MODELING LIVE CATTLE SUPPLY WITH DIFFERENT PRICE EXPECTATIONS

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Abstract

Using live cattle production data from 1995 to 2001, we investigated live cattle supply represented by both net placement and marketings with two price expectation models, naïve and futures. The results show significant evidence of different price expectations when cattle feeders make decisions on net placement and marketings of live cattle. Our study also suggests that cattle feeders are risk averse on average.

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Key Words: live cattle supply, net placement, naïve expectation, futures market.

Introduction

Though equilibrium price and quantity are determined by both supply and demand, shocks to the live cattle market are mainly from the supply side. Fundamental analysis of live cattle supply can help in forecasting quantities and prices of live cattle in the future and understanding cattle feeders' supply decision in response to prices. Cattle feeders make decisions on how many cattle to put on feed and sell based on expectations of the fed cattle prices at time of marketing. Thus the questions arise: what expected prices should be used in projecting fed cattle supply quantity, how do these expected prices affect live cattle supply, and does price risk, which is reflected in price volatility, have any impact on cattle feeders' supply decisions?

This study is intended to provide insights into these questions by modeling live cattle supply with different modes of price expectations and risks as factors in cattle feeders' decisions. In particular, we compare the fit of the futures price model (where the expected fed cattle prices are proxied by futures prices) with that of a naïve expectations model (where spot prices are used) in live cattle supply analysis. Supply quantities are measured in both net placement of live cattle and fed cattle marketings to better understand supply behaviors.

The expected result is that the next-period supply model (live cattle placement model) using futures prices will outperform the one which uses recent prices because the futures market reflects the rational expectations of the whole market and is a better predictor for future prices. The elasticity of supply in response to expected price and risk will be analyzed in the final model.

Past Studies

Jarvis modeled the microeconomics of cattle supply where each cattle producer maximizes a discounted stream of future profits. He showed, among other things, that theoretically it is possible for a negative short-run supply response to exist. Moreover, when applied to the Argentinean beef-cattle industry, he found evidence of negative short-run supply response.

Futures prices can be viewed as rationally held expectations of subsequent cash prices. Leuthold and Hartmann (1981) examined the forecasting accuracy of the live cattle futures market on a quarterly basis for the period 1971 through 1978. They compared the forecasts from the futures market to forecasts from a straightforward econometric model of the cattle market. Their results suggested that on balance the live cattle futures market was a marginally superior forecaster.

Garcia (1988) showed that even though a better forecasting model (in a MSE sense) than the futures market can be found to forecast the prices of live cattle, the simulation results, based on the most accurate forecast generate, low but extremely variable profits. The study didn’t show strong evidence of inefficiency of the live cattle futures market.

If futures prices of commodities can be expected to be subsequent cash prices, they can be used as expected prices at the time of marketing, especially given the increasing important role of hedging as a way to lock in the future profits in live cattle production. Even if the producers are not hedging in the futures market, they can refer to the futures market for future prices when making supply decision. Koontz and Purcell

(1988) showed that cattle feeders respond to changes in the distant live cattle futures by changing level of placements.

Several studies have used futures prices in analysis of agricultural commodities supply. For example, Gardener (1976) used futures prices in soybean and cotton supply analysis and found that the model using the futures prices has a better fit than the one using lagged prices. The elasticity of supply was also found to be higher when futures prices were used. In Gardener's model, a lagged acreage (supply quantity) variable was used to capture the partial adjustment of the supply.

Antonovitz & Green (1990) estimated supply response models for fed cattle incorporating risk by including both the mean and variance of output prices. Six different estimates of mean and variance were obtained using futures prices, ARIMA processes, as well as naïve, adaptive, and rational expectation models. The results for supply response to price expectations and volatility were mixed when different estimates of prices were used. Interestingly, the model using futures prices had a negative supply response to price expectations and a positive response to variance.

Data and Model

In this study, the supply of live cattle was measured with net placement and fed cattle marketing since various studies have indicated that cattle feeders may have different price responses with respect to these two supply quantities (Marsh, 1994; Sarmiento and Allen, 2000). Net placement is the net increase to the current cattle stock, and fed cattle marketing is the number of fed cattle (steers and heifers) that are ready to be sold. Most studies have modeled live cattle supply with just fed cattle marketing data, with some yielding quite different supply elasticities, even with different signs. Though the models, data, and estimation methods differ among the studies, the conflicting results may reflect a failure to model both short-run and long-run cattle marketing decisions (Marsh, 1994). Sarmiento and Allen (2000) showed that the long-run response can be captured with error-correction equations with monthly data over a long period of time. Our model is to reflect only short-run supply because of data limitations. Nevertheless, our study with a relatively short period of bimonthly data is sufficient to test price expectation models for two measures of live cattle supply.

The supply of live cattle, measured in net placement and fed cattle marketing, is plotted in Figures 1 and 2. Both net placement and fed cattle marketing have a distinct seasonal pattern, with net placement peaking at the fifth bimonth (September and October) and the marketing of fed cattle (steers and heifers) reaching a top in the middle of the year (from May to August). This seasonal pattern is largely determined by biological factors in cattle production. Gee et al. (1979) found that the feeding periods for both the Midwestern and western regions are five to eight months. The figures show the length between the peaks in net placement and fed cattle marketing is about eight months, four-bimonth breeding period appearing to be more appropriate for this study. The formation of price expectations with futures prices should reflect this biological cycle.

Following Antonovitz & Green (1990), supply response for the U.S. fed cattle market is modeled by specifying quantity as a liner function of prices of inputs, such as corn and feeder cattle, and the mean and variance of producers' expectations of output prices. It is reasonable to assume that cattle feeders take information on input prices as given when they make decisions on supply quantities. Thus, decisions are based on expectations of live cattle prices and risks at time of marketing, which is about eight months later for cattle feeding. In addition, our model should be able to handle the non-stationarity of live cattle supply resulting from the seasonal patterns. In this study, a transfer function model, also known as dynamic regression model, is used. The regressors other than the lagged dependent variable enter into the model as multiple input variables. The aggregate supply for fed cattle is therefore specified as

(1) $PLACE_t = \alpha_0 + \alpha_1 PCN_t + \alpha_2 PF_t + \alpha_3 P^*_{t+r} + \alpha_4 \sigma^*_{t+r} + \alpha_5 PLACE_{t-6} + \varepsilon_t$, and

(2) $MART_t = \beta_0 + \beta_1 PCN_{t-r} + \beta_2 PF_{t-r} + \beta_3 P^*_t + \beta_4 \sigma^*_t + \beta_5 MART_{t-6} + \varepsilon_t$,

where $PLACE_t$ and $MART_t$ are the net placement of live cattle and the fed cattle marketing in period t, respectively. In the net placement model (1), PCN_t and PF_t are cash corn price and cash feeder cattle price at time t when live cattle placement decision is made; P^*_{t+r} and σ^*_{t+r} are the live cattle price and its standard deviation expected by the live cattle feeders in period t for the bimonth $t+r$ when live cattle are ready for market. In the fed cattle marketing model (2), PCN_{t-r} and PF_{t-r} are cash corn price and cash feeder cattle price r bimonths earlier than the marketing period; P^*_t and σ^*_t are the live cattle price and its standard deviation expected by live cattle feeders in period $t-r$ for the bimonth t. The seasonal patterns of live cattle placement and marketing can be captured by quantities of the previous year (or 6 bimonths before). The parameters will be efficient only if the residual series are proven to be white noise.

Based on the production cycle of live cattle and timing of live cattle futures (available in even months), bimonthly time series data were used for the supply model. Some 39 bimonthly observations from 1995 through the third bimonth of 2001 were used to estimate the models. In this study, the feeding cycle, r, is determined to be 4 bimonths, as evidenced in Figures 1 and 2. Supply was represented by the net placement of live cattle and fed cattle marketing in the major cattle feeding states in the United States. Corn price was expressed as that for grade 2 yellow corn in central Illinois region. Feeder cattle price was represented by that for medium quality steers about 600-650lbs in weight. All price variables were deflated with the CPI. Data on net placements, fed cattle marketings, and corn prices were obtained from USDA *Livestock and Poultry Situation and Outlook Reports*. The CPI data series are from the Department of Commerce *Survey of Current Business*. Futures market prices are from the Chicago Mercantile Exchange (CME) historical live cattle futures price database.

Naïve Expectations

Expectations are naïve if the producer simply uses the recent output prices at the time of decision on supply quantity. The mean and standard deviation of monthly spot prices from three bimonths before up to bimonth t were used to estimate P_{t+r}^{*} and σ_{t+r}^{*} in the live cattle net placement model. For example, to obtain the naïve expectation variables for the first bimonth of 1995, the mean and standard deviation of monthly prices from September 1994 to February 1995 were calculated. Since futures market prices converge to spot prices at the expiration of the futures contracts, live cattle futures market prices at expiration were used as spot prices for data comparability with respect to the futures price expectations model.

Futures Market Price Expectations

Cattle feeders could also use the futures price of live cattle to form expectations of the fed cattle price at the time of marketing. Even though there is only a small proportion of cattle feeders in the United States actually using the futures market to hedge live cattle, cattle feeders can make decisions based on futures market price, one of the primary uses of the futures market. The futures market can be regarded as a vehicle which allows the manifestation of the overall results of joint expectations of all market participants with respect to prices in the future.

In this study, to obtain the price expectations from the live cattle futures market, daily opening prices for the bimonth eight months before contract maturity were used. For example, to get the price expectation for the fifth bimonth (September and October) of 1995, the daily opening prices for October 1995 live cattle futures in January and February of 1995 were used to obtain the mean and standard deviation of the futures price. In other words, the decision on quantity to be supplied in the first bimonth of 1995 is made in response to expectation of price movements (in terms of level and volatility) in the fifth bimonth of the same year. This expectation is formed by observing the futures prices of live cattle for the October1995 contract in the first bimonth. The mean and standard deviation of price expectations were, in turn, deflated by the Consumer Price Index (CPI).

Estimation Results

The estimation results for the naïve expectations and futures price expectations models are reported in Table 1. Since the lagged dependent variable is used as one of the regressors, Durbin's h statistic, which is distributed to be standard normal, should be used as a measure to test for first order autocorrelation of the residuals. Our results show that all models are acceptable except the fed cattle marketing model with futures price expectation.

For the two measures of live cattle supply, net placement and marketing, one price expectations framework may fit the data significantly better than the other. To be specific, for live cattle placement, the model using futures price expectations outperforms the naïve expectations based on Akaike Information Criterion (AIC) or R-square value. With the same criteria, for fed cattle marketing, naïve expectations give a better fit than futures market price expectations. Residual diagnosis of selected models, net placement with futures price expectation and marketing with naïve expectation, does not reject the white-noise hypothesis for the residuals. The P-values of the Ljung-Box Chi-square tests to lags 6, 12 and 18 are 0.62, 0.62, and 0.39 for the net placement model with futures price expectations, 0.22, 0.54, and 0.80 for the marketing model with naïve expectations respectively.

The results suggest that cattle feeders are forward-looking in making supply decisions on net placements and concentrate more on recent prices in deciding on the number of fed cattle to supply to the market. In addition, the responses to different price expectations are of different signs for these two measures of live cattle supply. For net placement, the response is significantly positive, which means cattle feeders increase production when they foresee an increase in fed cattle prices. For the live cattle marketing, the response to recent fed cattle prices is negative, suggesting that cattle feeders sell less when faced with an increase in the current fed cattle prices. This may sound counterintuitive at first sight. However, just as Jarvis (1974) hypothesized, heifers are valued both as consumption goods and capital goods for cattle feeders. Therefore, in the short run, an increase in market prices of the fed cattle may encourage cattle producers to increase production capacity by holding heifers for breeding, thus increasing the current number of cattle on feed.

Estimates for most of the other parameters are as expected. Corn price is negatively related to live cattle net placement but is not a significant factor in cattle feeders' marketing decisions. The more expensive are feeder cattle, the fewer cattle will be placed on feed. Interestingly, feeder cattle price is significantly and positively related to fed cattle marketing. Aadland and Bailey (2001) also reported a short-run positive relationship between these two variables. The impact of expected variation in output prices (expected standard deviation of fed cattle prices) is negative which indicates that cattle feeders are risk averse on average.

Table 2 gives the short-run price elasticities of supply computed at means of supply quantities and expected prices. The elasticity of live cattle net placement with respect to expected futures price of fed cattle is 1.81, much higher than the elasticity with respect to price under the naïve expectations assumption. This result is consistent with the findings of Gardener (1976), who used futures prices in soybean and cotton production analyses. He found that a model using futures prices had a better fit than the one using last-period prices. Also, the elasticity of supply was higher when futures prices were used. For fed cattle marketing, our results show a negative and inelastic price changes under the naïve expectations assumption.

Conclusion and Discussion

By using data from 1995 to 2001, we modeled live cattle supply, in both net placement and fed cattle marketing quantity, with fed cattle prices in naïve expectations and futures price expectations models. The results show that live cattle feeders are more likely to be forward-looking in making placement decision. Supply response to the change in expected futures price is quite elastic. As rationally held expectations of subsequent cash prices, futures market prices are quite valuable in forecasting the next-period fed cattle supply.

In contrast, when cattle feeders make decisions on fed cattle marketing, naïve expectations seem to work better. Recent prices are more likely to form the basis for the cattle feeders' decision on how many cattle to market. Actually, for the fed cattle marketing, naïve expectations utilize more recent information than is the case for futures price expectations that are formed at the beginning of the feeding cycle. In addition, for the fed cattle marketing model, the short-run supply response with respect to change in price under naïve expectations is negative which confirms the cattle-as-capital-goods hypothesis.

Table 1 Regression Results from Models with Different Price Expectations

	Live Cattle Placement		Fed cattle Marketing	
Independent Variables	Spot	**Futures**	**Spot**	Futures
Constant	8.11*[a] (12.37)[b]	**-4.09** **(14.07)**	**24.56*** **(4.95)**	18.82* (9.03)
Corn price	-2.96 (1.74)	**-7.35*** **(2.08)**	**0.75** **(0.58)**	0.66 (0.86)
Feeder cattle price	-0.14 (0.16)	**-0.73*** **(0.24)**	**0.19*** **(0.05)**	0.16 (0.08)
Expected fed cattle price	0.24 (0.28)	**1.44*** **(0.55)**	**-0.50*** **(0.10)**	-0.20* (0.09)
Standard Deviation of fed cattle price	-2.37 (1.78)	**-12.13*** **(4.16)**	**-1.42*** **(0.63)**	-0.16 (1.70)
Lag 6 of the dependent variable (last year price)	0.85* (0.09)	**0.83*** **(0.07)**	**0.58*** **(0.09)**	0.65 (0.11)
Durbin's H statistic	0.77	**-0.85**	**1.00**	2.81
AIC	462	**450**	**396**	415
R-square	0.83	**0.88**	**0.82**	0.67

[a] Asterisk indicates significance of a two-tailed test at 0.05 level.
[b] Values in parentheses are t-ratios.

Table 2. Short-run Price Elasticities of Live cattle Supply Measured in Net Placement and Marketing at Mean Levels of Supply and Expected Prices

	Cattle Supply Models	
	Live Cattle Placement (futures price expectation model)	Fed cattle Marketing (naïve expectation model)
Price Elasticities of Supply	1.81	-0.63

Figure 1. Bimonthly Net Placement of Live Cattle

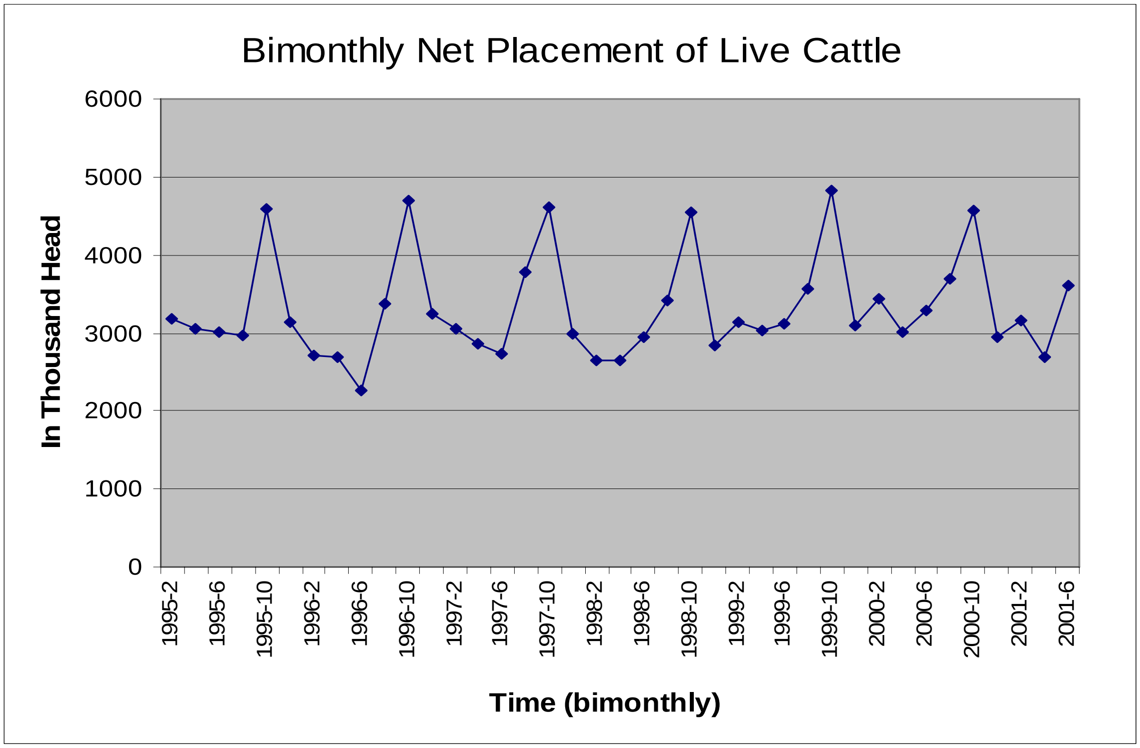
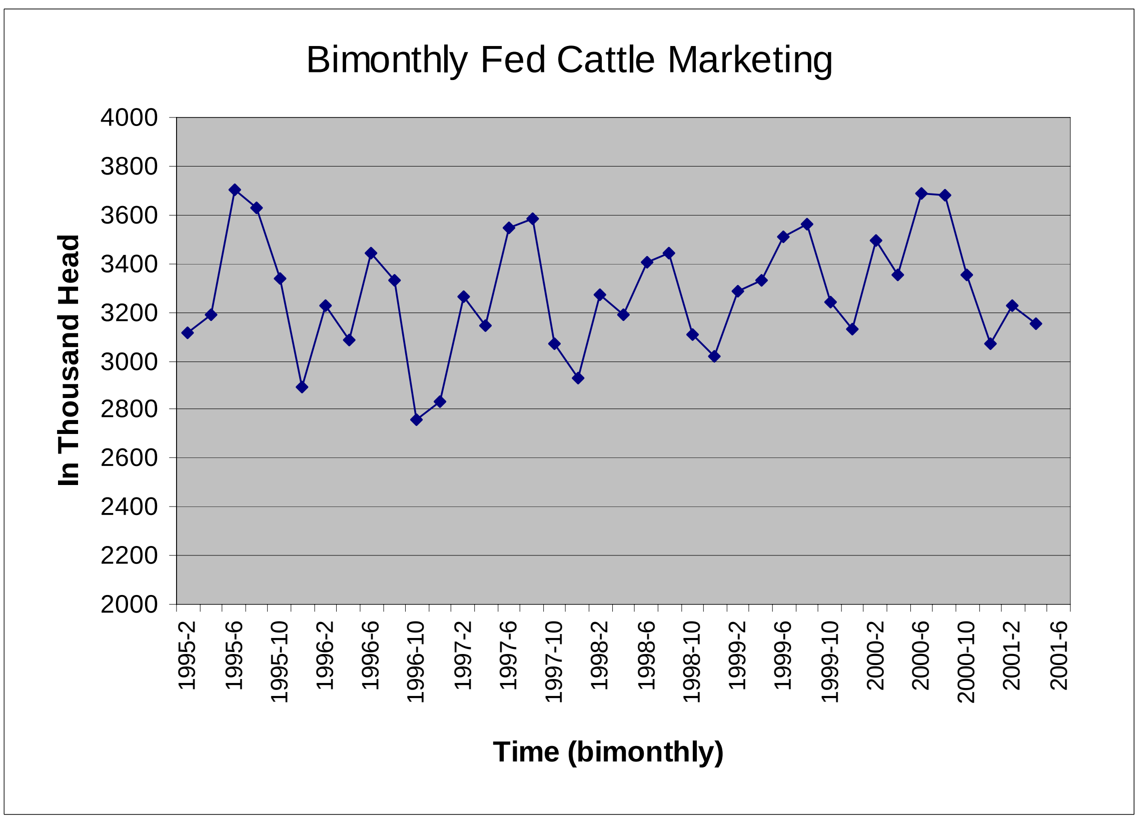


Figure 2. Bimonthly Fed cattle Marketing



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