EFFECTS OF CAPTIVE SUPPLIES ON SPOT MARKET PRICES : A PANEL DATA ANALYSIS

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Chapter I

Introduction

In recent years contract market has become an important transaction method in the U.S. livestock industry. Agricultural Economic Report (MacDonald et al, 2004) reports that contract market handled 12 percent of the value of the U.S.agricultural production in 1969, but increased its share to 28 percent in 1991 and 36 percent in 2001. The top four packers' process approximately 80 percent of the U.S. fed cattle, and the use of captive supplies has more than doubled from 22.5 percent to 50 percent in 1996. In the pork production, meatpackers acquired 87 percent of their hogs in spot markets in 1993, while procuring 11 percent through marketing contracts and 2 percent from their own farms (Hayenga, Rhodes, Grimes, and Lawrence, 2002). By 1997, the use of spot markets fell by half, and the spot market was able to handle only one-quarter of hog shipments by 2000, while half of the hog shipments were through marketing contracts and another quarter were from packer-owned farms (Hayenga, Rhodes, Grimes, and Lawrence, 2002). Contracts now cover nearly one-half of all livestock production, which is a significant increase from one-third in 1991-93 (MacDonald et al., 2004). Important research questions include: Does the contract market strategically depress the spot market price?; Will farmers lose or gain by the shift of the structure from the spot market to the contract market?

This research tries to respond to the above questions. The general objective is to examine the effect of captive supply contracts on the spot market prices. Specifically, the

objective is to estimate the effect of the amount of cattle supplied on marketing agreement and forward contract on the spot market prices. The study also estimates the effect of quality of cattle on the spot market prices. An econometric model of panel data was developed. The explanatory variables in the model are contract market, future market, quality of cattle and transportation cost.

Recently, the use of captive supplies in cattle procurement has been intensely debated in the U.S. beef industry. The USDA has been authorized to ensure competition in the meat industry under the Packers and Stockyards Act and has investigated the impact of captive supplies on spot market prices. Under the Packers and Stockyards Act, the mandatory price reporting has been imposed on packers starting from April, 2001 (Ward and Hornung, 2004).

There are basically three types of contract markets: marketing agreement, forward contract, and vertical integration (MacDonald et al., 2004). Marketing contract gives great control over product specification to the farmer and reduces the price risk associated with spot market pricing. Prices are determined before harvesting of crops or shipment of animals based on pricing formulas that both sides agreed in their contracts. The price calculations are usually based on spot market prices some weeks before the maturity date of the contract. This reduces the farmers' involvement in management and increases the packers control over managerial issues. Future contracts tend to give more managerial power to packers over the farmers. Under the contracts, packers typically provide substantial amount of inputs and technical advices, which give them more opportunities to control over the product than spot market transactions. Pricing also considers input values, output quantity and quality. In case of forward contract Ward,

Koontz, and Schroeder (1996) note that, "The feeder has the option of determining when to price the cattle (i.e., select a future's market price) and from that futures market price, a cash selling price is computed, based on the agreed up on basis." In case of vertical integration, there is no market price decision or contracts involved because the vertical integration is a single ownership of the cattle producer and packer. Pricing is simply an internal managerial decision.

Beef packers heavily rely on captive supplies in the form of engaging in future market contracts or vertical integration with feeders. The basic reason for the strategic shift in the management system is believed to be that captive supplies will enable packers to specify quality attributes of meat on the delivery and can pay premium or discount based on the evaluation. Some researchers claim that these types of contractual arrangements are likely to depress the spot market price and have a negative impact on the income and livelihood of some farmers (Crespi and Sexton, 2004; Azzam, 1998; and Xia and Sexton, 2004).

The Agricultural Economic Report (MacDonald et al, 2004) reported that the growth of captive supplies in the beef industry may have impact on cash market prices, which would affect all the stakeholders including farmers, packers, researchers and the policy makers. Previous studies show that there is a negative correlation between the contract market price and the spot market price (Ward and Hornung, 2004; Schroeter and Azzam, 2004). Whether the relationship is just a correlation between captive supplies and spot market prices or there is actually a causal relationship between them is debated.

Both Sexton and Zhang (2004) and Schroeter and Azzam (2004), show that the correlation between captive supplies and spot market prices has a causal relationship.

The negative relationship is a deliberate management practice by packers (Sexton and Zhang, 2004). They argue that packers use a geographic buffer zone within which they do not face competition from other packers. This creates a disincentive to jump the buffer zone and involve in the competitive market. Sexton and Zhang (2004), claim that, this action of packers will, therefore, reduce the spot market price. The negative relationship, Schroeter and Azzam (2004) argue, is not between the contemporaneous levels of captive supplies and the spot market prices but rather between the amount of captive supplies and the *ex ante* expectation of a change in price.

Previous studies have focused only on either spatial or temporal dimension in their models. The current study considers both temporal and spatial dimensions and therefore conducts panel data analysis. The spatial dimension of our panel data analysis helps to capture differences that arise due to geographical and socio-economic differences of states. This study includes five states; Kansas, Texas-Oklahoma, Nebraska, Colorado and New Mexico. These states are selected based on data from GIPSA thatshow s that the majority of cattle producers are located here and the four major packers that are dominating the market are located in these regions. As the number of states in the study increases it helps to make generalizations of outcomes at the national level. The five states in the study have different marketing arrangements, and therefore a simple time series analysis will not be able to capture the relationship between captive supplies and spot market prices.

The temporal dimension of this study includes time span from April 2001 to December 2004. Previous studies used a maximum of 2 years monthly or weekly data. The data from both the temporal and spatial dimensions were pooled to see if the same

results can be obtained without using a panel data analysis. SAS outputs revealed that most variables in thepool ed data are insignificant. The number of lags in weeks was determined by using Pearson's Correlation Coefficient test. The effect of the cumulative lag was tested using Koyck's method.

While specifying the model, some researchers used shipment of cattle at the date of maturity as dependent variable for models of both contract marketing and future marketing types of captive supplies. Others used the spot market price as the dependent variable. We conducted a Granger Causality test to determine the cause and effect relationship between captive supplies and spot market price. The PROC VARMAX procedure was used in SAS, and based on test results, spot market price was found to be the dependent variable while contract markets and future markets were the explanatory variables.

Following the studies of Azzam (2000), Ward, Kuntz and Schroeder (1998), Schroeter and Azam (2004), and Schroeder et al., (1993) this study controls for quality of cattle while examining the effects of captive supplies on the spot market prices. As prices in both types of contract markets (the marketing agreement and future contracts) are calculated based on certain attributes of the cattle (like weight at maturity date) it is important to control for quality variable in this type of analysis. Cattle supplied before the maturity date are expected to lack the attributes of a good quality while cattle supplied after the maturity date are expected to be, among other things, over age. Regression analyses were conducted both with and with out the quality variable and quality was found to be an important variable that affects the spot market prices in context with captive supplies.

The current study uses better and more updated data than previous studies. Earlier, all data about price and income of packers were obtained through the voluntary reporting by packers, and therefore, expectedly, were not complete. Responding to concerns by farmers and all stake holders, the congress passed an Act whereby packers were forced to report data about their price and income levels. The Mandatory Price Reporting, which was enforced by congress in 1999, began to be implemented in April 2001. All previous researches, except for the research by Ward and Hornung (2004), made use of the GIPSA/AMS data. Data from GIPSA, in particular price and income variables, have the merit of being data of each transaction in the livestock industry. However, as they were collected from the voluntary report of packers, have the demerit of being incomplete data set. The new data set is more complete as compared to the data set from GIPSA, however, it does not have data of each transaction. It rather has the weekly average of the daily transactions of cattle. This paper made use of weekly data of prices from the new data set from the mandatory reporting.

Following the introduction, the next section discusses relevant literatures on the relationship between captive supplies and spot market prices. Data and model specification are discussed before the results section. Finally, conclusions are presented.

Chapter II

Literature Review

The USDA stipulates that the term, "agricultural contracts," refers to contracts used to arrange for the transfer of agricultural products from farms to downstream users such as processors, elevators, integrators, retailers, or other farms. In recent years agricultural contracts have been increasingly implemented in agricultural production. Agricultural products have been increasingly differentiated and specialized to meet consumers' demands. Therefore, to be able to produce and market the differentiated and specialized products, agricultural production has to have a close supply chain management. This has led some farmers to opt for contracts.

Previous studies indicate that new production technologies, consumers who become more sensitive to the product quality and the need for improved coordination among participants in the production system are among the forces driving the move from spot markets to contracts (Carriquiry and Babcock, 2002). Consumers are becoming more discriminating on their choice of meat consumption, and together with new production technologies, these necessitate a closer attention of product quality at the farm level. Sykuta and Parcell (2001) point out that producers' introduction of new products and services tailored to satisfy consumer demand creates the need for much stricter coordination mechanisms than what can be accomplished with traditional spot markets.

One of the key objectives of contract marketing is to obtain complete market information. Microeconomic theory asserts that free flow of full information is one of the bases for the competitive market. In the spot (competitive) market, the product information is obtained based on attributes observable in live animals or harvested products. The observation is made on the spot while the transaction is been taken or in auctions. This information is believed to lead to an equilibrium price. The equilibrium price then sends the 'right' message to both consumers and producers in terms of the amount of production, attributes of products, cost of production, amount and type of inputs employed, taste and preference etc. The spot market, however, tends to fail to send the real signals. According to Sykuta and Parcell (2001), high quality meat did not fetch prices as high as expected. Consumers did not have enough knowledge (information) that made them pay higher prices. As high quality products are expensive to produce, producers will not have an incentive to produce these products if they do not get higher prices. On the other hand, the cost advantage of economies of scale led to just few buyers which, in effect, gave them also a monopsony power over the market. Full information can not be obtained as the number of buyers exceeds overwhelmingly the number of sellers in the market.

Livestock producers tend to prefer contracts as they try to avoid fluctuating spot market prices. Many small scale farmers are risk averters and incline to strategies that reduce the risk of price fluctuations as they focus on meeting current financial obligations. The ability of farmers to adjust to short term fluctuations is limited as compared to industrial good producers. This will make them liable to shift to risk aversion strategies at the expense of reduced prices and income. Buyers, in this case packers, are in a better position to take the risk as they get their products from diversified

sources and by the virtue of being 'big' can get out of crisis better than farmers can do. The benefit packers can get from shifting risk to their side is a cheaper price of livestock. Another reason for farmers to shift from spot market to contracts is due to the high transportation cost. Livestock producers can not move around their animals from one buyer to another because the transportation cost is expensive. It is also true that the further the producers try to go, the more risky they need to take by loosing weight and probably death of livestock. In this case contracts come at rescue for the farmers as they will give them a guaranteed price and therefore will not have to travel around with cattle. The cost of looking for credible buyers on each transaction is also alleviated when farmers are engaged in contracts.

Contracts are not without costs and/or risks to farmers. It is also expensive and risky to abide by contracts. Once a farmer has committed to a specific quantity and quality the burden of meeting these specifications is on his shoulders. If he could not abide by the contract, he might end up loosing more than he would have lost if he had not engaged in the contract.

Few packers, who have the market power, may have the capacity of raising the cost of entry to the market. They can make it difficult to other small packers to compete in the market. This results in reducing the competition and strengthening their market power. This in effect keeps the spot market prices lower than competitive prices. The meat packing industry, especially, is an industry which benefits highly from economies of scale. That makes it difficult for new packers to enter the industry as the cost of slaughtering per animal is high and they can not possibly compete with big packers who can effectively reduce that cost.

Packers use a pricing strategy called Top of the Market (TOMP) that fixes the price of cattle at the maturity date of the contract based on the highest price of the spot market price at that date (Xia and Sexton, 2004). This will leave other packers out of the market as they can not possibly meet that price at their entry stage. Ultimately, few packers will control the market and exercise oligopsony power to reduce the prices below the competitive level. Love and Burtton (1999) also suggest that packers can have an exclusive contract to a limited amount of cattle at higher prices without affecting the price of other cattle they are buying. This will give them the double advantage of having the right amount of cattle they need (not being in short of cattle) and also reducing the competitive price.

(Ward and Hornung, 2004) claim that the shift towards contract markets is a result of the failure of the market prices to accurately signal the demand of the consumers. Until April 2001, contract market prices were not reported; therefore, it was difficult for farmers to make decisions on their sale price. The unavailability of information gave an edge for the packers for an unfair competition. In 1999, congressional legislation—The Livestock Mandatory Price Reporting Act—required large meatpackers to report all livestock transaction prices to AMS/USDA. From its earliest days, the USDA has provided various level of agricultural market information to the public. In 1915, the first USDA market news report was issued at Hammond, LA, reporting prices and movement of strawberries. Livestock prices were reported soon after in various formats, and a voluntary livestock price reporting system was in place at AMS/USDA by 1946 (MacDonald et al., 2004). Information on quality of cattle based on attributes such as carcass quality were also standardized and published. Yield grades provide a numerical

five-point scale for evaluating yields of beef from a carcass, based on measurements of the thickness of fat at different points on the carcass.

Love and Brutton (1999) stated that on one side, economists see firms' decisions to vertically integrate as a means of reducing transactions costs, assuring supply while reducing price risk, or of alleviating efficiency losses resulting from underutilized resources (Azzam 1998). On the other side, economists see vertical integration as a means for firms to reduce competition or extract market rents. Heightened concentration facilitates collusion among packers, resulting in depressed livestock prices and elevated meat prices.

The economies of scale reasons for contract markets include, larger plants have lower costs, and operate at higher plant utilization than smaller plants further lowering their costs. These enable larger plants to bid higher prices to attract cattle and draw cattle away from smaller firm and drives up its costs.

Several agricultural economists have estimated the relationship between captive supplies and spot cattle prices over many years span. Azzam (2002) found a negative relationship between the captive supply and the spot market price. This indicates that when the captive supply goes up, the spot prices in the cattle market go down. Many researchers agree that there is a negative relationship between captive supplies and spot market prices (Ward and Hornung, 2004; Schroeter and Azzam, 2004; Sexton and Zhang, 2000). However, they differ on whether or not the negative relationship means that an increase in captive supply usage causes a decline in cattle prices, thus hurting independent cattle producers. Azzam (2002) made a distinction between regional level and plant level analysis of the relationship between captive supplies and spot market prices. According to him, “the tendency for spot market cattle prices to be ‘low,’ other

things equal, in weeks in which captive supply slaughter is 'high,' does not necessarily mean that there is an underlying mechanism whereby large deliveries of captive supply cattle in a particular week cause that week's spot market price to fall. Even if the week-to-week fluctuations in a region's spot market price of fed cattle were generated completely independently of the region's use of captive supplies, the incentives that influence the delivery scheduling decisions of feeders and packers would still give rise to a negative correlation between the observed spot price and the volume of captive supplies."

Continuing on the debate whether the relationship between captive supplies and spot market is just correlation or causal, Zhang and Sexton (2000) claim that the relationship between captive supplies and spot market prices is not just causal but rather a deliberate management activity of packers. The packers have created a buffer zone within which they exercise monopoly power. This has effectively reduced the spot market price, as packers have less incentive to jump the buffer zone and come to the competitive market.

Schroeter and Azzam (2004) also tried to determine whether the relationship between captive supplies and spot market prices are correlation or causation. They concluded that captive supplies have effectively reduced spot market prices. They found a negative relationship not between the contemporaneous level of captive supplies and price but between captive supplies and an *ex ante* expectation of a week-to-week price change.

Ward, Koontz, and Schroeder (1998) assumed a purely competitive market in the beef industry. They claim that captive supplies affect both demand for and supply of

cattle so the effect on the competitive price is not clear. The relative effect, according to them, depends on the specific market. Love and Burton (1999) relaxed the assumption of a competitive market and included vertical integration of the feeder and the packer. They found a negative sign of elasticity of supply. But they could not conclude that the negative sign is due to market power, because according to them, vertical integration helps packers gain efficiency as the supply of cattle will be under their control.

Elam (1992) and Eilrich et al. (1990) found that spot market prices were lower than contract market prices and concluded that it could be the price they were paying for not having to bear the risk involved. They also found that captive supply deliveries were inversely related to fed cattle prices. Hayenga and O'Brien (1990) examined the effect of captive supplies on weekly average fed cattle prices and price variability, they found effects that were usually not significant or that had mixed positive and negative signs relative to other market prices. Schroeder et al. (1993) report a negative relationship between forward contracting and fed cattle prices. Price impacts differed among packers and sub periods within the six-month period and were not significant for some packers and time periods.

Packers' incentives to engage in contract markets, according to Zhang and Sexton (2000), is the profit they make by creating the buffer zone which enables them to exercise monopoly power. No packer will have the incentive to jump the buffer zone, which they created due to locational advantage, and be involved in the spot (competitive) market. This act, in effect, will depress the spot market price. The other incentive, according to Schroeter and Azzam (2004), is the profit they gain by the reduced prices of the spot market due to *ex ante* expectation of future changes in price.

Contract market price is, at times, settled using calculations based on contemporaneous market prices. Sexton and Xia (2002) examined the competitive implications of such pricing arrangements, "focusing in particular upon so-called "top of the market pricing (TOMP)" in cattle procurement, wherein the contract guarantees the producer the highest cash price prevailing at the time of delivery". They showed that contracts have a depressing effect on the spot market prices especially when, "…the same buyers who purchase contract cattle with the TOMP clause also compete to procure cattle in the subsequent spot market."

One of the important variables that enter the contract is the quality of the cattle at the time of delivery. A number of hedonic studies exist pertaining to the quality of beef. May, Forristall and Lawrence (2002) assessed the cost of keeping the quality of beef. The positive and negative correlations between carcass traits and carcass and performance traits result in economic tradeoffs that change across input costs and quality grade premiums and discounts. The long-run trend in the U.S. beef industry is having fewer cattle grade Choice and more grade Select. Ward and Hogan (2003) built models for estimating beef quality. They concluded that, "… if a producer markets fed cattle on a grid, there appears to be an advantage in the first quarter of the year for cattle likely to grade a higher percentage of quality grade Select. For heavier cattle more likely to contain a higher percentage of yield grade 4-5 carcasses, a producer would appear to benefit with an anticipated marketing date in the second quarter".

Several papers used a data set from GIPSA. The USDA, being concerned about the effect of captive supplies on the spot market prices, has issued a mandatory price reporting by the packers. The Livestock Mandatory Reporting Act of 1999 requires meat

packers to report detailed price and quantity information on cattle, hogs, lambs, and products to United States Department of Agriculture's Agricultural Marketing Service (AMS) on a daily basis. The Livestock Mandatory Reporting Act mandates reporting of transaction data only by beef-packers who slaughter annually an average of 125,000 cattle, pork packers who slaughter annually 100,000 swine, or lamb packers who slaughter 75,000 lambs. Although the thresholds exempt close to 94 percent of cattle packers, 93 percent of pork packers, and 97 percent of lamb packers, mandatory reporting accounts for 80-95 percent of the cattle, boxed beef, slaughter hog, sheep, and lamb (MacDonald et al., 2004).

The anticipated positive effect is that transparency enhances competition. As compared to the GIPSA data set which was obtained through a voluntary price reporting by packers, this one is more complete and reliable. There are only few missing values and has a high rate of accuracy (no simulation or estimation methods to make the data balanced).

Azzam (1998) on his study about the effect of the new data set concluded that "…the usefulness of the Act to the livestock industry may not be in the value of reported information to the feeders, as the supporters of the Act claim. Rather, by forcing packers to pool information at negligible marginal cost, the Act may foster more competitive conduct in the procurement of livestock."

Chapter III

Data

This paper uses the new data set from the Mandatory Price Reporting Act. The data was released beginning from April, 2001. A weekly data of spot market prices, amount of cattle delivered through the marketing agreement and forward contract, are used. Data for the cost of cattle delivery and quality are collected from GIPSA. The paper uses time series data of April 2001 to December 2004 and five states: Nebraska, Kansas, Colorado, New Mexico, and Texas-Oklahoma. The selected states produce the majority of beef in the U.S. and the top four packers are also located in these regions. Table 1 shows the summary statistics for each of the states. This data set is believed to be superior to the data set from GIPSA because in the latter type data is collected voluntarily and therefore is not complete. The Mandatory Reporting Act compels packers to report data about their price and income level, and this makes it a complete data set, though it records the average of the week and not daily transactions. The GIPSA data set records each transaction of the cattle market but have a lot of missing values. A complete data set is very important especially in a panel data analysis. The data for the quality of the cattle delivered is based on USDA's classification of cattle quality as select, choice, standard, and premium (1, 2, 3, 4, and 5 for each category). The number of cattle in each category is used to quantify the variable. The average of each day is

taken for the week's data and the same is done for each state. There were not much of a difference in the quality of cattle from week to week, but difference was observed from state to state.

Data is collected from the two types of cattle delivery method in captive supplies: marketing agreement and forward contract. In the marketing agreement, there is a standing agreement between the feeder and the packer to transact a certain number of cattle at a certain price level. Price is determined by a formula which involves the base price and attributes of the cattle such as yield grade, quality grade, and carcass weight. The base price tends to be related to the spot market price at the time of delivery. The marketing agreement gives the discretion of determining the volume of cattle to be delivered to the feeder while the specific date of delivery is determined by the packer. In case of forward contract, the feeder determines the volume of cattle delivery in a certain future period of time while the schedule of delivery within that future period of time is determined by the packer.

Chapter IV

Model Specification

This research uses a panel data analysis. The data was also pooled and OLS was used to estimate the variables for comparative purposes. It is expected that the different cross-sections may have different error variances. Greene (2000, p. 594), notes that for a cross-country comparison there may be variation in the scales of the variables in the model. It is also expected that there will be cross-section contemporaneous error correlation. The Breusch-Pagan Lagrange multiplier statistic was used to test for a diagonal covariance matrix (that is, no cross-section correlation) (Greene 2000, p. 601). As expected, cross-sectional contemporaneous error correlation was found. Based on the results, shown in table 2, it was concluded that just pooling the time series and cross-section data is not a good method for estimating the variables.

There has been a debate in the captive supply regarding whether the negative relationship between captive supplies and spot market prices is simply a correlation or is in fact causation. The general goal is not to study associations between variables (which is the case for studies that involve forecasting), but to assess causal

relationships between variables. Some researchers have used price as the dependent variable while others have used contract markets as the dependent variable.

This research uses the Granger Causality Test to determine the cause and effect relationship (Greene, 2000). The PROC VARMAX procedure was used in SAS. The test hypothesis is marketing agreement (forward contract) is the dependent variable while the alternative hypothesis is price is the dependent variable. Test 1 has marketing agreement (forward market) as the dependent variable while spot market price was the explanatory variable. Test 2, on the other hand, has price as the dependent variable and marketing agreement (forward market) as the explanatory variable. The results are shown in Tables 3 and 4. The results show that the test 2 is significant at 5% level of confidence while test 1 is insignificant for both marketing agreement and forward contract. This means that captive supplies are affecting the spot market prices and not the other way around. Following the above results, the spot market price was used as the dependent variable while marketing agreements and future markets are used as explanatory variables.

Following the causality tests, a price dependent model is specified as:

$$P_{it} = \alpha_0 + \alpha_1 amt1_{it} + \alpha_2 amt2_{it} + \alpha_3 qlty_{it} + \alpha_4 cst_{it} + \varepsilon_{it} \qquad (1)$$

where P_{it} is the spot market price at week t in state *i, amt1* is the amount of cattle delivered in the marketing agreement *by* state *i* in week *t* , *amt2* is the amount of cattle delivered in the forward contract market by state *i* in week *t* , *qlty* is the quality of cattle delivered at time *t* and state *i*, cst_{it} is the transportation cost of delivering cattle by farmers to packers, and ε is the random disturbance term. Quality of cattle and transportation cost are included in the model to take in to account the effects of beef

quality and transportation cost in changing spot market price. They are both expected to affect spot market price positively. The higher the quality of cattle is, the higher its price is in the market. As the cost of transporting the cattle from farm to packer increases, cattle price tend to increases.

To determine the effect of captive supplies on the spot market prices, coefficients of the amount of cattle supplied due to the marketing agreement contracts and future market contracts at time t (α_1 and α_2) are estimated. To determine the effect of quality on the spot market prices, the coefficient of quality of cattle (α_3) is estimated.

There may be time lag in the causal relationship between the spot market price and the captive supply. In other words, today's shipment may have impact on today's spot market price as well as spot market prices in the future. The Pearson's correlation coefficient was used to examine this issue. Table 5 shows that, the degree of correlation decreases for both marketing agreement and future market contracts, from current period to seven weeks lag period. The correlation converges to zero as the number of lag periods increase. This means that there is a cumulative effect of all lag periods of the contract markets in the spot market price. Koyck's (Theil, 1971) method (explained above) of converting the distributed lag form into an autoregressive lag form is used to see the cumulative effect of the lags.

Koyck's method was used to find the cumulative effect of the lag periods of the captive supplies on the spot market prices. Considering Koyck's method, equation (1) is rewritten as[1]:

[1] We also consider cumulative lag structure of quality and cost variable for the derivation purpose. However, we focus only on the cumulative effects of captive supplies on the spot market prices.

$$P_{it} = \alpha_0 + \sum_{j=0}^{\infty} \alpha_{j+1} amt1_{it-j} + \sum_{k=0}^{\infty} \beta_{k+1} amt2_{it-k} + \sum_{l=0}^{\infty} \gamma_{l+1} qlty_{it-l} + \sum_{m=0}^{\infty} \theta_{m+1} cst_{it-m} + \varepsilon_{it} \quad (2)$$

Estimating equation (2) is a difficult task mainly due to the multicollinearity problem. To estimate equation (2), we impose an assumption that the multiplicative coefficients, $\alpha_1 - \alpha_8$ and $\beta_1 - \beta_8$ converge to zero (The coefficients $\gamma_1 - \gamma_2$ and $\theta_1 - \theta_2$, are also assumed to converge to zero but they are not the focus in this study). More specifically, we assume the decline takes a geometric fashion. That is:

$\alpha_2 = \mu\ \alpha_1, \alpha_3 = \mu^2\ \alpha_1, \alpha_4 = \mu^3\ \alpha_1 \ldots$

$\beta_2 = \mu\ \beta_1, \beta_3 = \mu^2 \beta_1, \beta_4 = \mu^3\ \beta_1 \ldots$

$\gamma_2 = \mu\ \gamma_1, \gamma_3 = \mu^2\ \gamma_1, \gamma_4 = \mu^3\ \gamma_1 \ldots$

$\theta_2 = \mu\ \theta_1, \theta_3 = \mu^2\ \theta_1, \theta_4 = \mu^3\ \theta_1 \ldots,$

where $0 < \mu < 1$.

Rewriting equation (2) for (t-1) period and multiplying both sides by μ, we have:

$$\mu p_{it-1} = \mu\alpha_0 + \sum_{j=1}^{\infty} \mu^j \alpha_1 amt1_{it-j} + \sum_{k=1}^{\infty} \mu^k \beta_1 amt2_{it-k} + \sum_{l=1}^{\infty} \mu^l \gamma_1 qlty_{it-l} + \sum_{m=1}^{\infty} \mu^m \theta_1 cst_{it-m} + \mu\varepsilon_{it-1}$$

Subtracting (3) from (2) yields:

$$P_{it} = (1-\mu)\alpha_0 + \mu P_{it-1} + \alpha_1 amt1_{it} + \beta_1 amt2_{it} + \gamma_1 qlty_{it} + \theta_1 cst_{it-m} + (\varepsilon_{it} - \mu\varepsilon_{it-1}) \quad (4)$$

The error term in equation (4), $(\varepsilon_{it} - \mu\varepsilon_{it-1})$, is not a random error term as is assumed in an Ordinary Least Square regression analysis. However, if the sample size is large enough, the OLS result should not be affected by the randomness of ε_{it-1} (Theil, 1971).

There are two types of models in the panel data analysis: fixed effect and the random effect models. The Hausman specification test (Greene, 2000) was used to examine whether the fixed or random effects model should be used. The hypothesis is, to test whether there is a significant correlation between the random effect and regressors. If the correlation is not significant the random effect model can be used to estimate. If there is a significant correlation between the error terms and the regressors, the fixed effect model would be chosen.

The test statistics shows that the m-value (correlation coefficient) is 13.67 while the probability value is 0.142. The test statistics indicate that there is a significant correlation between the random effects and the regressors at the 5 percent level. Therefore, the random effect model is used instead of the fixed effect model in this research.

When the random effect model is a regression with a random constant term over cross-sectional units (states in our case), but constant over time (weeks in our case), the model is called one-way random effect model. However, when the random effects are considered over both cross-section and time series, the error components model are referred to as the two-way random effects model. In this case, the typical error term should be uncorrelated with both time series and cross-sectional component errors. This study considers the two-way random effects, and TSCS RANTWO procedure was used in SAS.

Autocorrelation is also tested in this study using the Durbin-Watson test (Greene, 2000). The presence of autocorrelation may be different for each panel or it may be uniform across the panels. The number of temporal observations was greater

than the number of regressors in this study, so it is assumed that there are common autocorrelation across all panels. Heteroscedasticity problem can also arise from group wise differences in the panel data. Both White and Breusch-Pagan tests were used to detect the presence of heteroscedasticity. Table 12 shows the presence of both autocorrelation and heteroscedasticity. A weight-adjusted combination of the White and Newey-West (Greene, 2000) estimator was used to address heteroscedasticity and autocorrelation problems in the model.

Chapter V

Results and Discussion

Correlation coefficient matrix shows that the spot market price at the week t is the most correlated with shipments from marketing agreement and forward contract markets at the week t. The result also shows that the spot market price is correlated with shipments from lagged periods of marketing agreement and forward contracts. The coefficient converges to zero as the lag increases. The lag of t-8 and beyond was found to be significantly reducing as compared to lags until t-7. Therefore only 7 lag weeks were used. Koyck's method was used to estimate the cumulative effect of the lags of the 7 weeks.

PROC TSCS RANTWO was used in SAS to run the panel data regression. The distributed lag form of Koyck's method was used to estimate the effect of the cumulative lags of marketing agreement and forward contract on the spot market prices. Then, Cross-sectional and time series data were pooled and the ordinary linear regression was used in SAS to compare results from both regression procedures. The panel data and pooled data regression were conducted for both the current period and the distributed lag form of Koyck's method. Both pooled and panel estimation was

conducted with and without the quality variable to study the importance of quality as an explanatory variable in the model.

Table 6 shows the results of the reduced form of Koyck's method of the pooled data. The distributed lags of Koyck's method were recovered from the results of the reduced lag form. Table 7 shows the results of both current and distributed lag of pooled data regression with and without quality. From the results it can be seen that both coefficients of marketing agreement and forward contracts are significant in the pooled data regression using the current shipment at the 5% level of significance. The quality variable is significant at the 10% level of significance. Results of the pooled data regression of distributed lag show that all lagged variables of marketing agreement and forward contract are insignificant at the 5% level of significance and all coefficients show a negative sign as expected. Quality of cattle was significant at the 10% level while transportation cost was significant at the 5% level. All coefficients in this regression have correct signs.

Results of the reduced form of Koyck's method, from the panel data regression are shown in table 8. The coefficients of distributed lags of Koyck's method were recovered from the results from the regression of reduced lag form. Table 9 shows the panel data regression results of both current and distributed lags with and without quality. In the regression with current shipment marketing agreement was found to be significant at 10% level of significance with the quality variable while it was found to be not significant without the quality variable. On the same regression forward contract was found to be significant at the 5% level of significance. Results of the distributed lag form show that both contract marketing and forward contract are

significant at the 5% level. Quality of cattle was found to be significant at the 10% level of significance. As expected marketing agreement and forward markets had a negative sign while quality of cattle had a positive sign.

Price elasticity of marketing agreement, forward contract and quality of cattle were calculated based on estimate values of the panel data estimates of lagged values. The results, table 10, show that for each additional cattle supplied in the marketing agreement price decreases by 0.1501 cents. Likewise, for each additional cattle supplied in the forward contract, price decreases by 0.2238 cents. For each additional cattle supplied in an upgraded quality level, price increases by 0.2546 cents.

Based on these results, it can be concluded that quality is an important explanatory variable in the relationship between captive supplies and spot market prices. As expected, a positive relationship between quality of cattle and spot market prices was found. The results also showed that both marketing agreement and forward contract of the distributed lag form are significant. From this it can be concluded that the negative relationship is not just between the current period of spot market prices and captive supplies but also that there is a cumulative effect of lag periods of captive supplies on the current spot market price.

Comparing the distributed lag results of tables 6 and 7 with that of table 8 and 9, it can be seen that variables of pooled data are not significant at 5% confidence level while variables of panel data are significant at the 5% confidence levels. The Breusch-Pagan Lagrange multiplier statistic used to test for a diagonal covariance matrix also shows that, cross-sectional contemporaneous error correlation was found. Though it can not be concluded, from the output, pooling data is wrong, statistical

significance of estimates suggests that panel data analysis fits the data better than the pooled regression.

Chapter VI

Conclusion

In the past 30 to 40 years contracts markets have grown to have a significant share. A recent USDA report shows that (MacDonald, et al 2004) contracts share of the market is about 50% while the largest four packers slaughter 80% of the cattle(MacDonald et al., 2004). An important question is will the shift in the marketing structure depress the spot market price?

The improvement in technology in the processing industry, like the 'beef boxing' technology, coupled with an increasing demand of quality products, has necessitated a closer follow up and coordination of the supply chain management. The contracts are considered to enable farmers the risk associated with their business. The risk is shared by packers who are in an advantageous position to take the risks. As small entities in the business, producers are liable to price fluctuations and therefore are prone to high risk. This, of course, may be at the expense of reduced prices and income at the farm level. High transportation cost and lack of full information are among the variables that led producers to engage in contracts. The contracts have given packers the advantage of lower prices and standardized quality products. The cost of contracts for packers is writing contracts every time for each lot of cattle sold and the risk of producers not being able to fulfill the contracts.

Many researchers agree that captive supplies and spot market prices have inverse relationships. The debate is on the cause and effect relationship. Zhang and Sexton (2000) assert that the relationship between captive supplies and spot market prices is not just causal but rather a deliberate management activity of packers. Schroeter and Azzam (2004) concluded that captive supplies have effectively reduced spot market prices. They found a negative relationship not between the contemporaneous level of captive supplies and price but between captive supplies and an *ex ante* expectation of a week-to-week price change.

This paper also examined the cause and effect relationship between captive supplies and spot market prices. Unlike previous researches, which used either only temporal or spatial dimensions, a panel data analysis was used. To test the cause and effect relationship the Granger Causality Test was used. It was found that captive supplies affect spot market prices and not the other way around. The Pearson's Correlation Coefficient matrix showed that spot market prices are correlated the most with current period shipments of cattle but are also correlated with lagged period shipments. The effect decreases as the number of lag period increases. The Koyck's method was used to estimate the cumulative effect of the lag periods. The data was pooled and Ordinary Least Square procedure was used for current and lag periods with and without the quality variable. The panel data regression was also used for current and lagged periods with and without the quality variable.

From the results of both regressions it was found that marketing agreement, forward market and quality of cattle significantly affect spot market prices when the panel data regression was used. It was also found that both the current and lagged

weeks affect spot market prices, though the current week affects the most. The signs of marketing agreement and forward contract were found to be negative while quality has a positive sign. Findings in this study were consistent with previous studies such as Zhang and Sexton (2000) and Schroeter and Azzam (2004).

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Table 1. Descriptive Statistics

	Marketing Agreement		Forward Contract	
State	Mean	Standard Deviation	Mean	Standard Deviation.
Colorado	605.0000	29.1100	202.0000	22.0124
Kansas	623.8000	30.0169	209.2000	18.0194
Nebraska	618.0000	36.0821	201.0000	29.9600
New Mexico	653.0000	35.4232	208.0000	23.3200
Texas-Oklahoma	634.0000	29.5668	214.0000	21.3269

Table 2: The Breusch-Pagan Lagrange multiplier test

Test Statistics	51.4400
5% Critical value of Chi-Square distribution	8.7600

Table 3. Granger Causality Test

	Chi-Square	**Pr > ChiSq**
Test 1: Dependent variable: Marketing Agreement Explanatory variable: Price	5.46	0.2567
Test 2: **Dependent variable: Price** **Explanatory variable:** **Marketing Agreement**	11.54	0.0192

Table 4. Granger Causality Test

	Chi-Square	**Pr > ChiSq**
Test 1: Dependent variable: Forward Contract Explanatory variable: Price	8.13	0.1976
Test 2: **Dependent variable: Price** **Explanatory variable:** **Forward Contract**	10.66	0.0431

Table 5. Pearson's Correlation Coefficient

Marketing Agreement	Price	Forward Contract	Price
No Lag	-0.49481	No Lag	-0.43730
Lag 1	-0.48952	Lag 1	-0.43419
Lag 2	-0.48670	Lag 2	-0.43046
Lag 3	-0.48656	Lag 3	-0.42950
Lag 4	-0.47761	Lag 4	-0.42482
Lag 5	-0.47724	Lag 5	-0.42416
Lag 6	-0.47725	Lag 6	-0.42045
Lag 7	-0.47417	Lag 7	-0.41695
Lag 8	-0.23167	Lag 8	-0.21366
Lag 9	-0.13476	Lag 9	-0.10978
Lag 10	-0.09867	Lag 10	-0.07986

Table 6. Pooled Data Estimation Using Reduced Form of Koyck's Method Form

Variable	Parameter Estimate	
	With Quality	Without Quality
Intercept	2.4579* (1.0778)	1.2466* (0.9632)
Lag Price	0.9687* (0.6163)	0.7243* (0.3242)
Marketing Agreement	-0.0077 (0.1124)	-0.0016 (0.0113)
Forward Market	-0.0067 (0.1132)	-0.0014 (0.0011)
Quality of Cattle	0.0211** (0.0208)	_
Transport Cost	0.0061* (0.0030)	0.0032* (0.0018)

* Significant at the 5% level of significance
** Significant at the 10% level of significance
Standard Errors are given in parenthesis

Table 7. Pooled Data Estimation Using Distributed Lag form of Koyck's Method

	Current Shipment		Koyck's Distributed Lag		
	With Quality	Without Quality		With Quality	Without Quality
Intercept	41.4123*	33.06756*		2.38097*	0.00116
	(3.4827)	(2.22187)		(0.00679)	(0.02256)
Marketing	-0.00416*	-0.03133*	Lag 1	-0.00746	-0.00084
Agreement	(0.00223)	(0.01254)		(0.07452)	(0.00366)
			Lag 2	-0.00723	-0.00061
				(0.04593)	(0.00199)
			Lag 3	-0.00670	-0.00044
				(0.02831)	(0.00039)
			Lag 4	-0.00668	-0.00032
				(0.01744)	(0.00012)
			Lag 5	-0.00657	-0.00023
				(0.01075)	(0.00004)
			Lag 6	-0.00636	-0.00017
				(0.00663)	(0.00001)
			Lag 7	-0.00616	-0.00001
				(0.00408)	(0.00001)
			Sum	-0.04716	-0.00262
Forward	-0.01104*	-0.03233*	Lag 1	-0.00649	-0.00101
Contract	(0.00712)	(0.01532)		(0.06977)	(0.00233)
			Lag 2	-0.00629	-0.00073
				(0.04299)	(0.00227)
			Lag 3	-0.00609	-0.00053
				(0.02649)	(0.00221)
			Lag 4	-0.00589	-0.00039
				(0.01633)	(0.00218)
			Lag 5	-0.00572	-0.00028
				(0.01006)	(0.00211)
			Lag 6	-0.00554	-0.00020
				(0.06203)	(0.00188)
			Lag 7	-0.00537	-0.00014
				(0.03823)	(0.00146)
			Sum	-0.03530	-0.00328
Quality of	0.42635**	_		0.0211**	_
Cattle	(0.41354)			(0.0208)	
Transportation	0.04231*	0.02383		0.0061*	0.0032*
Cost	(0.02761)	(0.03519)		(0.0030)	(0.0018)

Table 8. Panel Data Estimation Using Reduced Form of Koyck's Method Form

Variable	Parameter Estimate	
	With quality	Without quality
Intercept	3.1619*	2.4726*
	(1.0726)	(1.0321)
Lag Price	0.9559*	0.3866*
	(0.2158)	(0.1946)
Marketing Agreement	-0.0031	-0.0026
	(0.0033)	(0.0024)
Forward Contract	-0.0045*	-0.0038*
	(0.0027)	(0.0013)
Quality of Cattle	0.0131**	_
	(0.0108)	
Transportation Cost	0.0035*	0.0064*
	(0.0023)	(0.0031)

* Significant at the 5% level of significance
** Significant at the 10% level of significance
Standard Errors are given in parenthesis

Table 9. Panel Data Estimation Using Distributed Lag form of Koyck's Method

	Current Shipment		Koyck's Distributed Lag		
	With Quality	Without Quality		With Quality	Without Quality
Intercept	62.50147*	55.03132*		3.02259*	0.95591*
	(3.46678)	(4.32174)		(0.00441)	(0.02256)
Marketing Agreement	-0.02132*	-0.00307	Lag 1	-0.00288*	-0.0014*
	(0.01141)	(0.00421)		(0.00071)	(0.00047)
			Lag 2	-0.00276*	-0.00039*
				(0.00015)	(0.00009)
			Lag 3	-0.00264*	-0.00015*
				(0.00034)	(0.00002)
			Lag 4	-0.00252*	-0.00006*
				(0.00003)	(0.00001)
			Lag 5	-0.00241*	-0.00002*
				(0.00001)	(0.00001)
			Lag 6	-0.00230*	-0.00001
				(0.00001)	(0.00001)
			Lag 7	-0.00220*	-0.00001
				(0.00001)	(0.00001)
			Sum	-0.01771	-0.00204
Forward Contract	-0.01006*	-0.04133*	Lag 1	-0.00430*	-0.00147*
	(0.00906)	(0.01396)		(0.00058)	(0.00025)
			Lag 2	-0.00411*	-0.00057*
				(0.00013)	(0.00005)
			Lag 3	-0.00393*	-0.00022*
				(0.00003)	(0.00001)
			Lag 4	-0.00376*	-0.00008*
				(0.00001)	(0.00001)
			Lag 5	-0.00359*	-0.00003*
				(0.00001)	(0.00001)
			Lag 6	-0.00343*	-0.00001
				(0.00001)	(0.00001)
			Lag 7	-0.00328*	-0.00001
				(0.00001)	(0.00001)
			Sum	-0.02640	-0.00239
Quality of Cattle	0.38665**	_		0.0131**	_
	(0.35801)			(0.0108)	
Transport Cost	0.03590	0.02287		0.0035*	0.0064*
	(0.03914)	(0.04604)		(0.0023)	(0.0031)

Table 10. Price Elasticity

Variable	Elasticity
Marketing Agreement	-0.1501
Forward Contract	-0.2238
Quality of Cattle	0.2546

Table 11: Tests for Autocorrelation and Heteroscedasticity

Statistics	Durbin Watson	Breusch-Pagan	White
	1.5790	13.3650	17.8910

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