increases, other things being equal.

Whether a *particular* seller vaccinates his cattle before offering them for sale at a live cattle auction, however, depends in part on that seller's per unit cost of vaccination. Because different farmers have idiosyncratic characteristics, for some farmers $c \le c^s$ while for others $c > c^s$, depending on the exact values that each farmer attributes to the above variables. In other words, for some sellers vaccination is efficient, while others it is not.[3]

Do all sellers with $c \le c^s$ vaccinate their cattle? Unfortunately, there is no hard evidence on the rates of and reasons for vaccination by sellers, which is one reason we call for an extensive examination of vaccination practices. Nevertheless, we conjecture that larger ranchers will have an incentive to vaccinate, while cow-calf producers with smaller operations – which are the vast majority – will not. The reason is that, other things being equal, larger ranches will likely have lower per unit costs of vaccination than smaller ranches, because the size of operation allows fixed costs associated with developing a vaccination program to be amortized over a larger output. Moreover, smaller herds may have less risk of getting diseases, thus reducing the seller's perceived need (and hence incentive) for vaccination. For instance, for ranchers with small herds, the probability that an unvaccinated animal gets sick or dies might be lower than the corresponding probabilities for large cow-calf operations, resulting in a reduction in c^s for small-scale ranchers. This will make it less likely that a small-scale cow-calf producer will find it in his interest to vaccinate, other things being equal.

Vaccination by Buyers

Buyers have to choose whether to vaccinate the cattle they purchase. If cattle have been vaccinated, buyers would not need to revaccinate. However, buyers cannot know with certainty whether cattle they purchase have been vaccinated, even if sellers announce that their cattle have been vaccinated. Therefore, buyers must decide whether to believe announcements by sellers. Because buyers do not have full information about whether cattle have been vaccinated, let q, where $0 \leq q \leq 1$, be the (perceived) probability that the seller vaccinated his cattle. Buyers will not vaccinate if the cost of not vaccinating is less than the cost of vaccinating. This is true if

$$q(p_s^v s + p_d^v e) + (1-q)(p_s^n s + p_d^n e) \leq c + p_s^v s + p_d^v e \qquad (3)$$

or if

$$c \geq [s(p_s^n - p_s^v) + e(p_d^n - p_d^v)](1-q) \equiv c^b . \qquad (4)$$

The left hand side of equation (3) represents the expected cost to the buyer from not vaccinating. If consists of two parts, distinguished by the probability that the cattle purchased have been vaccinated (q) and the probability that the cattle purchased have not been vaccinated ($1-q$). The right hand side of equation (3) is the expected cost to the buyer of vaccination. Equation (4) says that it is not efficient for buyers to vaccinate cattle they purchase if the cost of vaccination is too high – that is, if the per unit cost of vaccination exceeds a maximum condition, c^b. This condition is similar to c^s (the condition for sellers), although for buyers it is also a function of, q, the probability that sellers have vaccinated.

There are two important points to be made here. First, as long as buyers (a) expect that some sellers have not vaccinated their cattle and (b) cannot identify at low cost who those sellers are, then $q < 1$ and thus, at least for some buyers, the $c < c^b$ condition will hold, resulting in buyers believing it is efficient to vaccinate (or revaccinate, if sellers have already vaccinated their cattle).[4] This suggests that buyer beliefs are important. In fact, the greater the (perceived) probability that cattle have been vaccinated, the less likely buyers will vaccinate, other things being equal (i.e., c^b decreases in *q*, resulting a greater likelihood that the cost of vaccination will exceed the maximum amount, making it inefficient to vaccinate). In the limit $c^b = 0$ as $q \Rightarrow 1$ (i.e., vaccination is never efficient if all sellers always vaccinate or buyers can know at zero cost which sellers have and have not vaccinated). Therefore, institutional or other factors that improve the quality and quantity of information transmitted from sellers to buyers could reduce the incidence of inefficient revaccination.

Second, if buyers believe with positive probability that sellers have vaccinated, (i.e., $q > 0$), then $c^b < c^s$. This suggests that, other things being equal, the per unit cost of vaccination for buyers, which includes not only the cost of the vaccine but also the opportunity cost of time and the reduced value of meat resulting from injection site lesions, must be lower than the per unit cost of vaccination by sellers before buyers will vaccinate, other things being equal. Thus, for some buyers $c \geq c^b$, suggesting that it is not efficient for them to vaccinate, even though the vaccination condition would be met from a seller's perspective (i.e., $c \leq c^s$ and $c \geq c^b$ could hold simultaneously).[5] But, some buyers might revaccinate anyway, for example, because they are concerned about commingling of cattle from different herds, or because they prefer certain vaccination regimens to others. Even in these cases, buyer revaccination is inefficient as long as $c \geq c^b$ (because c^b already incorporates the probabilities of cattle getting sick or dying, from, for instance, the co-mingled of herds). Simply, if $c \geq c^b$ then it is not efficient for a buyer to vaccinate.

Importantly, there is no hard evidence on the incidence of vaccination (or revaccination) of cattle by buyers (or sellers). Given the significance of the U.S. beef cattle industry to agriculture and the economy, particularly vis-à-vis increasing foreign competition, efforts to lower costs (by avoiding the problem of buyer revaccination, for instance) are paramount. Accordingly, we argue for a comprehensive empirical examination of the incidence and causes of buyer (and seller) vaccination of cattle as a means of understanding the nature and extent of the asymmetric information problem and of providing, if possible, mechanisms by which production costs could be lowered.

Solutions to the problem of asymmetric information

Institutions are the rules of the game in a society; more formally, they are the humanly devised constraints that shape human interaction (North, 1990). In the case of revaccination by buyers, institutional solutions to the asymmetric information problem would increase the quantity and quality of information about the cattle that buyers purchase, such as knowledge of parental lines, progeny, types of medications given, and feeding and handling regimes, thus allowing buyers to make more efficient vaccination decisions (i.e., vaccinate when efficient to do so, or when $c < c^b$, and not vaccinate when not efficient to do so, or when $c \geq c^b$). We consider briefly three institutional solutions to the asymmetric information problem: (a) source verification and traceability programs, (b) certified preconditioning programs, and (c) video and electronic auctions. Our purpose is not to provide a comprehensive examination of these programs. Rather, it is to assess their potential in solving the problem of asymmetric information in live cattle auctions in order to reduce the likelihood that buyers will engage in inefficient revaccination of cattle. We suggest that while these programs can be effective in alleviating some aspects of the asymmetric information problem, in practice they will be ineffective, given the structural characteristics of the U.S. cattle industry.

Source verification and traceability programs

"Source verification" refers to a program in which a third party assures the condition of the cattle to buyers, such as how the cattle was treated, their health status, feeding, vaccinations, weaning, castration, dehorning processes, etc. Source verification programs are often private initiatives of groups of farmers who "recognized that significant niche markets exist for consistent-quality beef and pork products and that other niche markets which address emerging consumer needs can be successful (e.g. Niman Ranch Pork)" (Bailey and Hayes, 2002, p. 2). Examples include the MFA Health Track Beef Alliance (information available online at http://www.mfaincorporated.com/livestock/beef/healthtrack/index.asp) and the University of Missouri Commercial Agriculture program's Premier Beef Program. In the case of Premier Beef, average value added for the years of operation (1998-2002) was $44.41 per head (information available online at http://agebb.missouri.edu/commag/beef/premierbeef/).

Source verification allows producers to capture higher premiums on quality. The reason is that information flow is guaranteed from the processor to the farm. Source verification also offers the possibility of traceability. "Traceability is obtained through a system of records and certifications that allow a product to be traced back to its origins. Currently, most red meat is traceable back to the processor but not to the farm level" (Bailey and Hayes, 2002, p. 1). Vertical coordination is a key part of facilitating information flow and thereby gaining premiums. Instead of cow-calf producers selling their cattle to backgrounders, groups of producers build alliances by integrating backgrounding and by retaining ownership of cattle, thereby gaining value added from the backgrounding activity when they market directly to feedlots.

There are considerable transaction costs associated with establishing a traceability program. First, there has historically not been a demand for traceability within the U.S meat market, in part because the industry does not depend heavily on exports – although over time this is changing. Standardization and price discrimination will effectively capture gains from niche markets for different grades of quality. Porter's approach for technical firms applies also in the case of cattle. Absence of product standardization impedes cost improvements (e.g. revaccination). Given the increased degree of uncertainty of consumers especially after the single BSE case in the U.S., lack of standards can lead to consumer's suspicion (Porter, 1980).

Additionally, in order to be able to trace back every animal (not only cattle) within a short period of time, as provisioned by the U.S. Animal Identification Plan (information available online at http://usaip.info), it is necessary that full coordination exists between all links of the beef chain, including cow-calf producer, backgrounder, feedlot, packer, wholesale, and retailer (Rentfrow, 2003). Importantly, traceability does not necessarily guarantee quality – vaccinated cattle might still get sick or die from illness or disease. If an animal gets sick or dies, is it because the animal was – or in spite of being – vaccinated? Although traceability might allow a cattle owner to trace the origin of his herd back to original owners, it cannot necessarily be used to "prove" to original owners that they had not vaccinated cattle if they had reported that they had. Only when traceability is combined with third party verification of traceability reports will buyers begin to believe seller reports that cattle have been vaccinated or with the building of brand equity that can occur in this type of coordinated system. But even here, the impact of traceability combined with third part verification will be that buyers will have more accurate perceptions of the probability that cattle purchased have been vaccinated, thus resulting in a reduced incentive for vaccinations (per the model presented above). However, third party verification is costly to implement, except in cases in which herd sizes are large (which allows for the amortization of verification costs over a greater level of production). Thus, the asymmetric information problem, manifested by revaccination of cattle by buyers, is not necessarily resolved here.

Certified preconditioning programs

Certified preconditioning programs, as the term indicates, involve formal certification and documentation about the preconditioning activities that have been implemented by sellers. The term preconditioning *per se* is quite loose and "there is no standardized definition for this term as it applies to beef calves prior to, during, and/or after the weaning and shipping period" (Lalman and Smith 2001, p.1). An example of a preconditioning program is Oklahoma Quality Beef Network (information available online at http://www.ansi.okstate.edu/exten/cc-corner/oqbnsummary.html). Premiums are calculated to vary between $3 and $8 cwt, which translates to $15-$40 per head (Avent, et al. 2003).

"Preconditioning programs involve a series of management practices on the ranch to improve health and nutrition of calves. Preconditioning adds value to calves benefiting the cow-calf producers. Preconditioning is not a new idea, but has received considerable attention in recent years in value-added programs for cow-calf producers, beef quality assurance programs, and strategic alliances in beef industry" (Avent, et al., 2003, p. 1). The premiums derived from preconditioning programs come principally from the weaning procedure. Weaned cattle suffer much less stress when transferred and co-mingled. This stress is a main source of disease and death among cattle (Lalman and Smith, 2001). For instance, Avent et al. (2003) provide evidence that the probability of sickness is reduced in preconditioning programs. Furthermore, according to Texas Cattle Feeders Association Feedlot Managers, precondition calves produce a higher percentage of Choice carcasses compared to non-preconditioned cattle (Avent, et al. 2003). Lalman and Smith (2001, p. 5) estimate that weaning in the ranch "can capture $50 – $75 per head of additional value compared to a production system where weaning, vaccination, and other management practices associated with preconditioning occur after shipment from the ranch of origin."

Preconditioning programs can alleviate the asymmetric information problem at live cattle auctions only when buyers trust the certification programs and procedures. If buyers do not fully trust the programs or the third parties responsible for certification, then they will not be willing to offer premiums for certified quality cattle, thus mitigating perceived benefits that sellers require in order to justify the added costs associated with preconditioning. Simply, if buyers base their vaccination decisions on the probability that sellers have vaccinated, then a lack of trust in the system will not increase the buyer's perception that sellers have vaccinated, thus resulting in many buyers believing it is efficient to vaccinate when, in fact, sellers have already done so. Furthermore, because preconditioning "works" when buyers trust the certification procedures and programs, problems of asymmetric information are not necessarily eliminated, but rather are transferred from sellers to entities maintaining the certification processes (i.e., will buyers trust the certifiers?).

Video and electronic auctions

Video and electronic auctions are a natural outgrowth of improvements in information technology. These auctions can reduce time as well as other transaction costs. In a video auction, buyers observe cattle via monitors and bid for them from their homes or offices without spending time to go to the auction place. Electronic auctions are typically online and consist of a description of a specified cattle lot (often with photographs), and an ability of potential buyers to enter bids. An important difference between video and electronic auctions is that video auctions are synchronous in that all buyers bid simultaneously, online or electronic auctions have a time margin. A second important difference relative to our discussion of information asymmetry is the amount of information offered. Video auctions have the potential of providing more important information about sellers and their cattle to buyers than online auctions because of the presence of a third party who visits the ranches and videotapes the cattle, thus verifying the condition of cattle at the source of production. This aspect is very important in solving at least a part of the problem of asymmetric information regarding vaccinations given to the cattle. In the case of online auctions, sellers will often report production protocols, such as cattle having had their vaccinations, but no "evidence" is offered to support the claims, thus resulting in asymmetric information problems. Bailey, Peterson, and Brorsen (1991, p. 465-66) studied and compared video auctions to regional auctions. They found that

> Satellite video auctions reduce travel time and expenses for buyers who can bid from remote locations. They also reduce buyers' search time since they can offer a large number of cattle quickly.… Using video auctions health problems are reduced because cattle is not mingled with those from other lots, and is transported to only one destination.… Video auctions may provide buyers with more information about the history of cattle, type of feed, and vaccinations than traditional auctions provide.… This information could reduce buyers' death losses, reduce veterinary costs, and increase feedlot efficiency.

As a result, video auction prices are often higher than regional market prices. Buyers "are willing to pay between $4.62 per head and $23.52 per head more for a 700-pound steer purchased through video auction than for a steer purchased at a traditional auction" (Bailey, Peterson, and Brorsen, 1991, p. 472). However, video auctions favor large producers. This is very important for our analysis. As Bailey and Peterson (1991, p. 402) conclude, "video auctions accommodate large transactions well, unlike traditional auctions that seem to be designed to facilitate relatively small transactions." Thus, because video auctions favor large producers, and because the U.S. beef cow industry at least at the cow-calf stage is dominated by small producers, it is unlikely that video auctions will soon become the norm. Making it the norm will be costly, given that sellers must "contract" with third parties to visit their farms and video tape their cattle. We do not expect that small-scale ranchers will necessarily find it in their interest to incur such expenses. Consequently, problems of asymmetric information will remain.

General drawbacks of the solutions

We argue that the structural features of ranching and the beef cattle industry in the U.S. make implementation of these approaches as solutions to the asymmetric information problem difficult. First, economic facets of beef production suggest that there will be significant transaction costs associated with implementing an alternative to commodity weight marketing of beef cattle, whereas in non-beef systems alternatives to commodity weight marketing have developed at relatively low cost. For example, the modern housing arrangements for pork and poultry allow (and even favor) identical genotypes and phenotypes in all areas of the country. The indoor environment of a pork facility in North Carolina may be constructed the same as a facility in Oregon. The type of swine, (including growth rate, feed efficiency, and so forth) needed in both facilities, can thus be identical favoring full integration and replication of production facilities and systems with little regard to location. One of the advantages of this system is that animals are transferred between stages of the system based on a variety of product characteristics and not just the animals' weight, as is currently the case in the commodity beef system. In contrast, the cattle industry has production facets that do not favor a transition to the level of vertical integration seen in these other industries and thus will likely not follow suit. The environment, forage type, and pest exposure in different areas of the North American continent dictate that cattle breeds and genetics are chosen that will enable the animal to excel biologically and economically in each of these areas and will differ depending on location. A particular breed and type of cow that is best suited for the Midwest is much different from that required in the Southwest, for example. Whereas poultry and pork production environments are tailored to the production systems, beef production systems are tailored to the local environments.

Second, beef cattle herds at the cow-calf stage of production are small, and are likely to remain small, particularly given the economic facets of cattle production mentioned above. Indeed, beef cow herds have an average size of 40 head, although many exceed 100 head of cattle (USDA, 2003). Given the cost of video auctions, only large-scale farmers will likely be willing to incur the associated costs. Traceability is also costly to implement, and, as mentioned above, does not necessarily resolve the incentive buyers might have to vaccinate cattle that have been reported to have been vaccinated unless there is third party verification, which also favors large producers. Only when identity preservation programs become mandatory and an effective system of compliance enforcement is established with the problem of asymmetric information in live cattle auctions be resolved. The implication is that proposed solutions to the asymmetric problem are unlikely to resolve the basic manifested problem – that of buyer revaccination of cattle they purchase.

Conclusions

Information asymmetry creates inefficient outcomes. Buyers do not minimize their costs and sellers do not maximize their rents. We examine the asymmetric information problem as it pertains to inefficient revaccination of beef cattle purchased through the live auction system. However, we expect that the problem of revaccination is only a manifestation of a larger problem of asymmetric information in the live cattle auction system. Furthermore, we do not expect that solutions to the asymmetric information problem are feasible in the near term, given structural characteristics of ranching and the beef cattle industry.

We propose that more research is needed in the nature and extent of asymmetric information in the beef cattle industry. For example, research is needed in order to determine the exact incidence of buyer revaccination and the structural and economic impact of this incidence. Furthermore, we expect that many buyers revaccinate their cattle because of a lack of trust in statements made by sellers or auction handlers, although many buyers might revaccinate their cattle for other reasons. Understanding buyer perceptions and the reasons they make the production decisions that they do will provide important insights into the asymmetric information problem, particularly if buyers (and even sellers) perceive there is a "problem" with the live cattle auction system. Potential solutions will likely be accelerated with the quantification of the problem and the understanding of the value that is being left on the table in status quo.

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Notes

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[1] According to the USDA (2003), "The average beef cow herd is 40 head, but operations with 100 or more beef cows comprise 9 percent of all beef operations and 51 percent of the beef cow inventory. Operations with 40 or fewer head are largely part of multi-enterprises, or are supplemental to off-farm employment."

[2] Hendrickson and Heffernan (2002) report the concentration ratio of the top four beef packers is 81 percent.

[3] For example, suppose a seller has the following values for the variables (with hypothetical values based loosely on information derived from University of Missouri, 2003; Avent, Ward, and Lalman, 2003; Lalman and Smith, 2001): $c = \$5$, $e = \$400$, $s = \$20$, $p_s^n = 7\%$, $p_s^v = 5\%$, $p_d^n = 3\%$, and $p_d^v = 1\%$, resulting in the condition $c = 5 \leq 8.4 = c^s$, which holds. Therefore, as long as the cost of vaccination is not too large, it is efficient for cattle owners to vaccinate their cattle. However, suppose another seller's parameters are: $c = \$5$, $e = \$400$, $s = \$20$, $p_s^n = 6\%$, $p_s^v = 5\%$, $p_d^n = 2\%$, and $p_d^v = 1\%$, resulting in the condition $c = 5 > 4.2 = c^s$, suggesting it is not in the seller's interest to vaccinate.

[4] Suppose a buyer has parameter values as follows: $c = \$5$, $e = \$700$, $s = \$20$, $p_s^n = 7\%$, $p_s^v = 5\%$, $p_d^n = 3\%$, and $p_d^v = 1\%$. Then $c^b = 14.4(1-q)$, and $c < c^b$ when $q < 0.65$. If buyers believe less than 65 percent of sellers have vaccinated, absent additional information (about sellers, for instance), buyers will believe it is efficient to vaccinate cattle they purchase, regardless of whether sellers have vaccinated their cattle.

[5] Suppose a buyer has parameter values as follows: $c = \$5$, $e = \$700$, $s = \$20$, $p_s^n = 6\%$, $p_s^v = 5\%$, $p_d^n = 2\%$, and $p_d^v = 1\%$. Then $c^b = 7.2(1-q)$, and $c \geq c^b$ when $q \geq 0.31$. If buyers believe more than 31 percent of sellers have vaccinated, then it will not be efficient for buyers to vaccinate their cattle, other things being equal. However, if these same parameter values existed for a seller, then $c^s = 7.2$. Since $c = \$5$, the $c \leq c^s$ will hold, suggesting it is efficient for sellers to vaccinate. Thus, for the same cattle and values of parameters, sellers would have an incentive to vaccinate, but buyers would not, as long as buyers perceive the probability that sellers vaccinated is $q \geq 0.31$.