Marketing Method Use in Trade of Fed Cattle:

Causes and Consequences of Thinning Cash Markets and Potential Solutions

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Invited Paper for the Session: What Should Be Done about Increasing Market Thinness? To be presented at the 2015 American Applied Economics Association & Western Agricultural Economics Association Joint Annual Meeting in San Francisco, California.

June 2015

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ABSTRACT

Trade of fed cattle through negotiated cash markets has thinned since the institution of mandatory price reporting. Why is this, is it a problem, and what can be done about it?: First, strong individual incentives to use formula marketing methods and not use the cash market are discussed – along with the basic institutions for fed cattle trade. Cattle feeding and beef packing enterprises were interviewed as to marketing method choice. Both organizations can document, substantial efficiencies in animal management, in business operation, and rewards for beef quality. These gains are worth more than costs associated with the loss of cash market information. Thus, individual incentives are clear. Second, econometric modeling of price dynamics in the five regional fed cattle markets, along with boxed beef and live cattle futures, find reductions in price discovery in regions with less cash trade. If the volume of cash trade in a region falls to 5-10% of total volume then that region contributes little to price discovery. That was the case of the Texas-Oklahoma-New Mexico region during 2014. This region is important but does no price discovery. Finally, price discovery is presented as a public good. And, in the case of negotiated cash fed cattle price, is being overused and underprovided. Recognizing the public good aspect of price discovery suggests market interventions are needed. Ten alternative prescriptions are discussed some of which are legislative and others that could be adopted by the industry through its associations. Thinning markets are a solvable problem.

Key Words: Fed Cattle Markets, Thin Markets, Formulas, Forward Contracts, Price Discovery, Public Good.

JEL Classification: D4, L2, H41.

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Cash markets have great appeal – and, as it turns out, take a lot of effort and have a lot of risks. The efficiency and welfare properties of cash markets that function through the invisible hand are well known (Varian). It is also well-known that transactions costs associated any market-based trade can be mitigated through other means of coordination. Price is but one mechanism of coordinating economic activity (Williamson). Therein are today's livestock and downstream product markets, the concern for cash market thinning, and the reasons for such. The purpose of this paper is threefold. The economic concepts should generalize but the specifics and examples will be cattle and beef market related.

First, the institutions used and incentives at work in cattle and beef markets will be described. There are four main methods of marketing fed cattle: cash markets, forward contracts, formulas, and packer-ownership. The institutions used are presented. Mechanics of the different institutions can lead to or circumvent broader questions. And the changes that are happening in fed cattle markets will occur in downstream beef product markets. Documenting the change and discussing the economic incentives causing the change is useful. In this context, results from interviews with cattle and beef industry members will be presented. For the past two-plus years, I have interviewed producers and major packers in the cattle and beef industry. I describe what these firms say motivates their behavior. In short, cash markets are disorganized and have large costs of use. Cash markets are too disorganized for producers and processors with any focus on supply chain management. There are strong incentives to not use the cash market. However, there remains strong interest in maintaining the cash market and in the price information. Industry members are well-aware of thinning cash market and interviews were conducted with an objective of also identifying potential solutions to the problem.

Second, evidence will be presented for cash fed cattle markets on how thin is too thin? The cash market is shrinking for economic reasons but how small can the residual cash market get before there is a problem? Econometric results using current data are presented in the context of the classic framework. Industry members are also interested in information on how thin is too thin. This information determines the urgency for action.

Third, what to do about it? An interested industry membership should ask and applied economic research should answer. Here is a new contribution that the thin-markets research has not provided before. It remains difficult to state for a specific empirical application if there is a problem and at what level of cash trade. And then the shortcoming of most research is: what can be done about it? Are the heavy handed prohibitions or restrictions – such as those proposed in the past 12 years – the only policy solution? A list of solutions to the thin markets problem is presented. It is argued that price discovery is public good. Once recognized as a public good then some type of market intervention or mechanism design is required. The economics discipline often treats information as a public good but less so its production. And that is exactly what price discovery is.

Institutions, Incentives, and Interviews

Price reporting in livestock markets underwent substantial structural change in the early-2000s (see Koontz and Ward.) A mandatory system was legislated to replace the voluntary system that had existed since the mid-1940s. Voluntary reporting only provided information on a sample of the negotiated cash trade. All other forms of transacting cattle were viewed as private treaties by the USDA Agricultural Marketing Service (AMS) – and as specifically not-the-cash market – and therefore were not reported. There are a number of methods of transacting cattle and there was relatively little information of the use and valuations. Mandatory pricing

reporting (MPR) provided information on all these methods. We now know the prevalence and valuations of animals traded through forward contracts, formulas, and the variety of premiums and discounts applied. Alternatives to the cash market are referred to as alternative marketing arrangements (AMAs) which are also known as captive supplies. Immediately after MPR was implemented the negotiated cash trade increased. (Figure 1 summarizes data available on marketing method use since the introduction of Livestock MPR.) Some authors attributed this increase to the new information (Perry et al.). However, since 2004 there has been a slow persistent reduction in the use of negotiated cash trade in favor of formula transactions. So what are these marketing methods?

Marketing institutions within fed cattle trade are fairly simple – and different from hogs and pork and other commodities.[1] There are four main marketing methods. First, there is the negotiated cash trade. The units associated with the negotiated price may be per hundredweight of live animal or per hundredweight of carcass beef – live price or dressed price. The critical issue is that there is bid and ask in the process. The cattle feeding seller and the packer buyer negotiate the price.[2] USDA AMS through Livestock MPR determines how trades are reported based on evidence of bid and ask. Bid and ask for delivery within a two week window is negotiated cash. Negotiated implies that there is price discovery effort and work conducted.

Forward contracts are similar to negotiated cash in that there is bid and ask on price. However, the cattle are delivered three weeks or more in the future. Forward contract prices can be fixed price levels – which can be found but are less prevalent – or are usually in terms of a basis to a live cattle futures contract. For example, a price negotiated in June for animals to be delivered in September may be priced at +$4.00/cwt relative to the October live cattle futures contract. Reported forward contracts may or may not have an actual signed contract. Some

packers use a standard contract library and others may put together a contract after the trade is agreed to, but often there is no contract. Recently, the bid and ask that began in the forward contract window (3 weeks plus) has continued into the cash market window (this week and next week). However, USDA AMS treats all basis trades as forward contracts because of the mechanics of physical reporting.

The final marketing method is packer-owned cattle and these are 100% packer-owned. This method is discussed and not referred again. The volume of 100% packer owned cattle is minimal and steady. There was a brief increase in packer owned cattle after the BSE incident late in 2003 as packers observed feeding profit opportunities and were concerned about animal availability. No similar increases have since occurred since. Packer feeding is often for cutting tests or meat yield research and is otherwise not much done. Prices are transfer prices, are generally not thought of as negotiated and not reported by the USDA AMS, only volumes are reported. The total volume in cattle is small relative to, for example, packer own hogs. Hog packers appear to own more hogs because they are able to control genetics, feeding and nutrition, and animal environment – as well as processing, fabrication and pork sales.

Formula trades of fed cattle have become the most prevalent marketing method that is an alternative to the negotiated cash market. Formula transactions are valued using prices discovered by individuals not involved in the transaction. Formulas have historically used plant-average prices (the formula cattle are valued at a base price that is the same as packer paid on all other cash transactions), USDA AMS regional prices (the formula cattle are valued at a base price that is the same as all packers in the region paid on cash transactions), averages of regional prices, and the national average price. It is difficult to find a formula that is based on live cattle futures prices or the wholesale boxed beef composite value but there are examples. In addition,

with the smaller cash trade then formulas may use averages of or changes in neighboring region prices. Most formulas have head-minimum requirements for a reported price to be used as a base. This base price is what is first reported by AMS. Formula transactions then usually have to stand premiums and discounts. Most formulas pay premiums and access discounts for higher and lower quality carcasses. There is a final reporting of the net value of formula transactions by AMS that reflects this post-slaughter information.

Formula trades do no price discovery and make use of the information provided, and resources expended elsewhere, on prices discovered by others. Formula trades use both base prices and premiums and discounts discovered through other means. Formula trades are approximately 60% of fed cattle transactions in all the major cattle feeding – and price reporting – states. The negotiated cash trade is about 25% and the balance is forward contracts (see Figure 1). In the USDA AMS reporting region of Texas-Oklahoma-New Mexico, formula trade is 90% of the transactions (see Figure 2). With less than 10% of the volume of trade in the negotiated cash market then it is unlikely that TX-OK-NM, a historically important cattle feeding region, will contribute much to price discovery for fed cattle. This is a substantial change – but something which has happened in hog markets. There is no cash hog market outside of the Iowa and Southern Minnesota region. And it is a trend in the beef product markets as well. A significant volume of trade in beef products are being valued through formula arrangements.

Contrasting regions, the following is observed in Kansas and Nebraska, along with the Texas Panhandle region (see Figures 3 and 4). Kansas is on a similar path with Texas. While Texas was always a region that made heavy use of formula methods, the move to substantial formula use within Kansas is more recent. Further, more forward contract cattle are observed and more variation in forward contract cattle is observed in Kansas. Packing entities that procure

in Kansas do more forward contracting. The recent increases in reported forward contracting with the Texas region and Kansas likely include some of the basis bid and ask that transitions into the cash window. Nebraska displays no clear trends or shifts. That region uses traditional cash markets and forward contracts. There are some increases in formulas but that method is not predominant. It is likely that the substance of price discovery with the U.S. cattle feeding regions has shifted away from the southern plains to Nebraska.

Over the past twelve years, I have had ongoing discussions with cattle feeding enterprises and beef packing enterprises regarding marketing method use. Most recently, with a project funded by the National Cattlemen's Beef Association, I have interviewed industry members about market method use and the additional issue of the thinning cash market. This work has been conducted over the past two-plus years (2013-15). I also worked on the Beef Project portion of the 2007 USDA RTI Livestock and Meat Marketing Study (Muth et al. 2007) and it involved interviewing industry members during 2003-2004 (Muth et al. 2005). These two projects were bridged with other opportunities to communicate with cattle and beef businesses. Specifically, there was substantive discussion after the release of the Livestock and Meat Marketing Study, during the 2008 Farm Bill development, around the 2010 Competition Workshops coordinated by the USDA and Department of Justice, and finally with the 2010 Proposed GIPSA Rules. I have explored the thin markets issue with the cattle and beef industry recently under the auspices of the NCBA project but have communicated regularly with the industry about marketing method use, price discovery, and competition issues.

For the thin markets project, I interviewed individuals that represent over 60 firms. Three of the four major packers where interviewed and this included personnel in procurement and management. Large formula operations were interviewed as were operations that extensively

forward contracted. Large and small negotiated cash market operations were interviewed. Many of the individuals represented multiple feeding entities, some were active in industry associations, and all were asked to identify the information that they provided that was unique or representative – the idea here was to leverage contacts. Several individuals that negotiated cash trade for their business also marketed cattle for a network of other operations. Confidentiality was promised to interview participants. Many interviews where coordinated through state cattlemen's associations: individuals were sought that would be forthcoming, representative, and important to the state region. Much discussion was reinforced across participants. And in many cases these interviewees were individuals from large long-term businesses.

Formulas always have the following structure. The cattle feeding enterprise contacts the beef packer to schedule anticipated marketings two-to-three weeks in the future. The packer then has the choice of day of the week for pen slaughter. Feedlots have essentially all, and packers have little to no, control over the marketing decision. Because of these mechanics the idea of formula cattle as being "captive supplies" is incorrect. Formula transactions are paid a base price and then there are meat quality premiums and discounts faced by the cattle owner after the cattle are slaughtered. The packer may own a percentage of the transaction. In the past, packers have provided some financing but this is now less prevalent. Nonetheless, formulas can and are constructed to create risk and return for the packer in terms of animal performance. There is communication between the cattle feeder and packer in these relationships but it is not price related. The packer agrees to pay "the market" and the cattle feeder agrees to receive "the market". Then there are premiums and discounts for cattle management. The communication is largely anticipated future availability of animals. Formula feeders communicate expected marketings and change that information as animals do better or worse during the feeding period.

A conceptual difference within formulas that is not apparent in USDA AMS price reporting is long-term versus short-term arrangements. Long-term formulas are evergreen agreements between cattle feeding and beef packing enterprises. The arrangement developed so that the cattle feeding enterprise could implement supply chain management. The packer usually had a similar goal in terms of plant utilization, slaughter and fabrication costs, and meat quality. Frequently, the long-term arrangements were to develop supplies of particular production methods and develop a path to market consistent supplies of those products. In addition, formula cattle feeding enterprises have conducted extensive internal cost-cutting exercises.

Short-term formulas have no long-term supply chain based relationship. They are most frequently used by a smaller packer or plant to procure high-quality or pens with specific characteristics needed to satisfy a marketing program. For example, several packers have cattle breed based programs, specifically Angus or Hereford, without formal long-run arrangements. The packer will often bid and the feeder will accept something like $2.00/cwt over the USDA AMS regional market practical-top price. The buyer and seller are pricing the value of the pen relative to that market base. And because the total price is not negotiated the transaction is reported as a formula. These short-term formulas are have been used extensively in the southern plains – and are emerging in the north.

Practical top prices are used because fed cattle prices for a given week are negatively skewed. A high base is used for most cattle formulas as opposed to the variety of bases – high, low, and middle – that are used with hogs. For example, the trading range for a given week and region may be $152-158/cwt with the majority of trade in $156-157/cwt and the weighted average being $156.65/cwt. The practical top is then $157/cwt. That is the price that would be reported for that type of formula trade the following week. (The $2 over the market formula

would be reported as $159.) Then most formula transactions have to stand for discounts and premiums. Long-tern formulas face premiums and discounts but short-term may not. The beef characteristics underlying the premiums and discounts are mainly the standard USDA Quality Grade and USDA Yield Grade. Premiums and discounts prices may then be unique to the plant, packer, or may be USDA AMS reported. This net price is then provided in AMS final reports. Longer-term formulas have then been designed to pay premiums for beef tenderness protocols, natural protocols, cut size and yield specifications, and other retail programs.

There are a variety of examples of formula arrangements where the packer owns a portion of the cattle and the feeder owns a portion of the meat. Some of these arrangements have persistently struggled and others have been very successful but most are usually a minority portion of the packer and feeder volumes. Some formula transactions are valuations within a vertical integration arrangement – both the cattle feeder and the packer own the cattle on feed and the beef meat products sold. And from that perspective, the price is a transfer price. However, these vertical integrated relationships tend to be unique.

One purpose of the interviews with formula operations was to determine the value of formula arrangements. Use of formulas allowed the cattle feeding industry to supply-chain-manage. Animal and meat quality was increased and production costs were reduced. Further, it was innovated by the cattle feeding industry. It is interesting that research tends to approach alternatives to the cash market in the context of market power and not as a technology change. Interviews find one impetus behind the increased use of formulas being driven by the feeding industry's cost cutting exercises. The use of formulas allows operations to increase quality and value of sales and decrease costs of feeding. More notably, formula operations run in excess of 90% of capacity whereas cash operations historically run at high-70s to low-80s in terms of

percent capacity. (One formula feeding enterprise ran in excess of 100% of capacity.) This is a substantial reduction in fixed costs.

There are also risks associated with participating in the cash market. The main risk is that the cattle will not be marketed in the most optimal week or in the predicted week. Use of the cash market results in the risk that negotiations will fail and pen marketing will be delayed. Larger cattle feeding enterprises communicated this and small cattle feeding enterprises communicated this. Large enterprises stated that they could not risk having significant portions of market-ready inventory not delivered the week that the animals needed to be marketed or the week that management planned on the animals being marketed. Small enterprises stated that they could not risk not having effective bids for a given week. This was common thinking in the southern plains. Packers communicated similar perceived risks. Predictable flows of AMA cattle and the additional communication in the marketing process improved scheduling of packing plant operations. This improved efficiency translates into reduced costs (see, e.g., Koontz and Lawrence). Many packing firms had reduced procurement staffs by half to two-thirds.[3] Likewise, program cattle – cattle associated with brand marketing or value-added – tend to be marketed through AMAs. Cattle feeding enterprises and packing enterprises structured the prices for these value-added beef products to be tied to the underlying cattle and beef market and not the relative supply and demand balances of the program cattle.

Formula operations achieved efficiency and value from formula arrangements relative to using the cash market. These operations could routinely construct $25 per head values associated with formula marketing. The $25 per head amount was a repeated and conservative figure. Businesses that made substantial use of cash markets disbelieved this evidence. And

well-run cash operations could have similar efficiencies, animal valuations, and overhead reductions but the complete system was less formal in the cash market business model.

Formula operations communicated a necessity to move away from cash market use. Participating in the cash market disrupted operations. Cash market information was often important but participating in that market was a detriment to the business and the cash market information value – discussed later – was substantially less than the value of the formula. No formula operation expressed any interest in returning to the cash market or in marketing any animals through cash markets. They viewed this as at least a $25 per head cost. The cash market had value in terms of price information but not in terms of opportunity. Within cash operations interviewed, individuals communicated a skill set, interest, and a strong perceived need for continuing to participate in the cash market. These business models, the individuals that create them and are attracted to them, are different from formula operations. Cash operations believed the work they did negotiating price had value – further, these operations expressed dissatisfaction with doing the price discovery work that the formulas then used. They clearly understood they were the residual market, there were fewer in this portion of the market doing the work, and were dissatisfied.

The other type of business model interviewed that made minimal use of the cash market was those that extensively forward contracted. There are a number of these operations. The forward contracting here is not hedging. Price risk management was an integral part of all feeding enterprises. The only operations that did not communicate this were diversified with farming and crop enterprises. Forward contracting operations were integrating upstream to feeder animal and calf suppliers, were sourcing cattle early, and had well-coordinated systems for sourcing based on pricing opportunities. (Long-term formula operations did this as well.)

Similar to formulas, forward contracting was indispensable to the business and more valuable that the cash market. Again, cash market information was important but risk management through forward contracts was essential to the firm. Forward contracting operations tended to have younger independent owners, more borrowed money and less investment capital.

Sourcing decisions for both forward contracting and formula operations were coordinated with growing operations both within the cattle feeding enterprise and with enterprises providing growing services. AMA organizations appeared to be integrating upstream to secure supplies as animals and forage resources were available. There was less integration downstream between cattle feeding and meatpacking operations – formal integration and not separate cattle feeding and meatpacking profit centers owned by a parent company. However, there is some formal integration and some innovative relationships. The valuing of most transactions between cattle feeders and meatpackers are based on price and in terms of live or carcass weight. With valuation based on price, profits of the cattle feeding and meatpacking businesses are not combined. Price creates separation. Some formally integrated operations also valued based on price. Others valued based on proportional ownership of animals. In these quantity-shared relationships, feeding organizations produced animals that make the packer money as well as the feedlot. And packers ran operations to make the feedlot money as well as the packer. These quantity-shares do not require fed cattle price information – only wholesale beef price information. The interviews demonstrated that these relationships also required substantial communication of financial information and trust not needed in arm's length price transactions. These quantity-share arrangements are present but not prevalent.

Interviewees were asked if fed cattle markets were too thin: what proportion of cash trade is too thin? And too thin implied the formula operation would not use the price from that market

or the cash operation would discount its information. There were marked differences between businesses that use the cash market and those that used alternatives. Cash market traders wanted to see 30-50% of trade in a regional market as cash trade. Formula operations were less concerned about thinning cash trade (10% was more than acceptable) as long as the resulting prices in the thin region mirrored prices in other regions. Forward contracting operations viewed themselves as not contributing to the thin markets problem. Clearly with the AMA operations, the focus of concern is on information revealed by price and not the price discovery process. Price discovery is the changing of prices to reflect changing market conditions. There was little recognition of this function – learning which markets revealed new market conditions first – as long as prices were not out of line with other markets then there was no problem. This is a striking finding: an understanding of price discovery is not common.

With the cash trade in Texas-OK-NM effectively going to zero in portions of 2014, formula operations in those areas and packers procuring through formulas were asked how they changed the pricing of those arrangements and what they would consider in the future. There were volume contingencies for the price used in every formula. There were volume minimums requiring additional communication and possibly the price used would change. Different neighboring USDA AMS regions were used instead or to form an average. Likewise, the price change in the neighboring region was used with the previous reported base in the too-thin market. The USDA 5-Area weighted average price was also used in raw form and with adjustments based on history to the thin region. A surprising result was the willingness to transition to futures contract based pricing or basis pricing of formulas – considered but not much used. Futures contract prices and averages of prior days were being considered for

formulas. Futures based basis pricing were also used for cash trades. And basis trades that were hedged by the cattle feeder were often converted to a hedged position for the packer buyer.

Formulas have value. So what's the negotiated cash market worth – in terms of opportunity for use and information provided? The value of price information can be interpreted as the value of the service of those that perform price discovery and plays a role in potential public good market interventions. Some of the industry members that were interviewed expressed a willingness to pay others to discover price that is then used in formula transactions. Many formula operations recognized the need for price information in their current – very successful and valuable – business models. Price information is ubiquitous in a market economy. However, its abundance is shrinking while it remains needed to value fed cattle transactions. This information is also needed in the context of risk management. It was recognized that without price information there is no historical basis information upon which risk management programs depend.

In addition to valuing formula marketing methods, formula operations were asked to value cash market price information. What is having cash market price information worth? What would they be willing to pay and similarly what would they be willing to be compensated to do the work of price discovery? The calculus hinges on how much greater is the value of formula marketing than the value of price information? Cash price information is not worth zero but is significantly less than the value of formula marketing. When pressed interviewees communicated that cash price information was worth $1-$3/head. There were a few larger valuations but all were less than $5/head. (Many businesses approached the question that the information was worth the value of the current – and possibly future – Beef Checkoff. The current checkoff is $1 per head and discussions are to increase that amount to $2 per head.)

These are willingness to pay measures. Willingness to accept measures were comparable for operations that negotiate in cash markets. However, formula and forward contracting operations were not willing to do this activity – they were willing to pay but not willing to be compensated. Cash operations were willing to accept almost any amount recognizing that they were paid zero now but were also not willing to sacrifice the ability use to short-term formula.

Interviewees were then asked about the value of cash price information in combinations of regional markets – for example, southern (TX-OK-NM and KS) and northern markets (NE and IA) – and the value of information at the national level of the 5-market weighted average. Combinations of markets were worth more and the national market was the most valuable but valuations did not escalate. Interviewees were fairly unwilling to value multiple and national markets – "it's more" – but cooperation with this thought experiment was marginal. Further, all recognized that the value of the cash markets are limited by that there is a futures market and it will simply more of the price discovery work. They also recognize that the performance of the futures market would be at issue with a thin cash market to which it is tied. But that was a problem for the Chicago Mercantile Exchange. The cash market valuations clearly suggest formula marketing will be the dominant method and that cash market use will continue to thin. (Another question is: do small payments by a large number of AMA operations to a small number of cash operations aggregate up to enough funds to maintain the cash market? This topic is being explored but not here.)

Thin markets price discovery research makes use of two parameters which are assumed in all past applied work that follows Tomek. The method is based on the Chebyshev inequality that communicates a sample size (number of transactions) needed to assess a population parameter relative to a sample statistic (this is a pricing error) with a certain probability. The

unknown parameters are the pricing error and the probability. Questioning interviewees about these two assumed parameters was a difficult exercise. The questions are almost unanswerable even for interested and informed participants. Prior research uses $1/cwt or substantially less and 90-95% for the probability. These numbers were too small and too large for those interviewees willing to continue the discussion. The $1/cwt error was the lowest figure suggested and 75-80% of the time was a more typical probability. These elicited parameters imply that industry member's working knowledge of markets say that effective price discovery can happen with historically small cash trade. The bigger issue to the industry was the long-term persistence of the problem and impact on business profitability. No interviewee was concerned that thin markets had negatively impacted business profitability over a significant time period. Although some cash businesses communicated that their work had moved prices higher week in and week out. If an impact on profitability was the case then interviewees said they would act. I followed up with, "What would you do?" Discussion was vague after that. Frequently, that question was then posed back to the interviewer. In short, the industry is aware of the issue, concerned that it may be a problem, and is to be open to prescriptions for industry action.

The information above gives a hint as to the direction the discussions went regarding, "What should the industry do about it?" There was an interest in almost any means of addressing the thin markets issue. However, there were no specific actions being taken. Actions that might impact discovery, price information, and price reporting being considered by businesses interviewed were all in the best interests of those doing them and no consideration was given to the impact on the marketplace.

Interviews progressed through the acceptability of the proposed policy prescriptions – discussed in the third section. There were interests in participating in industry discussion,

electronic trading, using marketing firms, and even compensating price discovery providers. But there was nothing currently being done to address the thin markets problem. There were vertical integration arrangements that eliminated the need for a cattle price. But vertical integration was done for business reasons and not due to fed cattle pricing concerns. Again, reasons were internal and not due to problems valuing fed cattle.

All prescriptions were not acceptable though. There was no interest in government intervention and regulation. And little interest in developing new information sources. There were also no technical fixes being used. There were those that were concerned for price discovery, and especially in the southern plains, but no actions to specifically improve it. The interest in electronic markets displayed the first-mover concern: they would want to see it work before they joined. It was well-recognized that overcoming transactions – primarily transportation – costs associated with trading cash fed cattle would be a problem for electronic markets. Many individuals talked also about the need for trust and that there are high transactions costs in trading cattle – there are things that can impact the profitability that may not be readily observable. Many other individuals talked that this was not an issue in that they had extensive databases of animal performance and profitability and that they established trust based on proven histories. There was interest in using market makers such as those commission based firms that trade cattle for members.

I do not believe volume will return to cash markets outside of industry direction or policy legislation. There are strong incentives for individuals to market fed cattle through methods other than negotiated cash trade. Interviews revealed the value of alternatives to the cash market. Marketing fed cattle is a technology with different short-run and long-run costs and different abilities to adjust or substitute. Formulas and forward contracts are too valuable relative to the

value of a thickly traded cash market. For those that use that business model, the individual economic incentive is to use formulas and forward contracts more and use the cash market less. The cash market has value – in terms of opportunities and information – but that value is small.

But the value of the cash market is not zero. And price discovery can be thought of as a public good. Many formulas use information from efforts of those that negotiate cash prices. Likewise, forward contracts require historical information on cash prices to construct basis estimates – or a history of basis bids and basis trades which are not public. However, alternatives to the cash market make use cash market information but do not contribute to its provision. This is the classic public good problem. To protect the commons – the value of the cash market opportunity and its information – the some interested party must do something to help the remaining cash market work better, offset incentives to not use the cash market, and/or create a market for price discovery. These are the policy prescriptions to consider after the next section.

How Thin is Too Thin?

Tomek is the classic work on thin markets. There are other classic publications that address the issue of thinning markets from an institutional perspective (e.g., Hayenga and Hayenga et al.). But Tomek's approach was empirical and almost all subsequent applied work on thinning cash markets uses the concepts he developed (see, e.g., Franken and Parcell, and Ward and Choi).[4]

That approach starts with Chebyshev's inequality

$$\Pr(|\overline{X} - \mu|) \leq \mathrm{k}) \geq \frac{1}{(\sigma^2 / Nk^2)}$$

where $\overline{X}$ is the sample statistic of interest and a random variable, μ is the unknown population parameter measured by the sample statistic, k is the error due to sampling, σ^2 is the variance of the underlying random variable, and N is the sample size. Tomek's work was innovative in that

the inequality is used to address the thin market question. The sample statistic is the observed market price, the population parameter is the underlying equilibrium price, and the variance is associated with the random variable that is the observed market price. The summary statistic for and variance of market price are estimated from data. Research then assumes a pricing error (k) and a persistence of the pricing error (Pr). With these four measures a sample size (N) can be solved for. This sample size is the number of transactions needed for the observed market price with the measured variance to be within the pricing error for a given probability

$$N = \sigma^2 / (1 - \Pr) k^2 .$$

This is an answer the how thin is too thin question and can be compared to the actual number of transactions. Similarly, the pricing error (k) can be solved for. Given the estimated and assumed parameters, and the actual number of transaction, the pricing error communicates how closely the market price will be to the underlying equilibrium price.

Empirical work has used a variety of measures of the price mean and variance. Original work used means and variances of the price series. Subsequent work has also used conditional means – regression models – and errors from with those models. All work following Tomek's approach though continues to need the researcher to make assumptions about the magnitude of the pricing error (k) and the persistence (Pr). This work will do that well and the discussion will be modified in the context of information gathered from interviews.

Conditional means and errors are used from an error-correction vector autoregression (ECVAR) model of cattle and beef prices. Other recent research uses bivariate time series regression models so this approach is an expansion and incorporates more conditioning information (see, Franken and Parcell, and Ward and Choi). The standard ECVAR is

$$\Delta Y_t = (\alpha\beta')Y_{t-1} + \sum_{i=1}^{p} \Gamma_i \Delta Y_{t-i} + \varepsilon_t$$

where Y is the vector of prices of dimension q, Δ is the difference operator, Γ are the autoregressive parameters, p is the lag length, α and β are the cointegration parameters, and ε the vector of errors. There are seven prices (q = 7) in the system for this application: five fed cattle cash market prices from the USDA reporting regions, the nearby live cattle futures contract price, and the boxed beef composite value. Weekly prices are used from January 2002 through December 2014. This is the time period when livestock mandatory price reporting was instituted and after the initial problems. The boxed beef composite value has added to it the weekly beef byproduct value. Thus, the net boxed beef value is a beef and byproduct value.

The model includes the five USDA AMS regional fed cattle markets. The dynamic interactions of those five markets are modelled as well as the futures market that can be delivered upon from the cash markets and the downstream product market that the cash markets supply. These series and the equilibrium and dynamic relationships imply conditioning knowledge. An expectation of a specific regional price can be framed relative to knowing the history of all five regional price series, futures prices and boxed beef values. Thus, the model of price discovery for a given cash market accounts for the past price changes and equilibrium differences in all of the regional cash markets, the futures market, and the downstream market. Most prior research models pairwise price series and thus the unexplained variation remaining in the residual overstates what is not known. The approach is similar to Lee, Ward, and Brorsen but the model use is different. That application established temporal causality between price series of different marketing methods. This application uses conditional means and residuals.[5]

All of the seven prices series are nonstationary (see Table 1). This opens the possibility of a cointegrated system. Johansen tests for the order of cointegration are also conclusive (see Table 2). There are six cointegrating vectors and this implies that this is one common trend

underlying all seven of the price series. The number of cointegrating vectors result is intuitive in that it implies there are pair-wise equilibrium relationships between all of the prices. Knowing any one prices provide strong information about magnitude of all of the other prices. The common trend result is also intuitive in that there is one underlying stochastic relationship driving the nonstationary behavior of all seven of the price series.

Details of the ECVAR model are not essential to the thin markets question. (Complete results will be available in an Experiment Station publication in draft.) What are needed are predictions from the model, actual prices, and estimates of the errors to discuss the thin markets question. And to do this we need to be confident that the ECVAR is reasonably well-specified. There is no structural change in the cointegrating relationship ($\alpha\beta'$). (There is a modest structural change between the boxed beef value and all fed cattle prices if the beef byproduct value is not included. The beef byproduct series is at an elevated value late in the series as it too has a stochastic trend with upward drift.) Each of the six cointegrating relationships requires an intercept. This implies the prices have mean differences. But there is no deterministic trend in the cointegrating relationship. Likewise, there is no deterministic trend needed in the autoregressive portion of the model but there is an intercept as all prices drift higher over time. The residuals are modestly non-normal and have modest autoregressive heteroscedasticity.[6] But these two problems mainly impact hypothesis testing which is not done here. What are needed to address the thin markets question are predictions from the model and residual errors, and these are consistently estimated without accounting for non-normality or heteroscedasticity.

The ECVAR was estimated and is used to produce: predictions and residuals from the five cash market models were produced and aggregated by the month for the sample. Thus, each month has 4 or 5 observations. This is a standard practice in this literature – means or

conditional means are estimated and the variances for portions of the sample are examined along with the number of transactions. With an assumed pricing error (k) and probability, the number of transactions needed to establish a thick market can be calculated. These are the red lines presented in Figures 5, 6, and 7 and are identified as the number of "needed" transactions. Mandatory price reporting also provides the number of head marketed through negotiated cash in the five regional markets. The number of transactions is not available and not obtainable by USDA AMS. Studies that examine fed cattle transactions data routinely find that 100 head is the average number in a transaction. Thus, the weekly volume marketed is aggregated by month divided by 100 to estimate the number of transactions per month. These are the black lines presented in Figures 5, 6, and 7 and are identified as the estimated "actual" transactions.

Three regional markets are presented graphically and discussed. The remaining two USDA MAS regional markets will be included in the discussion. Using traditional pricing errors and probabilities, the Texas-OK-NM regional market became too thin during 2014. The negotiated cash trade fell below 4% in early 2014 and has had weeks of zero cash trade. As important as the region is in cattle feeding, since 2014 it negotiates almost no cash trade. This event in the Texas region was fairly predictable. In January 2013, Cargill Meat Solutions – the third largest beef packer in the U.S. – closed the Plainview, Texas cattle and beef plant after several years of poor margins and an outlook for continued negative margins. Plainview was a 4000 head per day plant and 16% of the packing capacity in the Texas Panhandle. Prior to its closure, packing capacity was in excess of feeding capacity in that region. After its closure, those two capacities are much more in line. Interviews revealed that after the closure the remaining plants could be booked and have no interest in cash cattle for two-to-three continuous weeks. Some additional communication between the feeder and packer was needed by feeding

enterprises to establish a schedule for impending marketings. The easiest means to do this was formula or forward contract.

The result of the recent change in the Texas region is similar to the history of Colorado. Colorado has had relatively little cash trade since 2008 and is too thin to contribute much to price discovery. Colorado drifted below a 5-7% cash trade in 2008. Kansas is similar but not as pronounced as the Texas region (Figure 6). The negotiated cash trade in Kansas became too thin in mid-2014. There remains small cash trade but, unlike Texas, there are cash trades in all weeks. Here, though the too-thin result emerges with a cash trade less than 20% of the total trade. And the specific amount is not transparent as it is not driven by a hypothesis test. It appears to be 10-15%. The thickest market is reported in Figure 7 and that is Nebraska. Cash trade in Nebraska varies between 15-35%. It is trending towards less cash market use but the trend is not as pronounced as the Texas region and does not start with very low cash trade like Colorado. The cash trade in Nebraska through much of 2014 appears to be double or triple the volume that is needed for price discovery – within the parameters assumed. Finally, Iowa is similar to Nebraska. That region has the least observable trend away from cash. However, the total volume in that market is small. It is also likely that there are more transactions than estimated due to smaller pen size transactions. But this issue may not play any role in qualifying the conclusions. A few transactions of smaller pen sizes may be argued to be the same as one transaction with a large number of head. Regardless, it is Nebraska that is the thickest negotiated cash fed cattle market and likely does the majority of price discovery work in fed cattle markets.

How do the empirical results change when results for the interviews are considered? The industry communicated that it is willing to use information from considerably thinner markets. The acceptable pricing error was at least $1.00/cwt and the probabilities were all smaller than

95%. 80% was common. These parameters add little to the analysis though. Here almost any cash trade is useful, 1-2%, and the thinnest markets may not too thin. The "needed" line does not move down much as it is bounded by zero. The industry provided parameters suggest that 1-8 trades per week over a month are adequate. But this disagrees somewhat with how formulas are constructed. Head minimums imply the need for 15-30 transactions per week.

So how thin is too thin? It depends on the market and the measures used. Texas appears too thin at a cash trade below 5%. Kansas requires a higher volume and may be impacted by thinning cash trade in Texas. Regardless, 2014 was a watershed year for the southern plains and the reduction in price discovery. And it is likely that Kansas continues to follow the trend. Nebraska by contrast does not have the same problem. It has two to three times the needed negotiated cash transactions. Making a recommendation to the cattle industry is not a transparent exercise but based on these results less than 5% cash trade appears to be likely too thin. Establishing a cash trade greater than 5% would be needed. To be confident that cash trade contributes to thick price discovery then a cash trade greater than 10% is likely needed.

As an alternative to the number of transactions, Figures 8, 9 and 10 present for the same regional markets the pricing errors for 95% and 80% probabilities. Specifically, in Figure 8, we see the pricing error spikes above $3.00/cwt for four of the last six months in 2014 in the Texas region when a 95% probability is used. The pricing error is $1.50/cwt when an 80% probability is used. (A smoothed same-color line is included to illustrate.) The numbers of transactions in Kansas are higher during 2014 but we still observe an increase in the potential pricing error. The values are $1.00/cwt and $0.50/cwt for 95% and 80% probabilities. Finally, the pricing errors in the thickest market, Nebraska, are both below $0.50/cwt. This $0.50/cwt pricing error suggests

solid price discovery in Nebraska. But the $1.50-$3.00/cwt pricing errors for Texas are large. The $3.00/cwt is above most of the acceptable pricing errors discussed in the interviews.

In short, Nebraska is the thickest market and has adequate transactions such that there are little pricing errors with small persistence given the underlying variability market price. However, a similar statement cannot be made for the Texas region. In that region, the transactions are few enough to risk large pricing errors with persistent probability. And quality of price discovery in Kansas is in between that of Texas and Nebraska but with conditions much more close to Texas. Further, if the industry wishes to make recommendations about how much cash trade is needed then 5% appears to be a reasonable minimum and 10% made be needed.

Policy Prescriptions

Thin markets are not new to agriculture. The size of the cash fed cattle market is thinning but is substantially larger that than for hogs, dairy products, eggs and poultry products. Markets for beef products are also thinning. There are strong economic incentives to trade agricultural products through means other than cash markets. Firms that reduced their cash market use have benefited. However, the marketplace as a whole has likely not. So, what can be done?

Cash markets and the information that are provided through those markets can both be thought of as public goods. The price discovery process is a public good. This idea is a unique contribution of this work. The thin markets issue has not been presented as a public good problem (the exception is Meyer). In this framework, solutions to the problem are more transparent and have an increased likelihood of success.

Public goods are unique economic entities that often require special treatment. Market forces misallocate public goods. Information, and particularly for agricultural markets it is price information, is regularly treated as a public good. It is non-excludable and non-rivalious. And

price information may be underprovided if left to the market. USDA AMS intervenes, with legislative authority, and provides information – but they do not produce the information. The industry has changed technology whereby they need price information but they have economized and do not contribute to its production. It is not just price information but the effort – the work to negotiate – to discover price that is the public good.

The public good issue within the thinning of cash fed cattle markets has to do with the use of cash market information by AMA enterprises. Cash market participants invest resources to trade and discover cash market fed cattle prices. Enterprises that use formulas and forward contracts free ride on these efforts of the cash market participants. This is the tragedy of the commons.

Providing the economically optimal level of a public good in a competitive economy requires group action and some level of market intervention (Green and Laffont) or market design (Roth). The proposed actions to address the thinning of cash fed cattle markets address these extra market actions and comprise a spectrum from soft recommendations to meet, discuss, and largely elicit voluntary action by individuals all the way to structured initiatives that mandate behavior and address the issue through constructing economic incentives. Intermediate recommendations focus on new information and changing business practices. This is a fairly standard approach to provision of a public good: communication and some level of informal pressure – progressing to – information, technology, privatization, market design and legislation. The non-standard thing is the treatment of price discovery as the public good, identifying the unique institutions related to the cattle and beef industry, and incorporating into recommendations the positions communicated as relatable from the interviews. The prescriptions are alternatives that were presented to the NCBA. There are a variety of

alternatives to choose between and multiple alternatives may be adopted. The following ten prescriptions are in the order of perceived least to most effective and most to least flexible.

The first potential action is: Industry Communication and Voluntary Leadership. Industry members through its associations can meet, discuss the issue, and access what individuals are willing to do to address it. This is not a naive prescription. Many public goods – across the spectrum of common property agricultural, fishery, and environmental resources – are managed through informal institutions. These institutions include: families, communities, churches, local governments, and associations. Industry members often value the common good so that meeting, discussing the problem, and agreeing to individual action will support the quality and quantity of the public good. This prescription is easy to do and can be done immediately. But it will take time to build the trust and social capital that is needed to make progress. The strength of the approach is that it is the most flexible. The weaknesses are many: discussion requires openness and honesty, there is time commitment by many parties, and it may be difficult to establish progress on the issue. But I am working with NCBA on this committee and there are plans for it to meet regularly at the association's mid-year meeting.

The second potential action is to: Increase Flexibility of Cash Trade Reporting. This work will be between the industry associations and government entities that price report (USDA-AMS). The current structure of livestock mandatory price reporting provides substantial transparency. All fed cattle transactions are reported or are considered for reporting. There is no sampling bias or loss. However, this transparency and automation is rigid. Substantial changes require legislation and significant changes may require federal government rulemaking. The fed cattle industry has transitioned into using more cash-futures basis pricing for cash trades – similar to the grains industry. However, these basis trades are reported as forward contracts by

AMS. In fact, it was communicated in the interviews that some cash trades are converted to basis prices to prevent the use of that information by formulas. Increased flexibility in reporting the basis trades would, modestly thicken reporting of cash trades. This is an important point with livestock mandatory price reporting subject to legislative reauthorization in 2015. The cattle and beef industry needs reporting to be as flexible as possible so that changes in how the industry does business can be incorporated into reporting.

There were common statements during the interviews of, "When are we just going to do this with the futures market?" That being trade cash cattle relative to futures prices. There was recognition of the cattle industry transitioning into trading like that in the grains industry. However, that transition creates a substantial price reporting problem. Futures based pricing does not work in how AMS reports cash prices. This method of trading was simply not done during the implementation of MPR. There may need to be legislation that allows for flexibility in mandatory reporting.

The other increased flexibility that is needed is some consolidation of the categories of fed cattle that are reported. A multitude of USDA Quality Grade distributions are reported. Further, separate steer, heifer and mixed pen prices are reported. Transactions are sliced a number of ways and each is reported. It would be useful to determine which differences are significant and report those. For example, steer and heifer prices are not significantly different for fed cattle. Further, it would be useful to determine industry accepted base animal or transaction and report it – and then important premium and discount groups and report those. This would consolidate the plethora of prices currently reported.

Third, develop and fund: New Market Reporting and Trading Technology. Substantial numbers of other asset markets trade through electronic means. The fed cattle industry does not.

e-Markets are common and accepted. But not for fed cattle trade. A smaller cash market trade through e-markets may provide substantial price discovery. The industry might be able to get by with much smaller cash trade if it was done through electronic media. But most electronic trading systems – business-to-business or consumer – became successful because of lower transactions costs. It is very easy and cheap to trade stocks and other financial assets through electronic systems. A substantial difficulty for the fed cattle market will be the physical transportation of animals. Electronic trading cannot eliminate shipping costs. Further, for cattle there may be other transactions costs addressed by personal relationships that develop between trading partners that may be lost in e-systems. Typically, you have to have major buyers and major sellers commit to using an e-system so that there is enough volume to attract other buyers and sellers. This should be a long-term goal of the industry – to support the design, funding and implementation of more efficient cash trading systems.

The strengths of this prescription are this is the path used by financial markets – and is the natural result of progress in many industries. e-Markets are common and accepted. But adoption of new systems to happen within commodity systems with substantial physical transactions costs may be difficult.

Fourth, update and develop: New Trading Institutions. Institutions are the rules and customs associated with trading fed cattle. For example, a packer being "on the cattle" is used to convey that a packer showed first interest and gets first chance to bid on a pen. Anyone else interested is going to have to increase the bid. Industry members could develop institutions associated with cash trading that improve the functioning of and remove risks to cash markets. This can be thought of as an updating and expanding of the "seven-day pick-up" and "pencil shrink." In the past, cattle feeders and packers had agreed that cattle are delivered within seven

days of purchase and that the pay-weight is some reduction in the load out weight. The industry needs to look for ways of doing business that support the cash market. For example, an idea would be for negotiated cash cattle to be slaughtered early in the week. There could to be agreed to institutions that there are no delays to the scheduling or pickup of cash cattle or that any delays will have compensation. Today's institutions were developed in the 1960s and 1970s. The industry simply needs to do some updating to address issues. Strengths of this approach are that market institutions can remove risks of cash market use. However, institutions can be undercut without formal adoption and arbitration processes.

Fifth, develop and maintain: Industry Standard Business Practices. In all interviews of cash market traders there were examples of trades that that were not perceived as reported, that created price transparency problems, and that were not in the best interest of the industry. All interviewed cash traders had some interesting and problematic experience or story. All of these examples communicate a need for standardization of business practices. In the grains industry, for example, all trades are FOB buyer's location and the seller pays freight. Further, any modification of the terms by the buyer is paid for by the buyer. These standards are adopted and enforced by the National Grain and Feed Association. Membership implies agreement and compliance. And the association hears and moderates disputes. Cash grain prices are more straightforward to report because of these practices. Many of the communicated and perceived problems with the fed cattle trade would be eliminated by adopting the two sentences above in a Trade By-Laws document. Formalizing trading institutions can improve cash market function. It means giving up some freedom of individual action to protect the common good of all. The function of many other trade associations is to facilitate business – as well as lobby, policy advocate, and support research (another public good).

Institutional change can have a strong impact what businesses do, but any change has to enforceable, and a strong point of this prescription is that it is clearly needed as communicated in the interviews. However, institutional change with enforcement will be slow and expensive.

Sixth, provide: New Market Information. Information can remove some risk associated with using cash markets. More information about the cattle feeding industry's inventory and timing of potential fed cattle marketings – and combining that with committed and delivered information from mandatory price reporting – will remove some of the risk associated with using the cash market. One big risk in marketing fed cattle that is eliminated by formulas (especially the use of short-term formulas) is the uncertainty of whether a packer or packers that are in my area will be in the market this week. This is a common problem in the southern plains markets. More information about available supplies and needs would address this risk and moderate the incentive to formula. But while removing risk associated with the cash market, this information also very much reveals competitive positions of market participants. This point is a high hurdle and shows that it is difficult to mitigate the incentives to formula and forward contract. It is doable but very revealing of potential market opportunity.

Seventh, the industry can through its associations: Employ Market-Makers. All financial markets that function well employ market makers. Market makers are compensated and/or derive some compensation from their trading. This is a proven system within successful equity and electronic markets. But it does require compensation. One method of compensating market makers would be to develop a system whereby businesses that use alternatives to the cash market and that make use of cash market price information would provide the compensation to market makers – for example, to a business entity that provides marketing services for negotiated cash

businesses. This would create a cash market. But it is unknown if the cash market volume would be sufficient or excessive for effective price discovery.

Eight, develop: Tradable Permits or Certificates. This is a market solution to the public good problem. The critical economic issue with thin markets is that there is no market for price discovery. There is an opportunity to create or design a market here. Prices are simply reported by AMS which addresses the information side of the public good problem but AMS reporting does not produce price discovery. Permits, or Certificates, would require some level of cash trade by all individual businesses of a certain size. The businesses that then do not wish to market cattle through negotiated cash would trade those certificates to businesses that do – and offer compensation.[7] A market for cash information is thus created. Further, the market is not inflexible like regulation or observable only through subscriptions like privatization. And it is not uncertain if the market volume is sufficient or excessive like with market makers. The market volume can be changed as needed: the required volume of cash trade – the number of certificates – could be decreased if certificates are too expensive, increased if certificates are too cheap, or the market would be closed if small numbers of certificates are worthless. The market for price information provides and communicates its value.

The strength of this prescription is that it is a market solution to the thin markets problem. It is the approach used to address pollution issues. It develops a market for cash price information and price discovery. But the approach is innovative and not tried before in any industry to address price discovery. This prescription may be the avenue that is pursed as an alternative to legislative mandates.

Nine, the industry could support: Privatizing the Collection and Reporting of Prices. This is another traditional method of solving public good problems. Allowing a private entity to own

price reporting – change the public good to a private good – would result in users of price data having to pay subscription fees and would allow compensation to those providing the information and the price discovery. However, this does not recognize that many other upstream and downstream industries need economic information on fed cattle prices to make economic decisions. Cow-calf, seedstock, food service, and food retailers all make use of fed cattle price information. So this path would have a negative impact on related industries or would potentially increase their costs. Also simply privatizing does not address the non-excludability issue. Owners of the information will also have to spend resources to protect against the sharing of copyrighted price information.

This prescription is also not a straw man recommendation. This has occurred in poultry and eggs. For example, egg prices and turkey prices are privately collected and reported and buyers and sellers subscribe to the information service. Further, these marketing service organizations work to do price discovery between buyer and sellers. But the egg and turkey industries are not the cattle industry and the history of price reporting in eggs, turkeys and cattle are not similar. While, marketing firms also provide price discovery services between producers and processors. It is not surprising that this information is neither well known nor visible. Likewise, firms are making inroads for the same services with pork producers and processors. It is likely that the cattle industry is geographically diverse enough and has enough small producers that privatization is some distance in the future and risks negative policy actions. But there is precedence in other livestock industries – that is not well-known.

Ten, and finally, develop industry supported: Legislate Mandates. A traditional means of addressing public good problems is to use legislation to require certain behavior and prohibit others – introduce regulation to mandate cash market use. Minimums of cash trade could be

established. However, no interviewees support this path. The question is also well researched and the answer is that this would cost the cattle and beef industry and experience suggests regulation is hard to modify or undo.

The final prescription – albeit without the industry support aspect – is what has been attempted to date for the fed cattle industry. The Johnson Amendment to the 2002 Farm Bill proposed prohibiting all AMAs. Revisions to the amendment proposed required 25% cash market purchases. The amendment, was not in the final bill and, lead to Congressional funding of the 2007 Livestock and Meat Marketing Study. The 2010 GIPSA Proposed Rules did not prohibit AMA use but set a variety of guilty-until-proven-innocent hurdles to their use – in practice the rules would have substantively limited AMA use. It has been a considerable amount of time since 2010, much less 2002, but I would suggest what was needed during this time period was some discussion of market-based solutions or institution based solutions to the issue – in addition to the market power research. Thinning cash markets for cattle and hogs was very foreseeable. By not considering anything other than prohibition, we have thin markets issues and concerns about price discovery in livestock markets. I believe the prescriptions listed is a good starting point for industry member, policy related, and applied research discussions.

Conclusions

The thinning cash fed cattle market is the result of participants making use of alternative marketing arrangements (AMAs). For the fed cattle industry AMAs are largely formula cattle and less so forward contracts. Participating in the cash market has costs. There are strong incentives for individual businesses to move away from using the cash fed cattle market. Discussions with industry members reveal that the costs of participating in the cash market are high. Making use of formulas or forward contracts reduces these costs. In short, fed cattle are

marketed in a timelier manner so that meat quality and animal performance are improved and these enterprises are also more efficient in management and operations. Businesses could construct $25 per head values associated with AMA use. Fed cattle pens have a known buyer and will have market price risk well-managed. Cash markets can be relatively disorderly. Negotiating in the cash market has the risk that the effort fails and fed cattle are marketed at higher costs later. These positions were reinforced by interviews of packing businesses. Coordinating the marketing of fed cattle allowed lower costs, better plant management, and improved flows of quality-differentiated products. Alternatives to the cash market were found to be more valuable relative to the value of thicker cash markets. Further, marketing method use, from discussions with the industry, have the appearance of changes in combined production and marketing technology.

The cash market is not as valuable to those that have business models based on formulas or forward contract. But that information is important. Often valuable to those businesses that use formulas and forward contracts, and also to all those upstream businesses that produce seedstock and feeder cattle as well as all those downstream businesses that provide beef food products and services. But the individual incentives are clear and we will have thinner fed cattle price discovery in the future.

The incentive that benefits the individual does not, in fact, benefit the overall marketplace in terms of the quality of price discovery. Fed cattle price discovery as of 2014 is effectively conducted in Nebraska. There is some price discovery in Kansas and Iowa, and essentially none in Colorado and Texas. As important as the southern plains are in the production of fed cattle there is relatively work conducted there to determine the value of those fed cattle. Empirical methods associated with measuring the impact suggest that 5% cash trade or lower results in

diminished prices discovery. Further, that cash trade of 10% or greater may be needed to have a margin in the number of transactions such that the quality of price discovery is insured.

To date, the thin markets discussion has not recognized the public good aspect. Formula and forwarding contracting operations use information provided through the efforts of negotiated cash market participants. Cash market price information is used in many formula operations and is decision support information for forward contracting operations – thus AMAs are freeriding. The extent of the freeriding has become problematic in some regional markets – in the southern plains. The solution to the problem: what to do about thinning cash markets involves mechanisms known to solve public good problems. The solution involves selective or some combinations of: communication, institution development, technology, information, market making, or legislation. But to date, only legislation has been proposed.

The communication approach involves pressure to manage the public good. If price information is sought by the industry then someone within the industry must to the work. This is a first step, and may work, but has no enforcement. Institution development is an extension of communication with the benefit of improved enforcement. The industry at a minimum needs to update the "seven-day pickup" and attempt to create marketing institutions that help the cash market work better. Some of these institutions could then be formalized into standard business practices. Again, the industry needs to work on businesses practices that help or at least do not harm the negotiated cash markets.

The technology approach involves investing in and developing electronic markets. Technology may thicken price discovery with fewer negotiated cash trades. Fed cattle are still largely traded between two people – representing businesses – and based on past dealings and personal relationships. New technology would allow the fed cattle trade to move past use of

phones and voice communication. However, whereas electronic means substantially reduced transactions costs in financial markets it is doubtful that this technology can much reduce the physical transportation costs that accompany fed cattle marketing.

Information can address the public good problem but the free-riders here are well-known. What is needed is new market information that will mitigate some of the risks that drive some cash market users to AMAs. Developing information on the extent of the forward buy and the potential marketable inventory mitigates that risk. However, this information is very competitive position revealing, will be expensive and difficult to pursue, and appears unlikely to succeed.

Market making is innovative. The missing market is the market for price discovery services. Hiring market makers directly solves the problem – this is what the thick equity markets do – but the question of extent remains: is enough funding voluntarily provided? Tradable permits or certificates requiring price discovery solves the volume problem. The value of the permit communicates if too many or too few have been issued. And establishing this market makes the users of price information compensate providers of the information – along with communicating the value of that information.

These alternatives all merit examination and allow the industry to attempt to address the problem or issue before resorting to legislative mandates.

References

Anderson, J.D., C.E. Ward, S.R. Koontz, D.S. Peel, and J.N. Trapp. 1998. "Experimental Simulation of Public Information Impacts on Price Discovery and Marketing Efficiency in the Fed Cattle Market." Journal of Agricultural and Resource Economics, 23: 262-278.

Franken, J. R.V. and J.L. Parcell. 2012. "Evaluation of Market Thinness for Hogs and Pork." Journal of Agricultural and Applied Economics, 44: 461-475.

Green, J. R., and J.-J. Laffont. 1979. Incentives in Public Decision-Making. Amsterdam: North-Holland.

Hayenga, M.L. (ed.) 1978. Pricing Problems in the Food Industry (with Emphasis on Thin Markets). University of Wisconsin, North Central Regional Research Publication, NC-117 Monograph 7.

Hayenga, M.L., B.L. Gardner,A.B. Paul, and J.P. Houck. 1978. "The Concept of a Thin Market." In Pricing Problems in the Food Industry (With Emphasis on Thin Markets), ed., M.L. Hayenga, University of Wisconsin, North Central Regional Research Publication, NC-117 Monograph 7, pp. 7-13.

Koontz, S.R., and J.D. Lawrence. 2010. "Impacts of Alternative Marketing Agreement Cattle Procurement on Packer Costs, Gross Margins, and Profits: Evidence from Plant-Level Profit and Loss Data." Agribusiness: An International Journal, 26: 1-24.

Koontz, S. R., and C.E. Ward. 2011. "Livestock Mandatory Price Reporting: A Literature Review and Synthesis of Related Market Information Research." Journal of Agricultural and Food Industrial Organization, 9: 9.

Kleindorfer, P.R., D.J. Wu. 2003. "Integrating long-term and short-term contracting via business-to-business exchanges for capital-intensive industries." Management Science 49: 1597–1615.

Lee, Y., C.E. Ward, and B.W. Brorsen. 2012. "Procurement Price Relationships for Fed Cattle and Hogs: Importance of the Cash Market in Price Discovery." Agribusiness: An International Journal, 28: 135-147.

Meyer, S.R. 2013. A Tragedy of the Commons – How Do We Proceed Without a Spot Market? Presentation for USDA Agricultural Outlook Forum. Arlington, VA. 22 February.

Muth, M.K., G Brester, J. Del Roccili, S.R. Koontz, B. Martin, N. Piggott, J. Taylor, T. Vukina, M. Wohlgenant. 2005. "Spot and Alternative Marketing Arrangements in the Livestock and Meat Industries – Interim Report." Research Triangle Park, NC: RTI International for USDA Grain Inspection, Packers and Stockyards Administration.

Muth, M.K., S.C. Cates, M. Coglaiti, S. Karns, Y. Liu, J. Taylor, C. Viator, J. Del Roccili, M. Asher, S.R. Koontz, J. Lawrence, J. Schroeter, G. Brester, J. Atwood, J. Marsh, and B. Martin. 2007. GIPSA Livestock and Meat Marketing Study – Volume 3: Fed Cattle and Beef Industry – Final Report. Research Triangle Park, NC: RTI International for USDA Grain Inspection, Packers and Stockyards Administration.

Nelson, R.G., and S.C. Turner. 1995. "Experimental Examination of a Thin Market: Price Behavior In A Declining Terminal Market Revisited." Journal of Agricultural and Applied Economics, 27: 149-160.

Perry, J., J. MacDonald, K. Nelson, W. Hahn, C. Arnade, and G. Plato. 2005. Did the Mandatory Requirement Aid the Market?: Impact of the Livestock Mandatory Reporting Act. USDA Economic Research Service, LDP-M-135-01, September.

Peterson, H.H. 2005. "Trading Behavior in a Marginal Organized Market." Journal of Agricultural and Resource Economics, 30: 449-468.

Rhodus, W.T., E.D. Baldwin, D.R. Henderson. 1989. "Pricing Accuracy and Efficiency in a Pilot Hog Market." American Journal of Agricultural Economics, 71: 874-882.

Roth, A.E. 2007. "The Art of Designing Markets." Harvard Business Review, October.

Tomek, W.G. 1980. "Price Behavior on a Declining Terminal Market." American Journal of Agricultural Economics 62: 434-444.

Varian, H.R. 1994. Microeconomic Analysis, Third Edition. New York: W.W. Norton & Company.

Ward, C.E., and S.-C. Choi. 1998. "Evaluating Potential Changes in Price Reporting Accuracy." Proceedings of the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. Chicago, IL. [http://www.farmdoc.uiuc.edu/nccc134].

Williamson, O.E. 1998. The Economic Institutions of Capitalism. New York: Free Press.

Endnotes:

[1] Hogs and pork use a plethora of formulas and contracts (See Grimes and Plain.). Other commodities tend to make extensive use of forward contracts and then trade futures to offset or accentuate risk (See Kleindorfer and Wu).

2 Buyers and sellers may negotiate premium and discount prices along with the base price and this is defined as a negotiated grid price. It is reported separately by USDA AMS but it is a negotiated price. (See Figures 1-4.)

3 A single order buyer costs a packer at least $100 thousand dollars per year in salary and benefits. Thus, buyers are significant operations overhead for individual plants.

[4] Alternative approaches specifically have the benefit of transactions data (see, for example, Rhodus, Baldwin and Henderson, and Peterson) or data from experiments (see Nelson and Turner, and Anderson et al.)

[5] Follow-up work here also examines causality using subsamples to examine how price discovery dynamics change through the post-MPR sample period. But they are not presented due to the manuscript length.

[6] These can be observed in Figures 5-7. There are increases in the unexplained variability in prices – which shows up in the residuals and residual error variances – during the BSE event in late 2003 and early 2004. Likewise, they emerge late in the sample with the market volatility in 2014.

[7] This is the carbon credit model, the RIN model for renewable fuels and automobile pollution reduction, and the model for Sulfur Dioxide and Nitrogen Oxide reduction.

Table 1: Unit Root Tests of Price Series.

Market Price	Rho	P-Value	Tau	P-Value
Texas	-1.21	0.8656	-0.43	0.9012
Kansas	-1.50	0.8356	-0.51	0.8869
Colorado	-1.72	0.8107	-0.58	0.8724
Nebraska	-1.54	0.8316	-0.55	0.8778
Iowa	-1.10	0.8764	-0.41	0.9055
Nearby Futures	-0.32	0.9393	-0.12	0.9453
Net Boxed Beef	-7.28	0.2571	-1.71	0.4282
By Product	-3.19	0.6336	-1.16	0.6944
Boxed Beef Value	-9.27	0.1597	-1.95	0.3073

Table 2: Johansen Rank Tests for Order of Cointegration.

Max Test				Trace Test			
H_0: Rank=r	H_1: Rank=r+1	Test	5% CV	H_0: Rank=r	H_1: Rank>r	Test	5% CV
0	1	102.174	45.28	0	0	409.207	132.00
1	2	86.7558	39.37	1	1	312.340	101.84
2	3	83.7775	33.46	2	2	227.026	75.74
3	4	60.8934	27.07	3	3	143.199	53.42
4	5	40.5097	20.97	4	4	84.0471	34.80
5	6	33.4946	14.07	5	5	40.3275	19.99
6	7	0.0016	3.76	6	6	2.6405	9.13

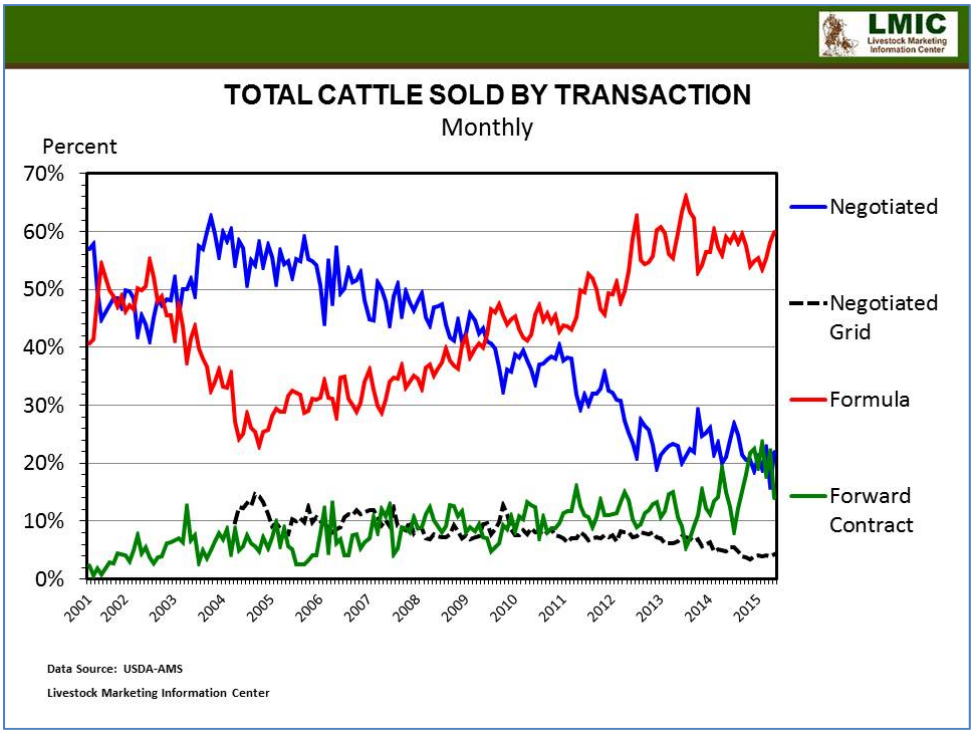

Figure 1: Marketing Method Use by Month since the Legislation and Implementation of Livestock Mandatory Price Reporting.

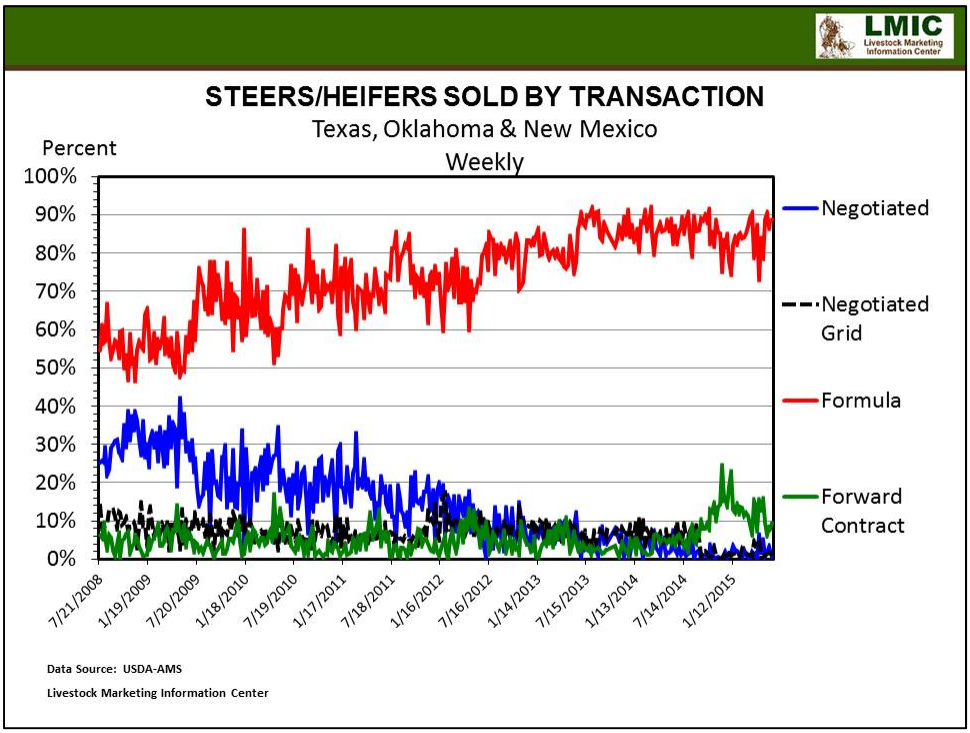

Figure 2: Marketing Method Use by Week in the Texas/Oklahoma/New Mexico USDA AMS Region.

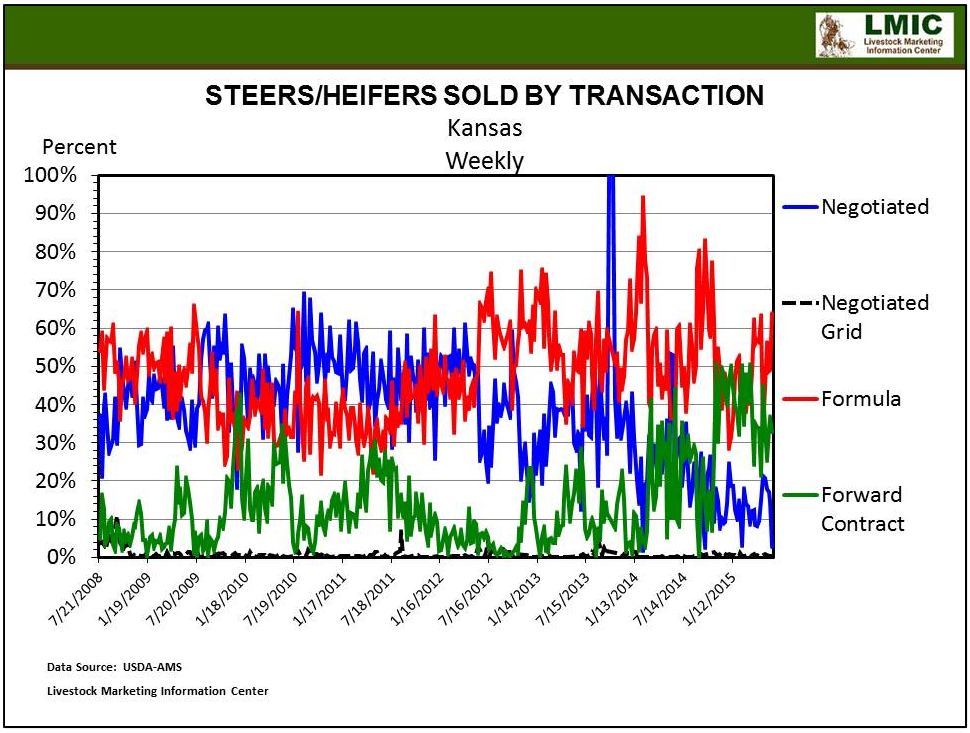

Figure 3: Marketing Method Use by Week in the Kansas USDA AMS Region.

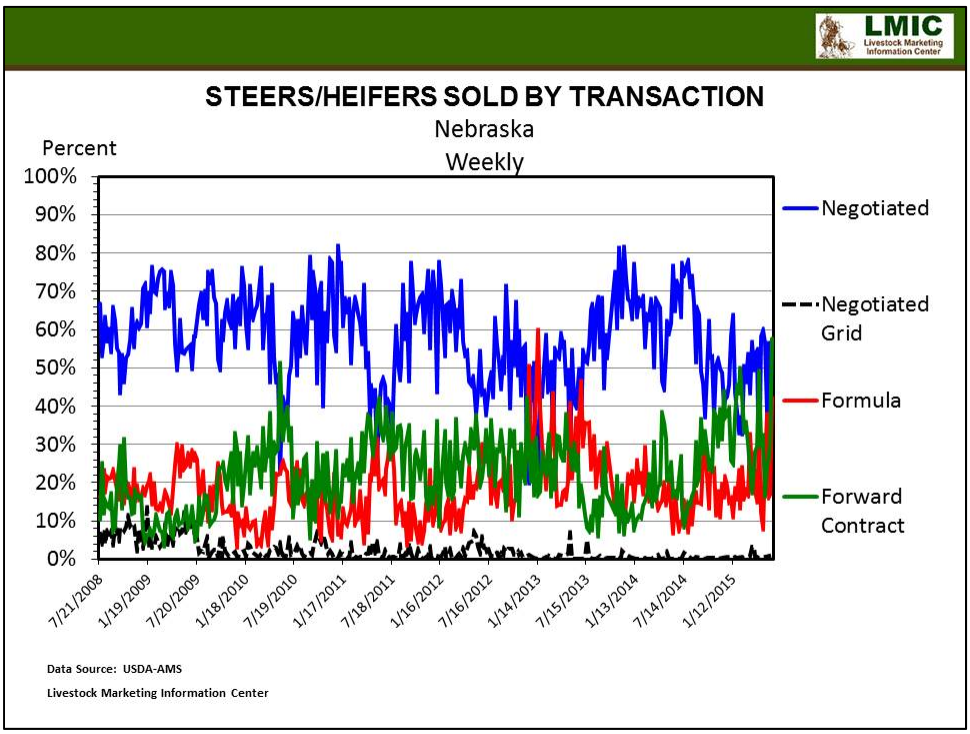

Figure 4: Marketing Method Use by Week in the Nebraska USDA AMS Region.

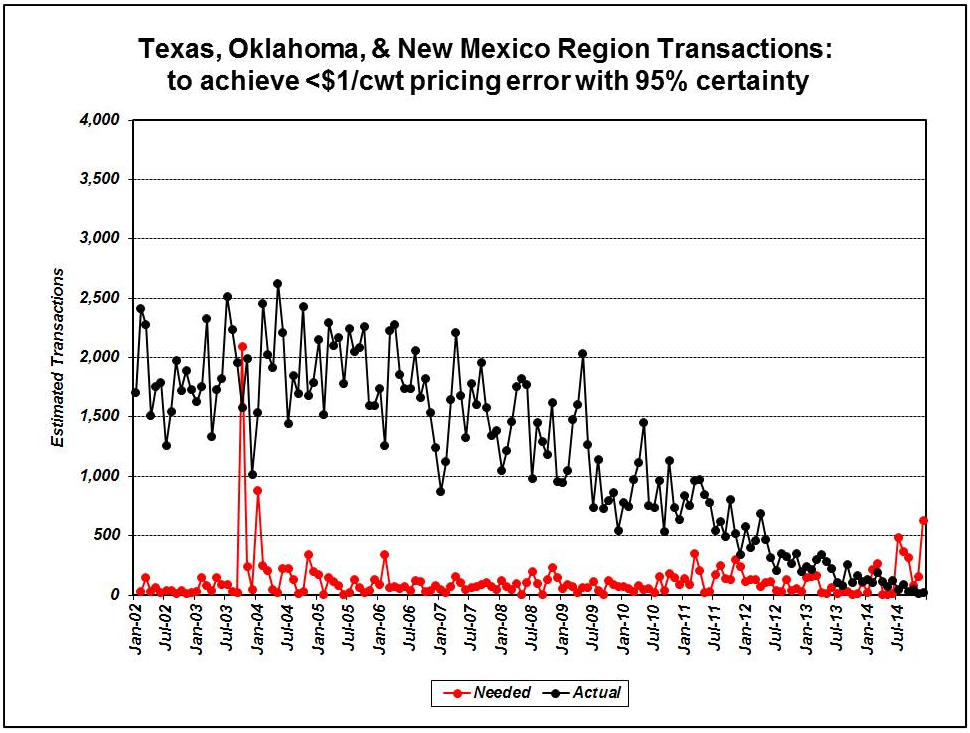

Figure 5: Estimated Actual Transactions and Transactions Needed to achieve <$1/cwt Pricing Error with 95% Probability for Texas-Oklahoma-New Mexico.

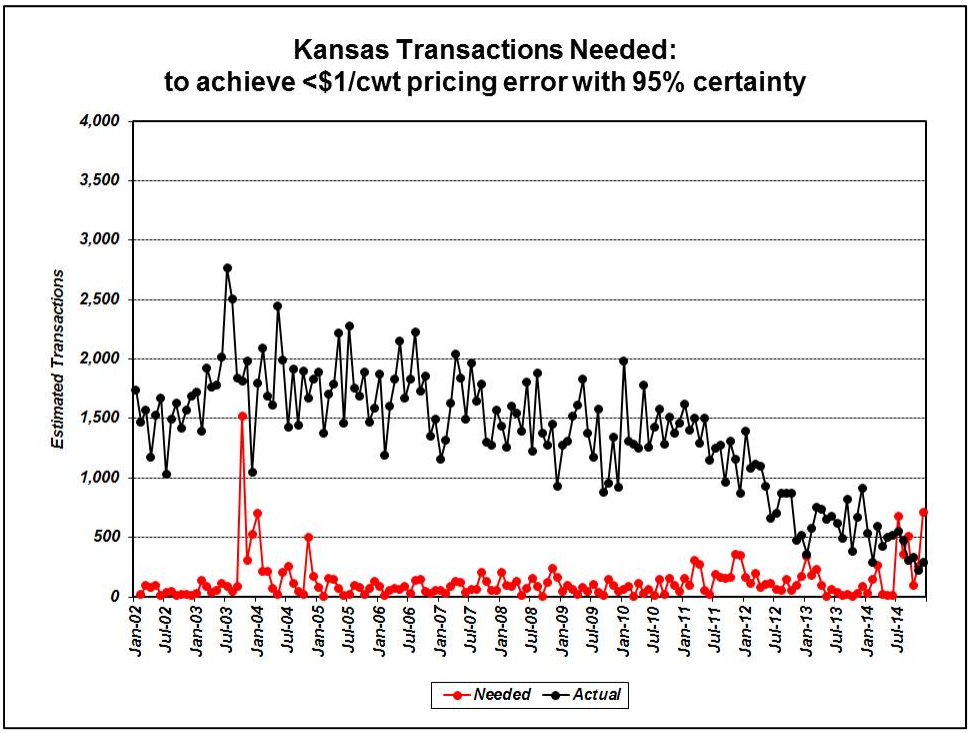

Figure 6: Estimated Actual Transactions and Transactions Needed to achieve <$1/cwt Pricing Error with 95% Probability for Kansas.

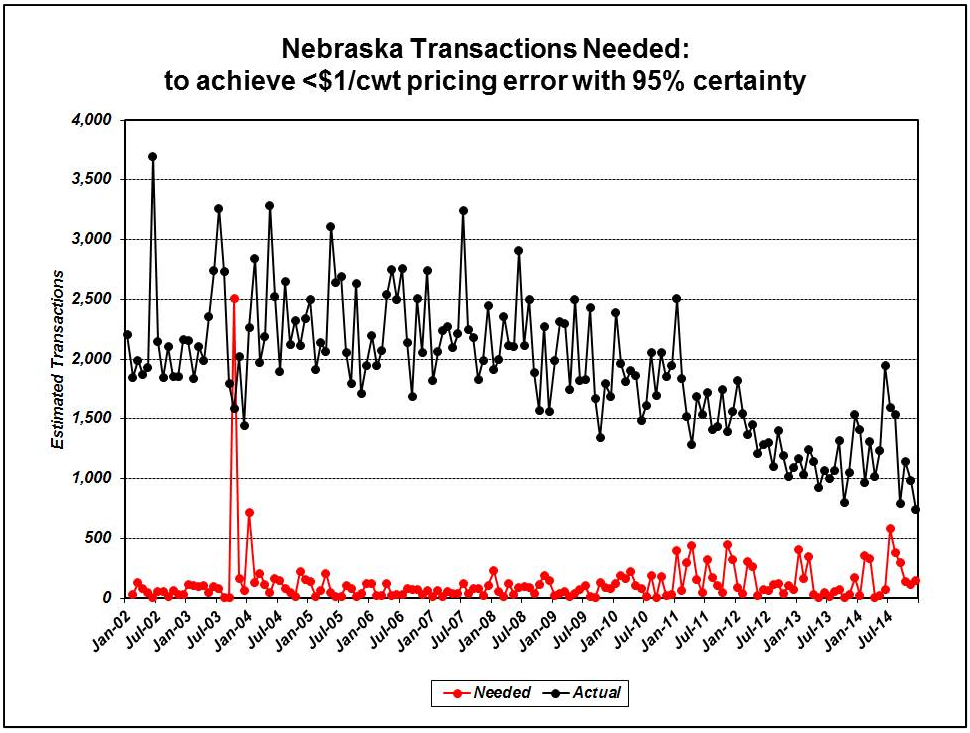

Figure 7: Estimated Actual Transactions and Transactions Needed to achieve <$1/cwt Pricing Error with 95% Probability for Nebraska.

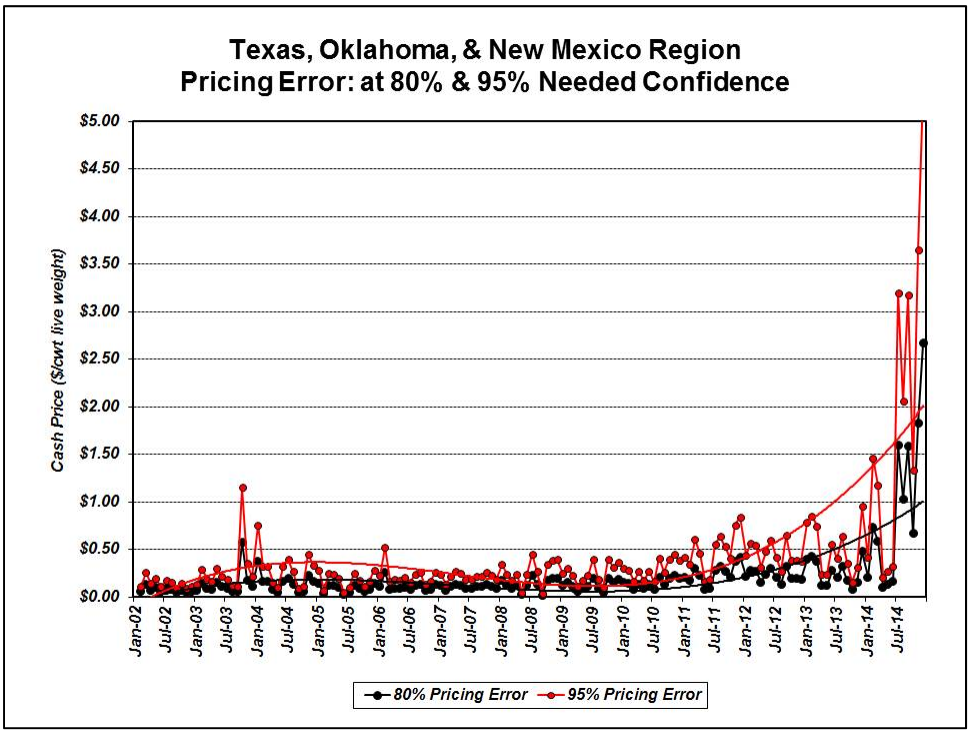

Figure 8: Pricing Error Given the Estimated Actual Number of Transactions for a 95% and 80% Probability for Texas-Oklahoma-New Mexico.

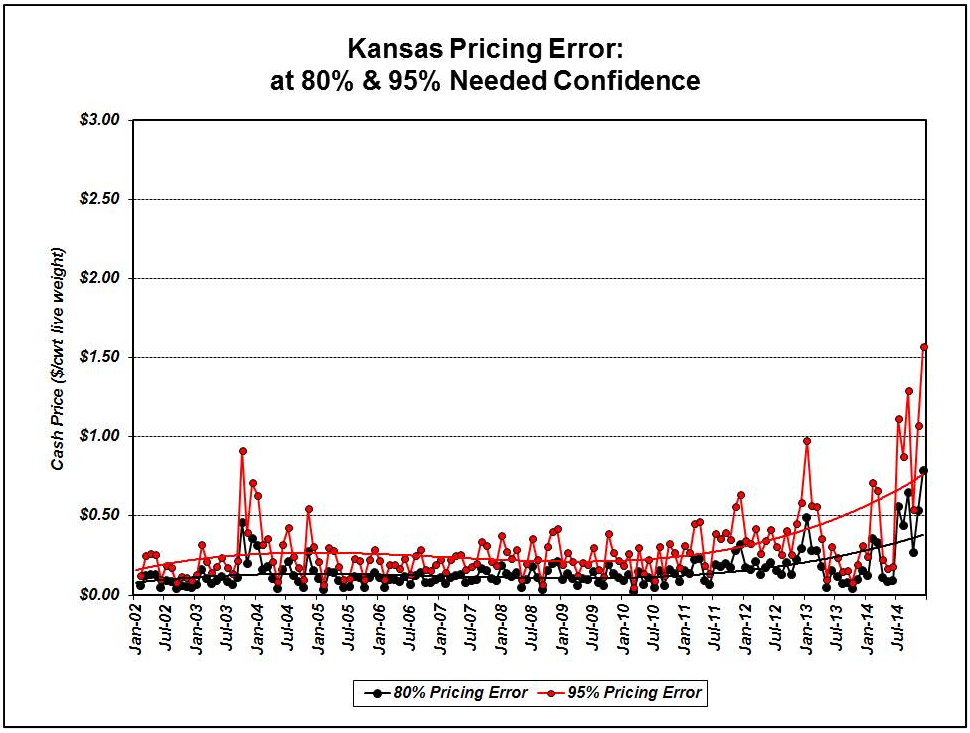

Figure 9: Pricing Error Given the Estimated Actual Number of Transactions for a 95% and 80% Probability for Kansas.

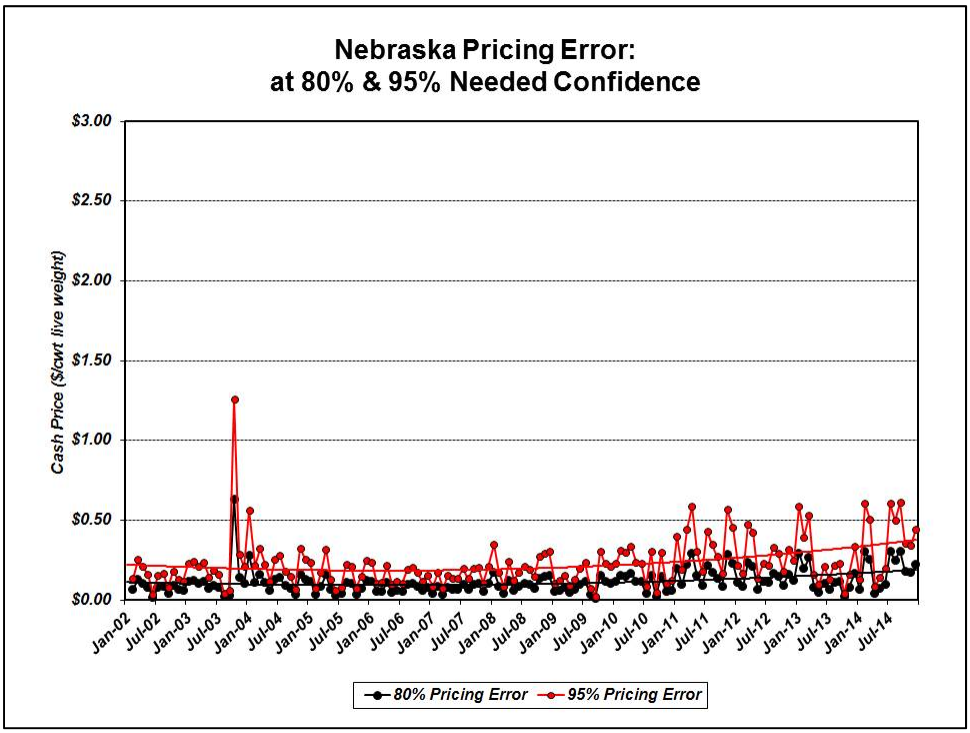

Figure 10: Pricing Error Given the Estimated Actual Number of Transactions for a 95% and 80% Probability for Nebraska.