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Matthew P. Schaefer

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FORECASTING ACCURACY, RATIONAL EXPECTATIONS, AND MARKET EFFICIENCY IN THE US BEEF CATTLE INDUSTRY

By

Matthew P. Schaefer

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ABSTRACT

FORECASTING ACCURACY, RATIONAL EXPECTATIONS, AND MARKET EFFICIENCY IN THE US BEEF CATTLE INDUSTRY

By

Matthew P. Schaefer

Recent studies have tested whether futures prices respond to U.S. Department of Agriculture inventory reports in accordance with the efficient market hypothesis. These studies use survey forecasts to identify the anticipated and unanticipated information contained in a report. However, this approach implicitly assumes the survey forecast to be an unbiased and efficient predictor of the data in the USDA report. Furthermore, previous studies have not tested the bias and efficiency properties of USDA *preliminary* estimates as predictors of final revised USDA figures. This study introduces a framework for conducting tests of the efficient markets hypothesis in the presence of biased and inefficient survey forecasts, and preliminary USDA estimates that are biased and inefficient predictors of final revised figures. The approach is applied to the US beef cattle industry and results are quite different from those obtained using the conventional analysis.

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DEFINITIONS

intention - an intention is defined as one agent's *ex-ante* anticipated action. Examples include; the number of acres an agent intends to plant; or the number of sows an agent intends to farrow.

survey forecast - a survey forecast is defined as the average of many individuals' *ex-ante* expectations of the actual value of an economic variable.

USDA preliminary estimate - a USDA preliminary estimate is defined as the USDA's first *ex-post* estimate of the actual value of an economic variable, and is subject to revision by the USDA.

USDA final revised estimate - a USDA final estimate is defined as the USDA's final *ex-post* estimate of the actual value of an economic variable. The final estimate is published after a certain period, which has typically been 5 years in the case of the USDA *Cattle on Feed* report. The final estimate is considered to be the best approximation of the variable's actual value.

INTRODUCTION

CHAPTER ONE

1.1 Introduction

This study is designed to help policy makers, econometricians, and market analysts evaluate the usefulness of information released in the US Department of Agriculture *Cattle on Feed* (*COF*) report, as well as private information, and other publically available information available from the USDA on cattle market conditions. Policy makers must make decisions about what information should be collected and reported to ensure fed cash prices and live cattle futures prices reflect available information about the supply and demand of live cattle. Econometricians must determine which information should be used to conduct tests of rationality, announcement effects, and the efficient market hypothesis. Producers and market analysts must make decisions regarding their positions in cash and futures markets with respect to survey forecasts and USDA data, relative to other available public and private information.

Chapter 2 of this study, *Does the USDA Cattle on Feed Report Still Provide New Information to Market Participants?*, investigates whether the *COF* report is fulfilling one of its public policy objectives, which is to provide new information for the formation of live cattle futures prices. First and second moments of release day live cattle futures price changes are compared to those of non-release days. The objective is to determine whether release day live cattle futures price changes have greater variance than non-release days, indicating the *Cattle on Feed* report does provide new information for the formation of live cattle futures prices.

Chapter 3, *Are Preliminary Estimates in the USDA Cattle on Feed Report Rational Forecasts of USDA Final Revised Estimates?*, tests whether USDA preliminary estimates of cattle on-feed, placements and marketings are rational forecasts of USDA final revised estimates by testing them for unbiasedness and efficiency. The objective of conducting tests of unbiasedness and efficiency is to determine whether USDA preliminary estimates optimally reflect available public and private information useful for the prediction of final revised estimates of cattle on-feed, placements and marketings. The results from this chapter have important implications for what information should be used to conduct tests of rationality, tests of announcement effects, and tests of the efficient market hypothesis.

Chapter 4, *Are Knight-Ridder Pre-Release Survey Forecasts of the USDA Cattle on Feed Report Rational Forecasts of USDA Final Revised Estimates*?, tests whether Knight-Ridder Financial News industry survey forecasts are rational forecasts of USDA final revised estimates using the same approach as used in chapter 3. Again, the objective is to determine whether the survey forecasts optimally reflect available public and private information useful for the prediction of cattle on-feed, placements, and marketings numbers. Furthermore, we determine whether a private firm's forecasts are strong form rational relative to their own private information. The results from tests of rationality conducted for the survey forecasts also have important implications on how tests of announcement effects and tests of the efficient market hypothesis should be conducted.

Finally, in chapter 5, *Market Efficiency in the US Beef Cattle Industry*, we introduce a framework for conducting tests of the efficient market hypothesis in the presence of biased and inefficient survey forecasts and preliminary USDA estimates. The methodology is employed to determine whether live cattle futures prices respond to the USDA *Cattle on Feed* report in accordance with the strong form of the efficient market hypothesis, and to test whether the report contains new information.

DOES THE USDA *CATTLE ON FEED* REPORT STILL PROVIDE NEW INFORMATION TO MARKET PARTICIPANTS?

CHAPTER TWO

2.1 Introduction

The objective of this chapter is to determine whether the USDA *Cattle on Feed* (*COF*) report still provides new information for the formation of live cattle futures prices. The first and second moments of futures price changes surrounding the release of the report are analyzed. For the period January 1980 through December 1989, Grunewald, McNulty, and Biere (1993) reported that live cattle futures prices one day following the *COF* report recorded a lock-limit price move over 15% of the time in the near-term, first deferred, and second-deferred contract horizons. In contrast, between January 1990 and May 1998 lock-limit moves occurred less than 1.3% of the time; 4 in the near-term, and zero in the first and second deferred contracts. Based on this evidence, market agents appear to be responding less dramatically to the information in the *COF* report since 1990.

If the information provided by the *COF* report does not alter the supply and demand situation of a sufficient number of traders, then the information may be considered irrelevant for price formation. Moreover, if the information contained in the *COF* report is not relevant for price formation, then testing whether prices efficiently respond to information released in the *COF* report would be irrelevant. Therefore, this analysis will help determine whether the *COF* report is fulfilling its public policy objective, which is to provide new market information for the formation of live cattle futures prices, as well as determine whether a test of market efficiency is still relevant.

Our results indicate price changes one day following the *COF* report do exhibit greater volatility in the 1980's than in the 1990's. However, release day price changes during the 1990's do still exhibit greater absolute mean value and volatility than non-release day price changes. This evidence suggests the *COF* report still provides new information for the formation of near-term, first- and second deferred contracts in the 1990's.

2.2 Theoretical Considerations

The task in this section is to test three null hypotheses which will provide empirical evidence on whether the *COF* report still provides important news for the formation of live cattle futures prices.

Hypothesis 1: Release day price changes over the period January 1980 through December 1989 have equal variance as release day price changes over the period January 1990 through May 1998. This is tested using an F-test of equal variances across two independent samples.

Hypothesis 2: Over the period January 1990 through May 1998, the distribution of live cattle futures price changes on release days have equal absolute mean value as non-release days. This is tested using *t*-statistics, and the Kruskal-Wallis one-way analysis of variance by ranks test.

Hypothesis 3: Over the period January 1990 through May 1998, the distribution of live cattle futures price changes on release days have equal variance as non-release days. This is tested using an F-test of equal variances across two independent samples, and the Savage test for positive random variables.[1]

The empirical approach used here has been presented in previous studies by Sumner and Mueller (1989) and Fortenbery and Sumner (1993). The approach is based on the assumption that market participants' reservation prices are a function of their supply and demand information. If the release of a USDA production report alters the supply/demand perception of a sufficient number of traders, then the newly perceived supply/demand situation should be reflected in a market price change (Fortenbery and

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[1]The distribution of price changes are truncated on both the left and right hand sides of the distribution. The absolute value of each price change limits the left-hand side of the distribution to zero. Also, the Chicago Mercantile Exchange limits daily price changes at $1.50/cwt. The daily price limit truncates the right hand side of the distribution at 1.50. The truncated distribution is therefore non-normal and all test statistics based on the normal distribution will yield erroneous results. For this reason *t*-and F-statistics will be compared to the Kruskal-Wallis and Savage non-parametric tests. The Kruskal-Wallis one-way analysis of variance by ranks test is equivalent to the Mann-Whitney U test when k=2, where k is the number of independent samples. If the Kruskal-Wallis test is significant, it indicates there is a significant difference between at least two of the sample medians in the set of k medians. As a result, the researcher can conclude there is a high likelihood that at least two of the samples represent populations with different median values (Sheskin, pg.397). The Savage test is designed specifically for positive variables. Under the null hypothesis, two distributions, $f(x)$ and $\lambda \cdot f(\lambda x)$ are identical; $\lambda = 1$. Under the alternative hypothesis, the first distribution has a greater variability and greater mean than the second; $\lambda > 1$. The modified savage statistic follows the standard normal distribution.

Sumner, 1993). The average market price change the day following the report will likely be zero. However, the average of the absolute value of price changes will be greater than zero. In addition, the magnitude of the change in traders' perceptions will be reflected in the magnitude of the price change (Fortenbery and Sumner, 1993).

The empirical analysis uses the movements of closing prices for near-term, first-deferred, and second-deferred live cattle futures contract horizons traded at the Chicago Mercantile Exchange. Daily data for trading days ranging from January 1980 through May 1998 were used. Release days are defined as the day following the *COF* report release since the report is released at the end of the trading day. Therefore, the relevant measured price change for an announcement on January 20 is the difference between the price at which the market closed on the 21st and the 20th. In addition, the sample includes price changes for non-release days, defined here as four days prior and four days after the price change on the announcement day. Since hypothesis 1 tests the equality of variances across two independent samples a price change in levels variable is used;

(1) $$\Delta P_{i+1,t} = \left(P_{i+1,t} - P_{i,t}\right)$$

where P represents futures price and i denotes the day of month t. Since hypotheses 2 and 3 test the equality of variance and mean, an absolute value of the price change is used and it is expressed in relative terms (proportional change). This variable is defined as:

(2) $$\left|\frac{\Delta P_{i+1,t}}{P_{i,t}}\right| = ABS\left[\left(P_{i+1,t} - P_{i,t}\right) / P_{i,t}\right]$$

where ABS refers to the absolute value.

2.3 Evidence of An Announcement Effect

This section provides separate descriptive statistics for release and non-release day price changes by contract used to test hypotheses 1, 2, and 3, as well as, results from *t*-tests, F-tests, and non-parametric tests discussed in section 2.2. The results suggest 1) nominal price changes in levels over the period January 1980 through December 1989 have greater variance than the same price changes over the period January 1990 through May 1998, and 2) over the period January 1990 through May 1998, the absolute value of release day relative price changes have greater mean value and variance than non-release days. This provides evidence the *COF* report does cause above normal price fluctuations in the live cattle futures market, despite the diminishing number of limit moves in the 1990's.

2.3.1 Hypothesis 1

Separate descriptive statistics for nominal live cattle futures price changes in levels one day following the *COF* report are given for the period January 1980 through December 1989 in table (1), and the period January 1990 through may 1998 in table (2). Results from the test of hypothesis 1 appear in table (3). Results indicate live cattle futures price changes displayed more volatility in response to the *COF* report during the 1980's than in the 1990's.

Table 1. Descriptive statistics for live cattle nominal daily release day futures price changes in levels, by month; 1980:01-1989:12

Statistics for $\Delta P_{i+1,t}$	Near-Term	First-Deferred	Second-Deferred
Nobs.	120	120	120
Mean	-0.048000	-0.010417	0.034333
S.E. of Mean	0.778	0.0782	0.07242
Median	-0.010000	0.0600000	0.100000
Maximum	1.50	1.50	1.50
Minimum	-1.50	-1.50	-1.50
Std. Dev.	0.852326	0.857011	0.793467
Skewness	0.074382	-0.03983	-0.135402
Kurtosis	2.295284	2.359175	2.623996
Jarque-Bera	2.593775	2.085015	1.073570
Probability	0.273381	0.352569	0.584625

Table 2. Descriptive statistics for live cattle nominal daily release day futures price changes in levels, by month;1990:01-1990:05

Statistics for $\Delta P_{i+1,t}$	Near-Term	First-Deferred	Second-Deferred
Nobs.	101	101	101
Mean	-0.074851	-0.031188	-0.049505
S.E. of Mean	0.06276	0.05341	0.04159
Median	-0.080000	0.030000	-0.200000
Maximum	1.37	1.20	0.98
Minimum	-1.50	-1.40	-1.15
Std. Dev.	0.630886	0.536849	0.418018
Skewness	-0.160547	-0.327507	-0.210317
Kurtosis	2.837339	2.956755	2.802243
Jarque-Bera	0.545234	1.813433	0.909171
Probability	0.761384	0.403848	0.634711

Table 3. Means, variances and F- statistics for hypothesis 1			
Stats for % Change	Near-Term	First-Deferred	Second-Deferred
1980:01 - 1989:12			
Variance	0.720406	0.728347	0.624343
1990:01 - 1998:05			
Variance	0.394076	0.285353	0.173009
F-stat	1.83**	2.55**	3.61**
DF	(119,100)	(119,100)	(119,100)

Notes: Double asterisk denotes significance at the 5 percent level. The F-test of equal variances is given as, $F = \max[s_1^2, s_2^2]/\min[s_1^2, s_2^2]$, where, respectively, s_1^2 and s_2^2 are the variances of the two samples. The F-test tests the null hypothesis of equal variances. If variances of the two groups are not statistically different, then a *t*-test using a pooled variance will be used instead of the *t*-test given above. Degrees of freedom for the F-test are figured as n-1 for both numerator and denominator.

2.3.2 Hypotheses 2 and 3

Descriptive statistics for the absolute value of live cattle relative release day and non-release day price changes for the period January 1990 though May 1998 are given in tables (4) and (5) respectively. Results from the test of hypotheses 2 and 3 appear in table (6).

Both the absolute value of release and non-release day relative price changes for each contract are non-normal, as was expected due to truncation on both sides of each distribution. Simple inspection of the descriptive statistics indicates release day price changes for near-term, and first- and second-deferred contracts each have higher mean and variance values than non-release days. The *t*-tests (F-tests) testing the null hypothesis of equal means (variances) across release and non-release days reject the null in every case. Results from these hypotheses tests indicate the absolute value of release day relative price changes have greater mean and variability than non-release days for each contract horizon. Results from the Kruskal-Wallis test are consistent with results from the *t*-tests of equal means. It is possible to reject the null hypothesis of equal median values for release and non-release day absolute relative price changes at the p-value of 0.002 level or lower for each contract horizon. As well, results from the Savage test are consistent with F-tests of equal variances; it is possible to reject the null hypothesis of equal variance and mean value across the distributions at the p-value of 0.001 level. Based on this evidence, we can conclude release day and non-release day price changes in the 1990's still belong to different distributions.

Table 4. Descriptive statistics for the absolute value of live cattle relative non-release day futures price changes in levels, by month;1990:01-1990:05

Statistics for $\left\lvert \frac{\Delta P_{i+1,t}}{P_{i,t}} \right\rvert$	Near-Term	First-Deferred	Second-Deferred
Nobs.	707	707	707
Mean	0.005357	0.004461	0.003527
S.E. of Mean	1.79E-4	1.52E-4	1.23E-4
Median	0.003938	0.003346	0.002825
Maximum	0.026643	0.002535	0.002439
Minimum	0	0	0
Std. Dev.	0.004759	0.004035	0.003278
Skewness	1.38346	1.65288	2.05264
Kurtosis	5.07824	6.572695	10.2567
Jarque-Bera	352.763	694.1049	2047.76
Probability	0.000001	0.000001	0.000001

Table 5. Descriptive statistics for the absolute value of live cattle absolute relative release day futures price changes in levels, by month; 1990:01-1990:05

Statistics for $\left\lvert \frac{\Delta P_{i+1,t}}{P_{i,t}} \right\rvert$	Near-Term	First-Deferred	Second-Deferred
Nobs.	101	101	101
Mean	0.007193	0.006152	0.004723
S.E. of Mean	5.62E-4	4.61E-4	3.76E-4
Median	0.005380	0.005215	0.003958
Maximum	0.024867	0.002021	0.001655
Minimum	0	0	0
Std. Dev.	0.005658	0.004635	0.003786
Skewness	1.07805	1.13548	0.898610
Kurtosis	3.58183	3.87806	3.22595
Jarque-Bera	20.9883	24.9484	13.8077
Probability	0.000001	0.000001	0.000001

Table 6. Means, variances, and statistical tests for hypotheses 2 and 3

Stats for % Change	Near-Term	First-Deferred	Second-Deferred
Non-Report Days			
Mean	0.005357	0.004461	0.003527
Variance	2.3E-05	1.6E-05	1.1E-05
Report Days			
Mean	0.007193	0.006152	0.004723
Variance	3.2E-05	2.1E-05	1.4E-05
t-stat	3.12**	3.50**	3.03**
DF	122	122	122
F-stat	1.40**	1.307*	1.322*
DF	(100,706)	(100,706)	(100,706)
Kruskal-Wallis Test			
χ^2-stat	11.37	15.822	9.435
prob.	0.0007	0.0001	0.0021
Savage Test			
t-stat	3.47	3.71	3.89
prob.	0.001	0.001	0.001

Notes: Double asterisk denotes significance at the 5 percent level, [b] Asterisk denotes significance at the 10 percent level. The t-test of equal means, degrees of freedom for the *t*-test, and F-test of equal variances are given as, $t = (\bar{x}_1 - \bar{x}_2)/\sqrt{s_1^2/n_1 + s_2^2/n_2}$, $\mathrm{DF} = \dfrac{(s_1^2/n_1 + s_2^2/n_2)^2}{(s_1^2/n_1)^2/(n_1 - 1) + (s_2^2/n_2)^2/(n_2 - 1)}$,

$F = \max[s_1^2, s_2^2]/\min[s_1^2, s_2^2]$, respectively, where, respectively, $\bar{x}_1$ and $\bar{x}_2$ are the means of release and non-release day samples; n_1 and n_2 are the number of observations from each sample; and s_1^2 and s_2^2 are the variances of the two samples. The F-test tests the null hypothesis of equal variances. If variances of the two groups are not statistically different, then a *t*-test using a pooled variance will be used instead of the *t*-test given above. Degrees of freedom for the F-test are figured as n-1 for both numerator and denominator.

2.4 Conclusions

The evidence suggests that release day nominal near-term, and first- and second deferred live cattle futures contract price changes occurring one day following the *COF* report, do exhibit greater volatility in the 1980's than in the 1990's. However, the absolute value of release day relative live futures price changes during the 1990's do still exhibit greater mean value and variance than the absolute value of non-release day price relative price changes in each contract horizon. We conclude from these results the USDA *Cattle on Feed* report is fulfilling its public policy objective which is to provide new information to market participants.

ARE PRELIMINARY ESTIMATES IN THE USDA *CATTLE ON FEED* REPORT RATIONAL FORECASTS OF USDA FINAL REVISED ESTIMATES?

CHAPTER 3

3.1 Introduction

Economic policy makers, market participants, and econometricians must often make decisions or inferences based on preliminary or incomplete data. Each agent faces a problem of judging the informational content of preliminary announcements based on all available information (Mankiw, Runkle, Shapiro, 1984).

In this paper, preliminary estimates of the USDA *Cattle on Feed* (*COF*) report are tested for rationality as predictors of final revised estimates relative to *public* and *private* information. While there has been much discussion on the impact of private information on the formation of expectations, little empirical evidence has been presented which indicates whether USDA preliminary estimates optimally reflect private information. The rationality test considered here is particularly interesting because we use USDA preliminary estimates as expectations of USDA final revised figures.

Given the widespread use of USDA data in tests of announcement effects and tests of market efficiency, an important empirical issue is the extent to which USDA estimates of economic variables are consistent with the rational expectations hypothesis. Tests of the rational expectations hypothesis are usually classified as weak form or strong form tests (Lovell, 1986)[2]. Weak form tests examine whether expectations of an economic variable are unbiased predictors of the subsequent realized values of the variable. Weak form tests also examine whether expectations of economic variables are efficient, in the sense past values of the economic variable cannot be used to explain the error between expected and the realized value (i.e. whether the forecast errors are auto-correlated). Strong form tests of rational expectations examine efficiency by testing whether the forecast errors can be explained by other theoretically relevant economic variables. If the expectations are strong form rational, all relevant variables are orthogonal to the forecast error (Colling, Irwin, and Zulauf, 1992).

Therefore, if expectations of an economic variable are rational they must satisfy both unbiasedness and efficiency conditions. Rational expectations therefore are optimal, in the sense the expectations' conditional mean is equal to the true mean of the economic variable, and that they have minimum variance in the class of all such linear unbiased expectations.

Our results show that preliminary estimates of cattle on-feed, placements, and marketings are not strong form rational relative to public and private information. This study is presented in the following way. Section 3.2 discusses the literature. Section 3.3 presents the theoretical framework. Section 3.4 discusses the implementation of the

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[2]Weak and strong form tests of rationality should not be equated with Fama's definition of weak, semi-strong, and strong form market efficiency. While they are related, they are distinct topics.

framework for data on cattle on-feed. Section 3.5 provides empirical results. Section 3.6 discusses the implications of our findings for other research. Section 3.7 provides concluding remarks.

3.2 The Literature

In the current literature there has developed a number of terms each referring to expectations made by private individuals, private firms, or the US Department of Agriculture. While each can denote an expectation of the same commodity, each are distinct in that they represent sets of different information, usually at different points in time. It is critical that a precise definition of each is clearly understood now to insure as little confusion as possible. A clear definition of terms as they have been presented in the literature, and in this study, is presented at the start of this thesis.

Preceding, Mankiw et. al develop a theoretical framework for analyzing *preliminary estimates* of economic data and then apply this framework to the money stock. The authors find Federal Reserve *preliminary estimates* of the money stock are best characterized as measured by classic errors-in-variables, implying the revision is not correlated with the true value (*final revised* estimate) of the series. However, the authors conclude the revision is forecastable using available public information. This implies the *preliminary estimates* are not strong form rational estimates of *final revised* estimates, even though they are unbiased.

Runkle (1991) tests whether USDA *Hogs and Pigs* report *preliminary estimates* of sows farrowed are rational forecasts of *final revised* sows farrowed. Runkle concludes that *preliminary estimates* are unbiased and efficient, and therefore are rational forecasts of *final revised* figures. It is not specified whether he performs a weak form or strong form test of rationality. In one other study, Baur and Orazem (1994) test whether USDA reported producers' *intentions* of orange production are strong form rational forecasts of *final revised* orange production[3]. They conclude USDA reported producer *intentions* of orange production, for each month they are collected during the growing season, are unbiased and efficient relative to specific public information. Thus, producer *intentions* of orange production are strong form rational forecasts of USDA *preliminary estimates.*

This study will extend the current literature in two respects. First, we test whether USDA *Cattle on Feed* report *preliminary estimates* of cattle on-feed, placements and marketings are unbiased and efficient forecasts of USDA *final revised* figures. Secondly, we conduct direct tests of efficiency relative to public and private information. Our results indicate USDA *preliminary estimates* of cattle on-feed, placements and marketings are not strong form rational. Finally, we discuss the implications of using these *preliminary estimates* to conduct tests of the efficient market hypothesis and tests of announcement effects.

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[3]In this case, the USDA 'final' estimate of orange production can be considered both a preliminary estimate and final estimate. The USDA releases only one estimate of orange production at the end of each production season and this figure is not revised. In this sense, it is both preliminary estimate and final estimate.

3.3 Theoretical Framework

USDA preliminary estimates of cattle on-feed, placements and marketings reported in the *COF* report are subject to revision at both regular and irregular intervals. In January, all monthly and quarterly estimates are reviewed and subject to revisions. The reviews are primarily based on slaughter data, state check-off or brand data, and any other data that may have been received after the original estimate was made. A random sample of U.S producers is surveyed to provide data for these estimates. The *COF* report estimates are prepared by the Agricultural Statistics Board after reviewing recommendations and analysis submitted by each state office. National and state survey data are reviewed for reasonableness with each other and with estimates from the previous month and/or quarter when setting the current estimates. After a period of what has historically been 5 years, the USDA releases 'final' estimates for a number of past years which are not revised again.

The preliminary estimates reported by the USDA are estimations, not simple weighted averages of raw data provided by private participants. Therefore, tests of rationality are appropriate. Were the preliminary estimates weighted averages, the appropriate hypothesis test would be a classic errors-in-variables test as demonstrated by Mankiw, Runkle, and Shapiro (1984).

Let $F^{*}_{i+n,t}$, $P^{*}_{i+n,t}$, and $M^{*}_{i+n,t}$ denote final revised figures of USDA reported cattle on-feed, placements, and marketings for month t, which are released on day $i+n$. Let $F^{a}_{i,t}$, $P^{a}_{i,t}$, and $M^{a}_{i,t}$ denote the preliminary announced estimates for the same month, which are released on day i. Note that final revised figures are available at some time later than the preliminary estimates. The important question for policy makers, market agents, and econometricians is whether preliminary estimates are rational, in the sense that they are unbiased and efficient forecasts of final revised estimates conditional on available information. If the preliminary estimate is rational, it is equal to the mathematical expectation of the final revision conditioned on the information which was known at the time it was made: that is, in the case of on-feed, $F^{a}_{i,t} = E\left(F^{*}_{i+n,t} \middle| \phi_{i,t}\right)$ where $\phi_{i,t}$ denotes all available information on day i concerning month t, and E is the mathematical expectations operator.

3.3.1 Hypothesis 1: Unbiasedness

The first implication of rationality is that forecasts must be unbiased. To determine if the preliminary estimates of cattle on-feed are unbiased the following model is estimated. The same method is used for evaluating placements and marketings.

(3) $$F^{*}_{i+n,t} = \alpha_0 + \alpha_1 F^{a}_{i,t} + u_t$$

The unbiasedness property requires the coefficients in equation (3) may be restricted to $\alpha_0 = 0$, and $\alpha_1 = 1$, and that u_t satisfy the following condition,

$E(u_t|\phi_{i,t}) = 0$.

3.3.2 Hypothesis 2: Efficiency

Efficiency imposes the additional requirement that any variable known at time (i,t) or before be orthogonal to u_t, that is $\beta = 0$ for any vector $Z_{i,t} \in \phi_{i,t}$. The preliminary estimates are rational forecasts of the final revised figures only if both unbiasedness and efficiency conditions are met. The efficiency hypothesis is tested by applying least squares to the following equation:

$$F^{*}_{i+n,t} - F^{a}_{i,t} = \alpha_0 + (\alpha_1 - 1)F^{a}_{i,t} + \beta' Z_{i,t} + u_t \tag{4}$$

for months $t = 1,2,....T$, which is constructed by simply subtracting $F^{a}_{i,t}$ from both sides of equation (4) and including variables in the set $Z_{i,t} \in \phi_{i,t}$. Efficiency implies that $(\alpha_1 - 1) = \beta = 0$, and that u_t satisfy the following condition, $E(u_t|\phi_{i,t}) = 0$. This implies the revision, $F^{*}_{i+n,t} - F^{a}_{i,t}$, is uncorrelated with available information, $Z_{i,t} \in \phi_{i,t}$.

3.3.3 Constructing an optimal forecast of final revised cattle on-feed

Define the optimal linear (minimum variance) forecast of $F^{*}_{i+n,t}$ conditional on information $\left\{F^{a}_{i,t}, Z_{i,t}\right\}$ to be:

$$F^{f}_{i,t} = \hat{b}_0 + \hat{b}_1 F^{a}_{i,t} + \hat{\beta}' Z_{i,t} \tag{5}$$

The values of $\hat{b}_0, \hat{b}_1$, and $\hat{\beta}$ are found by applying least squares to equation (5), over a period of which $F^{*}_{i+n,t}$ is known.

3.4 Data

3.4.1 Preliminary and final revised estimates

The preliminary estimates used in this study include estimates of cattle on-feed, placements, and marketings reported in the monthly USDA *COF* report from January 1986 through December 1994. The seven state *COF* report is released each month by the Agricultural Statistics Board of the U.S. Department of Agriculture (USDA). Each report contains preliminary estimates of the number of cattle on feed the first day of each month, the number placed on feed during the previous month, and the number marketed during the previous month. The final revised estimates are published in the ERS Statistical Bulletin, *Cattle: Final Estimates*, approximately every 5 years.

3.4.2 Public data

Pre-release survey forecasts of cattle on-feed, placements, and marketings generated by Knight-Ridder Financial News are used to approximate what the entire market expects the *COF* report to announce. Knight-Ridder obtains forecasts of each component by surveying approximately 20 industry experts for their expectations before the release of each report, then computes a simple average of the responses. This is what Knight-Ridder denotes as the industry survey forecast for each component. The individuals' forecasts and the industry survey forecasts are made available by electronic mail approximately two days prior to the release of the *COF* report.

Other public information used in this study includes net returns to feedlots which is a profitability measure, and lagged preliminary estimates of cattle on-feed, placements, and marketings. Net returns to feedlots is calculated as the difference between the selling price of fed cattle and returns to variable costs of high plains feedlots. Net returns data was collected from the USDA high plains cattle feeding simulator reported in the *Livestock, Dairy, and Poultry* report.

3.4.3 Private data

One of the innovations in this paper is the inclusion of private information in tests of efficiency. The private data used in this study include raw monthly private feedlot survey data for cattle on-feed, placements, and marketings, as well as feedlot capacity. The data are provided by Professional Cattle Consultants (PCC). PCC collects the data from individual feedlots approximately one week prior to the release of the USDA *Cattle on Feed* report. PCC compiles the responses and returns the aggregated results back to each feedlot in a newsletter format. Over the period of this study, the PCC survey constitutes between 1.3 and 2.2 million head of cattle. This represents approximately 20% of all cattle on-feed, placed, and marketed from the seven largest cattle feeding states in the United States each month. In this study the raw PCC data for each component is divided by feedlot capacity to eliminate variation due to feedlots entering and exiting the survey over the sample period.

3.5 Results

3.5.1 Test of unbiasedness of USDA preliminary estimates

Each variable was first tested for a unit root, and no evidence of a unit root was found in any of the data series so they are assumed stationary. Results of the unbiasedness tests are shown in table (7). With respect to preliminary estimates of cattle on feed, F-tests reject the null hypothesis of unbiasedness at essentially any significance level. With respect to preliminary estimates of placements and marketings, F-tests fail to reject the null hypothesis of unbiasedness at the 5% level, but not at the 10% level, in each case. The conclusion is that USDA preliminary estimates of cattle on-feed, placements, and marketings are not unbiased estimates of the final revised figures reported at some later date.

Table 7. Test of unbiasedness: USDA preliminary estimates

	α_0	α_1	$\overline{R}^2$	$Q(20)$[a]	$H_o: \alpha_o = 0, \alpha_1 = 1$	
On-feed	164.9	0.984	0.98	206.59**	F(2,106)	Prob > F
	(85.64)[b]	(0.01)			13.39	0.00001
Placements	11.61	0.996	0.99	36.44*	F(2,106)	Prob > F
	(12.23)	(0.007)			2.55	0.08
Marketings	79.02	0.95	0.94	39.66**	F(2,106)	Prob > F
	(37.75)	(0.02)			2.92	0.06

[a]Q(20) denotes the Ljung-Box Q-statistic computed at lag twenty which tests the null hypothesis that auto-correlation is zero with degrees of freedom equal to the number of lags, [b] standard errors in parentheses,** denotes significance at the 0.01 level, * denotes significance at the 0.05 level.

Table 8. Definitions of variables

$F^{*}_{i+n,t}$	USDA final revised cattle on-feed
$P^{*}_{i+n,t}$	USDA final revised placements
$M^{*}_{i+n,t}$	USDA final revised marketings
$F^{a}_{i,t}$	USDA preliminary estimates of cattle on-feed
$P^{a}_{i,t}$	USDA preliminary estimates of placements
$M^{a}_{i,t}$	USDA preliminary estimates of marketings
$F^{p}_{i-7,t}$	private PCC cattle on-feed
$P^{p}_{i-7,t}$	private PCC placements
$M^{p}_{i-7,t}$	private PCC marketings
$F^{e}_{i-2,t}$	Knight-Ridder survey on-feed forecast
$P^{e}_{i-2,t}$	Knight-Ridder survey placements forecast
$M^{e}_{i-2,t}$	Knight-Ridder survey marketings forecast
$NR_{i,t}$	net returns to feedlots (variable cost minus the selling price of fed cattle)
$F^{f}_{i,t}$	optimal linear forecast of actual revised cattle on-feed at time i,t
$P^{f}_{i,t}$	optimal linear forecast of actual revised placements at time i,t
$M^{f}_{i,t}$	optimal linear forecast of actual revised marketings at time i,t

3.5.2 Test of efficiency

To formally test whether preliminary estimates of cattle on-feed are efficient predictors of final revised cattle on-feed figures the following model is estimated:

(6)
$$F^{*}_{i+n,t} - F^{a}_{i,t} = b_0 + \left(b_1 - 1\right)F^{a}_{i,t} + \beta' Z_{i,t} + u_t$$

where $Z_{i,t} = \left\{ \begin{array}{l} F^{a}_{i,t-1}, F^{a}_{i,t-12}, F^{e}_{i-2,t}, P^{a}_{i,t-1}, P^{a}_{i,t-12}, P^{e}_{i-2,t}, M^{a}_{i,t-1}, M^{a}_{i,t-12}, M^{e}_{i-2,t}, \\ F^{p}_{i-7,t}, F^{p}_{i,t-12}, P^{p}_{i-7,t}, P^{p}_{i-7,t-12}, M^{p}_{i-7,t}, M^{p}_{i-7,t-12} \end{array} \right\}$ and

all variables are defined in table (8). The parameter estimates are as follows:

(7)
$$\begin{aligned} F^{*}_{i+n,t} - F^{a}_{i,t} = & -\underset{(327.12)}{162.13} - \underset{(0.064)}{0.111} F^{a}_{i,t} + \underset{(0.123)}{0.055} F^{a}_{i,t-1} + \underset{(0.055)}{0.005} F^{a}_{i,t-12} + \underset{(0.123)}{0.06} F^{e}_{i-2,t} \\ & + \underset{(0.025)}{0.006} P^{a}_{i,t-1} + \underset{(0.08)}{0.036} P^{a}_{i,t-12} - \underset{(0.101)}{0.04} P^{e}_{i-2,t} + \underset{(0.09)}{0.05} M^{a}_{i,t-1} \\ & + \underset{(0.089)}{0.032} M^{a}_{i,t-12} - \underset{(0.095)}{0.014} M^{e}_{i-2,t} + \underset{(154.0)}{70.6} F^{p}_{i-7,t} - \underset{(131.54)}{63.72} F^{p}_{i-7,t-12} \\ & + \underset{(450.89)}{536.15} P^{p}_{i-7,t} + \underset{(386.27)}{70.27} P^{p}_{i-7,t-12} + \underset{(806.22)}{273.76} M^{p}_{i-7,t} - \underset{(561.05)}{436.32} M^{p}_{i-7,t-12} \\ & + \underset{(0.101)}{0.84} u_{t-1} \end{aligned}$$

$$D.W. = 2.49, \quad S.E.R. = 69.88, \quad \overline{R}^2 = 0.70, \quad F = 13.60$$

An F-test of the joint hypothesis that each slope coefficient and lagged residual coefficient equals zero has a p-value of 0.00001. Therefore, we reject the null hypothesis that USDA preliminary cattle on-feed estimates optimally use all available public and private information at essentially any significance level.

To formally test whether the preliminary placements estimates are efficient predictors of final revised figures the following model is estimated:

$$P^{*}_{i+n,t} - P^{a}_{i,t} = b_0 + \left(b_1 - 1\right)P^{a}_{i,t} + \beta' Z_{i,t} + \varepsilon_t \tag{8}$$

where $Z_{i,t} = \left\{P^{a}_{i,t-1}, P^{a}_{i,t-12}, P^{e}_{i-2,t}, P^{p}_{i-7,t}, P^{p}_{i-7,t-12}, NR_{i,t-12}\right\}$. Parameter estimates are as follows:

$$\begin{aligned} P^{*}_{i+n,t} - P^{a}_{i,t} = & -\underset{(21.54)}{1.77} - \underset{(0.028)}{0.096}\,P^{a}_{i,t} + \underset{(0.012)}{0.001}\,P^{a}_{i,t-1} + \underset{(0.032)}{0.023}\,P^{a}_{i,t-12} + \underset{(0.04)}{0.05}\,P^{e}_{i-2,t} \\ & + \underset{(174.68)}{461.85}\,P^{p}_{i-7,t} - \underset{(175.49)}{309.50}\,P^{p}_{i-7,t-12} + \underset{(0.61)}{1.42}\,NR_{i,t-12} \end{aligned} \tag{9}$$

$$D.W. = 1.91, \quad S.E.R. = 27.25, \quad \overline{R}^2 = 0.11, \quad F = 2.76$$

An F-test of the joint hypothesis that each slope coefficient and lagged residual coefficient equals zero has a p-value of 0.012. Therefore, we reject the null hypothesis that USDA preliminary placements estimates optimally use all available public and private information at the 5% level, but not at the 1% level.

Likewise, the following model is estimated for marketings:

(10) $$M^{*}_{i+n,t} - M^{a}_{i,t} = b_0 + (b_1 - 1)M^{a}_{i,t} + \beta' Z_{i,t} + \xi_t$$

where $Z_{i,t} = \left\{ M^{a}_{i,t-1}, M^{a}_{i,t-12}, M^{e}_{i-2,t}, M^{p}_{i-7,t}, M^{p}_{i-7,t-12}, \sum_{j=4}^{8} \alpha_{i,j} P^{a}_{i,t-j} \right\}$. Parameter

estimates of the sum of lagged preliminary placements estimates are estimated as a second order polynomial distributed lag constrained to zero at the far end. Placements will be marketings in four to eight months and are assumed to follow a quadratic function. Parameter estimates are as follows:

(11) $$\begin{aligned} M^{*}_{i+n,t} - M^{a}_{i,t} = {} & \underset{(73.93)}{36.06} - \underset{(0.11)}{0.234} M^{a}_{i,t} + \underset{(0.044)}{0.072} M^{a}_{i,t-1} - \underset{(0.069)}{0.019} M^{a}_{i,t-12} + \underset{(0.072)}{0.11} M^{e}_{i-2,t} \\ & + \underset{(365.30)}{656.66} M^{p}_{i-7,t} - \underset{(259.75)}{72.14} M^{p}_{i-7,,t-12} - \underset{(0.005)}{0.0007} PDL1_{i,t-4} \\ & + \underset{(0.0023)}{0.003} PDL2_{i,t-4} + \underset{(0.126)}{0.24} \xi_{t-1} \end{aligned}$$

$$D.W. = 2.01, \quad S.E.R. = 26.78, \quad \overline{R}^2 = 0.24, \quad F = 3.88$$

where $PDL1$ and $PDL2$ denote the polynomial distributed lag terms. An F-test of the joint hypothesis that each slope coefficient and lagged residual coefficient equals zero has a p-value of 0.0005. Therefore, we reject the null hypothesis that USDA preliminary markings estimates optimally use all available public and private information at essentially any significance level.

From these tests we conclude USDA preliminary estimates of cattle on-feed, placements and marketings are not strong form rational forecasts of final revised estimates. Strikingly, the USDA, on average, does not even account for serial correlation from past errors when making preliminary estimates. Since the errors are made in a predictable manner, the preliminary estimates are not optimal forecasts. In section 3.3.3, we provide the models whereby optimal forecasts of cattle on-feed, placements and marketings can be computed.

3.5.3 Forecast evaluation

In this section we generate optimal forecasts of final revised estimates conditional on available public and private information available at the time the *COF* report is released, and at the time the Knight-Ridder survey forecasts are released. Finally, we evaluate the RMSE of the optimal forecasts relative to preliminary estimates and survey forecasts. Due to the unavailability of final revised estimates of cattle on-feed, parameter estimates of model (5) in section 3.3.3 can only be re-estimated approximately every 3-5 years; this also applies to placements and marketings over the past five years.

Table 9. Release Dates and Contents of USDA Statistical Bulletin, *Cattle: Final Estimates*

Available On-feed, Placements, and Marketings Final Revisions	Release Date
1980:01 - 1983:12[a]	1985:01
1984:01 - 1988:12[b]	1990:01
1989:01 - 1993:12[c]	1995:01
1994:01 - 1998:12[d]	1998:01

[a]ERS Statistical Bulletin # 720, [b]ERS Statistical Bulletin # 798, [c]ERS Statistical Bulletin # 905, [d]ERS Statistical Bulletin # 953.

Approximately every five years the Economic Research Service (ERS) issues a statistical bulletin entitled, *Cattle: Final Estimates*, which provides final revised estimates for monthly 7-state cattle on-feed, placements, and marketings. Table (9) shows when final revised data have been made available since 1985.

We estimate parameter estimates for model (5) using data over the sample period 1986:01 through 1988:12. Since the final revised data were made available on January 1990, and not again until January 1995, we then use the estimated model (5) to make cattle on-feed forecasts for the period 1990:02 through 1994:12. The same method is applied to placements and marketings. This insures that forecasts only use information available at the time the forecasts are being made. The forecasting models for cattle on-feed, placements, and marketings were specified as follows:

$$F^{*}_{i+n,t} = b_0 + b_1 F^{a}_{i,t} + b_2 F^{a}_{i,t-1} + b_3 F^{a}_{i,t-12} + b_4 F^{e}_{i-2,t} + b_5 P^{a}_{i,t-1} + b_6 P^{a}_{i,t-12}$$
$$(12) \qquad + b_7 P^{e}_{i-2,t} + b_8 M^{a}_{i,t-1} + b_9 M^{a}_{i,t-12} + b_{10} M^{e}_{i-2,t-1} + b_{11} F^{p}_{i-7,t}$$
$$+ b_{12} P^{p}_{i-7,t} + b_{13} M^{p}_{i-7,t} + u_t$$

$$P^{*}_{i+n,t} = b_0 + b_1 P^{a}_{i,t} + b_2 P^{a}_{i,t-1} + b_3 P^{a}_{i,t-12} + b_4 P^{e}_{i-2,t}$$
$$(13) \qquad + b_5 P^{p}_{i-7,t} + b_6 NR_{i,t-12} + \varepsilon_t$$

$$M^{*}_{i+n,t} = b_0 + b_1 M^{a}_{i,t} + b_2 M^{a}_{i,t-1} + b_3 M^{a}_{i,t-12} + b_4 M^{e}_{i-2,t}$$
$$(14) \qquad + b_5 M^{p}_{i-7,t} + b_6 PDL1_{i,t-4} + b_7 PDL2_{i,t-4} + \xi_t$$

where all right hand side variables have been defined previously in section 3.5.2, and $u_t, \varepsilon_t,$ and ξ_t have zero mean conditional on $\phi_{i,t}$. Out-of-sample forecasts of final revised cattle on-feed, placements and marketings were generated for the period 1990:02 through 1994:12, and evaluated using root mean square error evaluation. The ability of out-of-sample forecasts to predict final revised numbers were compared relative to preliminary estimates. Table (10) presents the results.

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Table 10. Forecast evaluation: RMSE comparison

	Preliminary Estimates	Econometric Forecasts
On-feed	89.92	311.83
Placements	33.80	37.15
Marketings	34.11	37.41

Results indicate none of the econometric forecasts beat preliminary estimates. The relatively poor cattle on-feed forecasts can be explained by the fact that model (12) exhibited significant first order auto-correlation in the errors. However, this cannot be corrected out-of-sample because the econometrician does not have access to final revised data at the time the forecasts are made. This results in biased parameter estimates and thus biased out-of-sample forecasts. Models (13) and (14) did not exhibit auto-correlation. Thus, the difference in RMSE between preliminary estimates and econometric forecasts of placements and marketing may be attributed to sampling error or the fact that they are not optimal forecasts. This is further analyzed in chapter 5 using futures prices.

3.5.4 Summary of section 3.5

Based on tests of unbiasedness and efficiency we conclude the USDA preliminary estimates of cattle on-feed, placements and marketings may not be strong form rational. However, the RMSE error analysis contradicts this evidence. Here, we assume preliminary estimates of cattle on-feed are strong-form rational, despite the fact they failed unbiasedness and efficiency tests, because of the RMSE evaluation. It appears that the bias and inefficiency of preliminary estimates of cattle on-feed estimates can be attributed to auto-correlation in USDA final revisions (i.e. final revisions are adjusted up or down together). However, since final revisions are released at irregular intervals, the information needed to account for the auto-correlation when forecasting is not generally available when the forecasts have to be made. With respect to preliminary estimates of placements and marketings, results from tests of unbiasedness, efficiency suggest these estimates are not strong form rational, but RMSE evaluation does not. Based on these results, we are indecisive about their rationality conditions.

3.6 Implications

In this section, we briefly discuss alternative methods to conduct tests of rationality, announcement effects and market efficiency when USDA preliminary estimates are biased and inefficient estimates of final revised numbers.

3.6.1 Test of the rational expectations hypothesis

An econometrician wishing to test the rationality of pre-release survey forecasts of cattle on-feed, such as those provided by Knight-Ridder, must decide whether to use final revised or preliminary estimates data to evaluate the rationality of the survey forecasts. Since we have shown that preliminary estimates of placements and marketings may not satisfy the following conditions, $P^{a}_{i,t} \neq E\left(P^{*}_{i+n,t} \middle| \phi_{i,t}\right)$ and $M^{a}_{i,t} \neq E\left(M^{*}_{i+n,t} \middle| \phi_{i,t}\right)$, which estimate should be used? The objective of tests of unbiasedness and efficiency is to determine whether agents optimally use all available information to forecast the true value of the variable. However, it is not clear in this case whether preliminary estimates are themselves optimal. Final revised data are the best *ex-post* estimate of the actual numbers which market participants are most interested in. Therefore, the final revised data should be used. The correct specification of the model for testing whether Knight-Ridder pre-release survey forecasts of placements are optimal forecasts is :

$$P^{*}_{t+n,t} - P^{e}_{i-2,t} = b_0 + (b_1 - 1)P^{e}_{i-2,t} + \beta' Z_{i-2,t} + u_t \tag{15}$$

Using $P^{a}_{i,t} - P^{e}_{i-2,t}$ as a dependent variable lead to inefficient parameter estimates, causing *t*- and F-tests to be less reliable. This can result in falsely accepting or rejecting the null hypothesis. The same logic holds true for testing marketings.

3.6.2 Tests of announcement effects

To test whether the *COF* report contains new information for the formation of live cattle futures prices, a vector of price changes one day following the reports release can be regressed on a vector of unanticipated information contained in the report. If the report contains new information, the coefficients of unanticipated information should be significantly different from zero. Previous studies have defined unanticipated information has the difference between preliminary estimates and survey forecasts (see Colling and Irwin (1990), Grunewald, McNulty and Biere (1993), and Colling, Irwin and Zulauf (1996,1997) for examples). However, if preliminary estimates are non-optimal forecasts of final revised figures, this approach will lead to a non-optimal forecast of unanticipated information. Since agents may be able to generate optimal linear forecasts of final revised estimates of placements ans marketings, but not cattle on-feed, the following model can be estimated to test for announcement effects and compared to results from the existing model presented by Pearce and Roley (1985):

$$p_{i+1,t} - p_{i,t} = b_0 + b_1\left(F^{a}_{i,t} - F^{e}_{i-2,t}\right) + b_2\left(P^{f}_{i,t} - P^{e}_{i-2,t}\right) + b_3\left(M^{f}_{i,t} - M^{e}_{i-2,t}\right) + \varphi_t \tag{16}$$

where $p_{i+1,t} - p_{i,t}$ is the change in close-to-close live cattle futures prices one day following the *COF* report. This model assumes agents are completely rational, in the sense they understand preliminary estimates of cattle on-feed cannot be improved due to auto-correlation in the USDA revisions, but that optimal linear forecasts of final revised placements and marketings can be generated.

3.6.3 Tests of market efficiency

Previous studies have turned a model such as (16) into a test of the efficient market hypothesis by including the survey forecasts as explanatory variables (see Pearce and Roley (1985) and Colling and Irwin, (1990)). The efficient market hypothesis asserts that information available before the release of a government report should already be reflected by prices, and thus not useful for the prediction of the price change following the report (Fama, 1970). Again, since agents may be able to generate the optimal linear forecast of final revised placements and marketings, the following model can be estimated to test whether the market's response to new information released in the *COF* report is efficient:

$$
\begin{aligned}
(17) \qquad & p_{i+1,t} - p_{i,t} = b_0 + b_1\left(F_{i,t}^{a} - F_{i-2,t}^{e}\right) + b_2\left(P_{i,t}^{f} - P_{i-2,t}^{e}\right) \\
& + b_3\left(M_{i,t}^{f} - M_{i-2,t}^{e}\right) + b_4 F_{i-2,t}^{e} + b_5 P_{i-2,t}^{e} + b_6 M_{i-2,t}^{e} + \varphi_t
\end{aligned}
$$

Market efficiency implies $b_4 = b_5 = b_6 = 0$. This implies that price changes occurring one day following the release of the USDA *COF* report cannot be significantly explained by information summarized by the Knight-Ridder survey forecasts. If biased and inefficient estimates of unanticipated information are used to estimate model (17), parameter estimates will be inefficient, rendering *t*- and F-tests less reliable. This is analyzed in chapter 5.

3.7 Conclusion

We find that USDA preliminary estimates of cattle on feed, placements, and marketings may not be strong form rational forecasts of USDA final revisions, conditional on available public and private information. Each fail the unbiasedness and efficiency tests, however, out-of-sample forecasts of cattle on-feed, placements and marketings cannot be generated which can out-forecast preliminary estimates. Here, we assume preliminary estimates of cattle on-feed are strong form rational because it appears that

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their bias and inefficiency can be attributed to auto-correlation in USDA final revisions which is not generally available when the out-of-sample forecasts have to be made. However, USDA placements and marketings revisions are not auto-correlated. Therefore, we are cannot know whether the difference between the RMSE of preliminary estimates and out-of-sample forecasts of final revised numbers are statistically different.

These findings do have an influence on empirical tests of the rational expectations hypothesis. The conclusion is final revised estimates should be used to test expectations for unbiasedness and efficiency when preliminary estimates do not optimally reflect available information, because the objective of each test is to determine if agents optimally forecast the true value of the variable, not the non-optimal preliminary estimate (i.e it is presumable the actual (final) number that rational agents are motivated to be interested in). These finding also have an impact on event studies which test for announcement effects and market efficiency. Optimal linear forecasts of final revised estimates can be used to approximate the true value of the economic variable in the presence of non-optimal preliminary estimates. This will improve the efficiency of such models and make *t*- and F-tests more reliable.

ARE KNIGHT-RIDDER PRE-RELEASE SURVEY FORECASTS OF THE USDA *CATTLE ON FEED* REPORT STRONG FORM RATIONAL FORECASTS OF USDA FINAL REVISED ESTIMATES?

CHAPTER 4

4.1 Introduction

Market participants and econometricians must often make decisions or inferences based on survey forecasts of USDA reports available prior to their release. The extent to which survey forecasts optimally use available information should be a key criterion in this decision process. In this paper, Knight-Ridder survey forecasts of cattle on-feed, placements and marketings are tested for rationality relative to *public* and *private* information. While there has been much discussion on the impact of private information on the formation of expectations, little empirical evidence has been presented which indicates whether survey forecasts optimally reflect private information.

Given the widespread use of the rational expectations hypothesis in tests of announcement effects and tests of market efficiency, an important empirical issue has become the extent to which expectations of economic variables are consistent with the rational expectations hypothesis. Tests of the rational expectations hypothesis are usually classified as weak form or strong form tests (Lovell, 1986)[4]. Weak form tests examine whether expectations of an economic variable are unbiased predictors of the subsequent

[4]Weak-and strong-form tests of rationality should not be equated with Fama's definition of weak-, semi-strong, and strong form market efficiency. While they are related, they are distinct topics.

realized values of the variable. Weak form tests also examine whether expectations of an economic variable are efficient, in the sense past values of the economic variable cannot be used to explain the error between expected and the realized value (i.e. whether the forecast errors are auto-correlated). Strong form tests of rational expectations examine efficiency by testing whether forecast errors can be explained by other theoretically relevant economic variables. If the expectations are strong form rational, all relevant variables are orthogonal to the forecast error (Colling, Irwin, and Zulauf, 1992).

Therefore, if expectations of an economic variable are rational they must satisfy both unbiasedness and efficiency conditions. Rational expectations therefore are optimal, in the sense the expectations' conditional mean is equal to the true mean of the economic variable, and that they have minimum variance in the class of all such linear unbiased expectations.

The private data used in this study is raw survey data collected directly from feedlots. It was obtained from Professional Cattle Consultants (PCC), a private firm which coincidently provides Knight-Ridder with monthly forecasts of cattle on-feed, placements and marketings which are presumably made using the data from their survey as well as other sources of public information. These forecasts are used, along with many other firms' and agents' forecasts to compute the common Knight-Ridder average "industry" forecast used in previous studies. As well as testing the industry survey forecasts for rationality, we test whether PCC's forecasts, are strong form rational relative to their own private data. Surprisingly, the results suggest the firm may not use their own data optimally. With regard to the survey forecasts themselves, results indicate Knight-Ridder survey forecasts of cattle on-feed, placements and marketings are also not strong form rational.

But do these results refute the rational expectations hypothesis or do they indicate that market agents do not reveal their true expectations when surveyed? It is more likely that market agents don't accurately respond to surveys such as Knight-Ridder's. It is very difficult to understand why we can employ basic linear auto-regressive models and out-forecast most of the individuals by such a significant margin. Based on our results, we conclude that Knight-Ridder industry survey forecasts of cattle on-feed, placements and marketings are not very useful for predicting final revised USDA values. We discuss the implications of our results for tests of announcement effects, and tests of market efficiency.

Section 4.2 discusses the literature. Section 4.3 presents the theoretical framework. Section 4.4 discusses the data used. Section 4.5 provides empirical results. Section 4.6 discusses the implications of our findings for other research. Section 4.7 provides concluding remarks.

4.2 The Literature

Two studies which test whether survey forecasts of agricultural supply variables are weak form rational forecasts of USDA *preliminary estimates* include Colling, Irwin, and Zulauf (1996,1997). Colling et al. (1996) test whether Knight-Ridder *survey forecasts* of corn, wheat and soybean exports are weak form rational forecasts of USDA *Export Inspections* report *preliminary estimates.* Colling et al. (1996) conclude Knight Ridder *survey forecasts* of soybeans exports are unbiased predictors of USDA *preliminary estimates*, and that forecast errors are uncorrelated. The conclusion is the Knight-Ridder survey forecasts of soybeans exports are weak form rational forecasts of USDA *preliminary estimates*. However, Knight-Ridder *survey forecasts* for corn and wheat exports failed the unbiasedness test, and therefore are not weak form rational forecasts. Colling, Irwin, and Zulauf (1997) test whether Knight-Ridder *survey forecasts* of frozen pork bellies are weak form rational forecasts of USDA *Cold Storage* report *preliminary estimates.* Colling et al. (1997) conclude Knight Ridder *survey forecasts* of pork bellies are unbiased predictors of USDA *preliminary estimates*, and that forecast errors are uncorrelated. The conclusion is the Knight-Ridder *survey forecasts* of frozen pork bellies are weak form rational forecasts of USDA *preliminary estimates*.

Several recent studies have tested whether *survey forecasts* of agricultural supply variables are strong form rational expectations of USDA *preliminary estimates,* relative to available public information. These studies include (Colling and Irwin (1990), Colling, Irwin, and Zulauf (1992), and Grunewald, McNulty, and Biere (1993)). These studies provide mixed evidence in support of the strong form rational expectations hypothesis.

Studies finding evidence in support of the strong form of the rational expectations hypothesis include Colling and Irwin (1990), Grunewald et al, and Colling et al. (1992). Colling and Irwin (1990) conclude Futures World News *survey forecasts* of hog breedings and marketings are unbiased and efficient forecasts of USDA *Hogs and Pigs* report *preliminary estimates* of both. Efficiency was tested by regressing survey forecast errors on the difference between *survey forecasts* and out-of-sample forecasts from auto-regressive models specified using only public data. Test results indicate out-of-sample forecasts contain no additional information useful for the prediction of USDA *preliminary estimates* of breedings and marketings (i.e. the survey forecasts are efficient). The conclusion is Futures World News *survey forecasts* of breedings and marketings are strong form rational forecasts of USDA *preliminary estimates*. Following Colling and Irwin's (1990) methodology, Grunewald et al. conclude Knight-Ridder *survey forecasts* of cattle on-feed are strong form rational forecasts of USDA *Cattle on Feed* report *preliminary estimates*. And finally, Colling et al. (1992) conclude Futures World News *survey forecasts* of marketings and breedings are unbiased and efficient predictors of USDA *Hogs and Pigs* report *preliminary estimates* of both. The authors conduct a direct test of efficiency and conclude the survey forecast errors are not explained by theoretically relevant public information. The conclusion is the Futures World News *survey forecasts* of breedings and marketings are strong form rational forecasts of USDA *preliminary estimates* of both.

Grunewald et al., using Colling and Irwin's (1990) approach, provide evidence refuting the strong form of the rational expectations hypothesis. The authors conclude Knight-Ridder *survey forecasts* of placements and marketings are unbiaseded, but inefficient relative to available public data. The conclusion is Knight-Ridder *survey forecasts* of placements and marketings are not strong-form rational forecasts of USDA *preliminary estimates* of both.

This study will extend the work of past studies in three respects. First, none of the studies mentioned have conducted direct tests of efficiency relative to public and private data. We conduct tests of unbiasedness and efficiency to determine whether *survey forecasts* are strong form rational, in the sense they optimally reflect available public and private data. Secondly, none of the studies mentioned have tested whether a single private firm uses their own data optimally. We test forecasts from a private firm represented in the monthly Knight-Ridder survey for unbiasedness and efficiency relative to private data which the company collects itself. Thirdly, tests of unbiasedness and efficiency are conducted using *final revised* USDA figures. *Final revised* figures are appropriate because, as determined in chapter 3, USDA *preliminary estimates* of cattle on-feed, placements and marketings are not rational forecasts of *final revised* estimates.

Finally, we discuss the implications of using biased and inefficient *survey forecasts* and USDA *preliminary estimates* to conduct tests of the efficient market hypothesis and tests of announcement effects.

4.3 Theoretical Framework

Let $F^{*}_{i+n,t}$, $P^{*}_{i+n,t}$, and $M^{*}_{i+n,t}$ denote final revised figures of USDA reported cattle on-feed, placements, and marketings for month *t*, which are released on day *i*+ n. Let $F^{a}_{i,t}$, $P^{a}_{i,t}$, and $M^{a}_{i,t}$ denote the preliminary announced estimates for the same month *t* which are released on day *i*. Let $F^{e}_{i-2,t}$, $P^{e}_{i-2,t}$, and $M^{e}_{i-2,t}$ denote Knight-Ridder survey forecasts of the same month *t*, which are released on day *i*-2. Note that final revised figures are available at some time later than the preliminary estimates. The same notation is used to denote both individual and average forecasts. The important question for market agents and econometricians is whether survey forecasts are rational, in the sense that they optimally use all available information at the time they are made to predict the final revised USDA figures. If the survey forecast is rational, it is equal to the mathematical expectation of the final revised figure, conditioned on the information which was known at the time it was made: that is, in the case of cattle on-feed,

$F^{e}_{i-2,t} = E\left(F^{*}_{i+n,t} \middle| \phi_{i-2,t}\right)$ where $\phi_{i-2,t}$ denotes available information, and E is the mathematical expectations operator.

4.3.1 Hypothesis 1: Unbiasedness

The first implication of rationality is that forecasts be unbiased. To determine if the survey forecasts of cattle on-feed are unbiased the following model is estimated. The same method is used for evaluating placements and marketings.

(18) $$F^*_{i+n,t} = \alpha_0 + \alpha_1 F^e_{i,t} + u_t$$

The unbiasedness property requires that the coefficients in equation (18) may be restricted to $\alpha_0 = 0$, and $\alpha_1 = 1$, and that u_t satisfy the following condition, $E(u_t|\phi_{i-2,t}) = 0$.

4.3.2 Hypothesis 2: Efficiency

Efficiency imposes the additional requirement that any variable known at time (*i*-2,*t*) or before be orthogonal to u_t, that is $\beta = 0$ for any vector $Z_{i-2,t} \in \phi_{i-2,t}$. The survey forecasts are rational forecasts of final revised figures only if both conditions are met. The efficiency hypothesis is tested by applying least squares to the following equation:

(19) $$F^*_{i+n,t} - F^e_{i-2,t} = \alpha_0 + (\alpha_1 - 1)F^e_{i-2,t} + \beta' Z_{i-2,t} + u_t$$

which is constructed by simply subtracting $F^{e}_{i-2,t}$ from both sides of equation (19) and including information in the set $Z_{i-2,t} \in \phi_{i-2,t}$. Efficiency implies that $(\alpha_1 - 1) = \beta = 0$, and that u_t satisfy the following condition, $E(u_t | \phi_{i-2,t}) = 0$. This implies the error, $F^{*}_{i+n,t} - F^{e}_{i-2,t}$, is uncorrelated with available information, $Z_{i-2,t} \in \phi_{i-2,t}$.

4.3.3 Constructing an optimal forecast of final revised cattle on-feed

Define the optimal linear (minimum variance) forecast of $F^{*}_{i+n,t}$ conditional on information $\{Z_{i-2,t}\}$ to be:

(20)
$$F^{\tilde{f}}_{i-2,t} = \hat{b}_0 + \hat{\beta}' Z_{i-2,t}$$

where $Z_{i-2,t} \in \phi_{i-2,t}$ includes relevant survey forecasts. The values of $\hat{b}_0$ and $\hat{\beta}$ are found by applying least squares to equation (20), over a period of which $F^{*}_{i+n,t}$ is known.

4.3.4 Constructing an optimal forecast of unanticipated information

Based on the result from section 3.3.3 in chapter 3, and the previous section 4.3.3, we now have the ability to create optimal linear (minimum variance) forecasts of unanticipated cattle on-feed at the time the *COF* report is released under three different scenarios. The result here is utilized in a later section to demonstrate how tests of announcement effects and tests of market efficiency can be improved in instances where USDA preliminary estimates and survey forecasts are non-optimal.

4.3.4.1 Scenarios 1,2, and 3:

Scenario 1: Both USDA preliminary estimates and Knight-Ridder survey forecasts of cattle on feed are non-optimal forecasts of revised final estimates conditional on information $\left\{F_{i,t}^{a}, Z_{i,t}\right\}$ and $\left\{Z_{i-2,t}\right\}$, respectively. Then the definition of unanticipated information on cattle on-feed that is contained in the *COF* report is

$$\left(F_{i,t}^{f} - F_{i-2,t}^{\tilde{f}}\right).$$

Scenario 2: USDA preliminary estimates are non-optimal and Knight-Ridder survey forecasts are optimal. Then the definition of unanticipated information on unanticipated information on cattle on-feed contained in the *COF* report is

$$\left(F_{i,t}^{f} - F_{i-2,t}^{e}\right).$$

Scenario 3: USDA preliminary estimates are optimal and Knight-Ridder survey forecasts are non-optimal. Then the definition of unanticipated information on cattle on-feed contained in the *COF* report is $\left(F_{i,t}^{a} - F_{i-2,t}^{\tilde{f}}\right)$.

4.4 Data

4.4.1 *Survey forecasts*

Each month Knight-Ridder Financial News conducts surveys of private livestock market analysts and major retail commodity firms to forecast upcoming USDA cattle on-feed, placement, and marketing numbers. After dropping the highest and lowest forecasts of each number, Knight-Ridder computes simple averages which it calls industry forecasts. Monthly Knight-Ridder forecasts from January 1986 to December 1994 are used in this paper, giving 108 observations. Knight-Ridder survey forecasts are widely disseminated are considered to be public information.

Knight-Ridder also publishes the individual analysts' forecasts used to calculate the industry forecasts. Using these data, we analyze individuals' forecasts for unbiasedness, and root mean square error forecast performance. Because Knight-Ridder does not include the same analysts in the survey every month, the number of observations available for most analysts is less than 108. We evaluate the unbiasedness and forecast performance of the 13 analysts which had contributed more than 60 observations over the sample period.

4.4.2 Preliminary and final revised estimates

The seven state *COF* report is released each month by the Agricultural Statistics Board of the U.S. Department of Agriculture (USDA). Each report contains preliminary estimates of the number of cattle on feed the first day of each month, the number placed on feed during the previous month, and the number marketed during the previous month. Final revisions are published in the ERS statistical Bulletin *Cattle: Final Estimates* approximately every five years. As determined in chapter 3, preliminary estimates over the period January 1986 through December 1994 are not unbiased and efficient predictors of USDA final estimates. This implies final estimates should be used to conduct tests of the rationality of survey forecasts.

4.4.3 Other public data

Other public information used in this study includes net returns to feedlots which is a profitability measure; and lagged values of USDA preliminary estimates of cattle on-feed, placements, and marketings. Net returns to feedlots is calculated as the difference between the selling price of fed cattle and returns to variable costs of high plains feedlots. Net returns data was collected from the USDA high plains cattle feeding simulator reported in the monthly *Livestock, Dairy, and Poultry* report.

4.4.4 Private data

The private data used in this study include raw monthly private feedlot survey data for cattle on-feed, placements, and marketings, as well as feedlot capacity. The data are provided by Professional Cattle Consultants (PCC). PCC collects the data from individual feedlots approximately one week prior to the USDA *Cattle on Feed* report, compiles the responses, and returns the aggregated results back to each feedlot in a newsletter format. Over our sample period, the PCC survey constitutes between 1.3 and 2.2 million head of cattle. This represents approximately 20% of all cattle on-feed, placed, and marketed from the seven largest cattle feeding states in the United States each month. In this study the raw PCC data for each component is divided by feedlot capacity to eliminate variation due to feedlots entering and exiting the survey over the sample period.

4.5 Results

This section presents empirical results for tests of unbiasedness, efficiency, and forecast performance conducted for Knight-Ridder industry survey forecasts and the individuals' forecasts reported by Knight-Ridder.

4.5.1 Analysis of industry survey forecasts

4.5.1.1 Test of unbiasedness of Knight-Ridder industry survey forecasts

Each variable was first tested for a unit root, and no evidence of a unit root was found in any of the data series. Results from unbiasedness tests on the industry survey forecasts are shown in table (11). F-tests reject the null hypothesis of unbiasedness for cattle on-feed and marketings forecasts at the 5% level. We fail to reject unbiasedness for placements based on the F-test. The conclusion is that Knight-Ridder industry cattle on-

Table 11. Test of unbiasedness of Knight-Ridder industry survey forecasts						
	α_0	α_1	$\overline{R}^2$	$Q(20)^a$	$H_o: \alpha_o = 0, \alpha_1 = 1$	
On-feed	371.71	0.96	0.97	34.90*	F(2,106)	Prob > F
	(133.23)[b]	(0.02)			10.76	0.0001
Placements	31.08	0.99	0.92	14.63	F(2,106)	Prob > F
	(48.29)	(0.03)			0.53	0.59
Marketings	140.20	0.91	0.83	27.83	F(2,106)	Prob > F
	(70.95)	(0.04)			3.78	0.03

[a]Q(20) denotes the Ljung-Box Q-statistic computed at lag twenty to which tests the null hypothesis that auto-correlation is zero with degrees of freedom equal to the number of lags, [b] standard errors in parentheses, * denotes significance at the 0.05 level.

feed and marketings survey forecasts are not unbiased estimates of USDA final estimates, while the placements are unbiased.

4.5.1.2 Test of efficiency: Knight-Ridder industry survey forecasts

Next, we test the industry survey forecasts for efficiency. Because a forecast must be both unbiased and efficient to be rational, results from testing the Knight-Ridder cattle on-feed, and marketings survey forecasts are presented simply to highlight information they may not be using optimally; in particular the PCC data. Results from tests of efficiency for the industry survey forecasts are presented below. The null hypothesis that industry survey forecast errors are uncorrelated with available information, $Z_{i-2,t} \in \phi_{i-2,t}$, is rejected for cattle on-feed, placements, and marketings. Information $Z_{i-2,t}, \phi_{i-2,t}$ is presented in table (12).

Table 12.	Definitions of variables
$F^{*}_{i+n,t}$	USDA final revised cattle on-feed
$P^{*}_{i+n,t}$	USDA final revised placements
$M^{*}_{i+n,t}$	USDA final revised marketings
$F^{a}_{i,t}$	USDA preliminary estimate of cattle on-feed (lagged values only)
$P^{a}_{i,t}$	USDA preliminary estimate of placements (lagged values only)
$M^{a}_{i,t}$	USDA preliminary estimate of marketings (lagged values only)
$F^{p}_{i-7,t}$	private PCC cattle on-feed
$P^{p}_{i-7,t}$	private PCC placements
$M^{p}_{i-7,t}$	private PCC marketings
$F^{e}_{i-2,t}$	Knight-Ridder survey on-feed forecast
$P^{e}_{i-2,t}$	Knight-Ridder survey placements forecast
$M^{e}_{i-2,t}$	Knight-Ridder survey marketings forecast
$NR_{i,t}$	net returns to feedlots (variable cost minus the selling price of fed cattle)
$F^{f}_{i,t}$	optimal linear forecast of actual revised cattle on-feed at time *i,t*
$P^{f}_{i,t}$	optimal linear forecast of actual revised placements at time *i,t*
$M^{f}_{i,t}$	optimal linear forecast of actual revised marketings at time *i,t*
$F^{\tilde{f}}_{i-2,t}$	optimal linear forecast of actual revised cattle on-feed forecasts at time *i-2,t*
$P^{\tilde{f}}_{i-2,t}$	optimal linear forecast of actual revised placements forecasts at time *i-2,t*
$M^{\tilde{f}}_{i-2,t}$	optimal linear forecast of actual revised marketings forecasts at time *i-2,t*

To formally test whether Knight-Ridder industry survey forecasts of cattle on-feed forecasts are efficient forecasts predictors of USDA final revised cattle on-feed estimates, the following model is estimated:

$$(21) \qquad F^{*}_{i+n,t} - F^{e}_{i-2,t} = b_0 + (b_1 - 1)F^{e}_{i-2,t} + \beta' Z_{i-2,t} + u_t$$

where $Z_{i-2,t} = \left\{ \begin{matrix} F^{a}_{i,t-1}, F^{a}_{i,t-12}, F^{p}_{i-7,t}, F^{p}_{i-7,t-12}, P^{a}_{i,t-1}, P^{a}_{i,t-12}, P^{p}_{i-7,t}, P^{p}_{i-7,t-12}, \\ M^{a}_{i,t-1}, M^{a}_{i,t-12}, M^{p}_{i-7,t}, M^{p}_{i-7,t-12} \end{matrix} \right\}$. The

parameter estimates are as follows:

$$(22) \qquad \begin{aligned} F^{*}_{i+n,t} - F^{e}_{i-2,t} = {} & \underset{(506.22)}{1589.03} - \underset{(0.105)}{0.57} F^{e}_{i-2,t} + \underset{(0.097)}{0.467} F^{a}_{i,t-1} - \underset{(0.029)}{0.026} F^{a}_{i,t-12} + \underset{(219.19)}{213.28} F^{p}_{i-7,t} \\ & - \underset{(242.78)}{329.74} F^{p}_{i-7,t-12} + \underset{(0.045)}{0.247} P^{a}_{i,t-1} + \underset{(0.11)}{0.18} P^{a}_{i,t-12} + \underset{(594.52)}{4218.56} P^{p}_{i-7,t} \\ & - \underset{(715.95)}{1045.33} P^{p}_{i-7,t-12} - \underset{(0.141)}{0.39} M^{a}_{i,t-1} - \underset{(0.141)}{0.574} M^{a}_{i,t-12} - \underset{(999.39)}{1063.90} M^{p}_{i-7,t} \\ & + \underset{(975.87)}{1418.12} M^{p}_{i-7,t-12} \end{aligned}$$

$$D.W. = 1.85, \quad S.E.R. = 105.88, \quad \overline{R}^2 = 0.63, \quad F = 13.55$$

where standard errors are in parenthesis. An F-test of the joint hypothesis that each slope coefficient equals zero has a p-value of 0.00001. Therefore, we reject the null hypothesis that Knight Ridder industry cattle on-feed survey forecasts optimally use all available public and private information at essentially any significance level.

To formally test whether Knight-Ridder industry placements survey forecasts are efficient predictors of USDA final revised estimates the following model is estimated:

$$P^{*}_{i+n,t} - P^{e}_{i-2,t} = b_0 + (b_1 - 1)P^{e}_{i-2,t} + \beta' Z_{i-2,t} + \varepsilon_t \tag{23}$$

where $Z_{i-2,t} = \left\{P^{a}_{i,t-1}, P^{a}_{i,t-12}, P^{p}_{i-7,t}, P^{p}_{i-7,t-12}, NR_{i,t-12}\right\}$. Parameter estimates are as follows:

$$\begin{aligned} P^{*}_{i+n,t} - P^{e}_{i-2,t} = {} & \underset{(62.36)}{-91.42} - \underset{(0.12)}{0.353}\,P^{e}_{i-2,t} + \underset{(0.033)}{0.102}\,P^{a}_{i,t-1} + \underset{(0.112)}{0.15}\,P^{a}_{i,t-12} \\ & + \underset{(590.44)}{3567.30}\,P^{p}_{i-7,t} - \underset{(577.73)}{1961.51}\,P^{p}_{i-7,t-12} + \underset{(1.78)}{0.393}\,NR_{i,t-12} \end{aligned} \tag{24}$$

$$D.W. = 1.76, \quad S.E.R. = 86.67, \quad \overline{R}^2 = 0.30, \quad F = 7.66$$

An F-test of the joint hypothesis that each slope coefficient equals zero has a p-value of 0.00001. Therefore, we reject the hypothesis that Knight-Ridder industry survey forecasts of placements optimally use all available public and private information at essentially any significance level.

Likewise, the following model is estimated for marketings:

$$M^{*}_{i+n,t} - M^{e}_{i-2,t} = b_0 + (b_1 - 1)M^{e}_{i-2,t} + \beta' Z_{i-2,t} + \xi_t \tag{25}$$

where $Z_{i-2,t} = \left\{ M^{a}_{i,t-1}, M^{p}_{i-7,t}, M^{a}_{i,t-12}, M^{p}_{i-7,t-12}, \sum_{j=4}^{8} \alpha_{i,j} P^{a}_{i,t-j} \right\}$. Parameter

estimates of the sum of lagged preliminary placement estimates are estimated as a second order polynomial distributed lag constrained to zero at the far end. Placements will be marketings in four to eight months and are assumed to follow a quadratic function. Parameter estimates are as follows:

$$
\begin{aligned}
M^{*}_{i+n,t} - M^{e}_{i-2,t} = {} & \underset{(100.4)}{182.11} - \underset{(0.102)}{0.242}\, M^{e}_{i-2,t} + \underset{(0.047)}{0.076}\, M^{a}_{i,t-1} - \underset{(0.102)}{0.136}\, M^{a}_{i,t-12} \\
& + \underset{(451.73)}{1270.22}\, M^{p}_{i-7,t} + \underset{(433.46)}{350.81}\, M^{p}_{i-7,t-12} + \underset{(0.0067)}{0.0109}\, PDL1_{i,t-4} \\
& + \underset{(0.0032)}{0.0079}\, PDL2_{i,t-4}
\end{aligned} \tag{26}
$$

$$D.W. = 1.92, \quad S.E.R. = 46.26, \quad \overline{R}^2 = 0.26, \quad F = 5.79$$

where $PDL1$ and $PDL2$ denote polynomial distributed lag terms. An F-test of the joint hypothesis that each slope coefficient equals zero has a p-value of 0.000015. Therefore, we reject the null hypothesis that Knight-Ridder industry marketings survey forecasts optimally use all available public and private information at essentially any significance level.

4.5.1.3 Forecast evaluation

Based on our sample period, 1986:01 through 1994:12, we estimate parameter estimates for model (20) using data over the sample period 1986:01 through 1988:12; the same approach is applied to placements and marketings. Model (20) is estimated using final revised data from 1986:01 through 1988:12, and this estimated model is used to make cattle on-feed predictions for the period 1990:02 through 1994:12[5]. The forecasting models for cattle on-feed, placements, and marketings were specified as follows:

(27)
$$\begin{aligned} F^{*}_{i+n,t} &= b_0 + b_1 F^{e}_{i-2,t} + b_2 F^{a}_{i,t-1} + b_3 F^{a}_{i,t-12} + b_4 F^{p}_{i-7,t} + b_5 P^{e}_{i-2,t} \\ &+ b_6 P^{a}_{i,t-1} + b_7 P^{a}_{i,t-12} + b_8 P^{p}_{i-7,t} + b_9 M^{e}_{i-2,t} + b_{10} M^{a}_{i,t-1} \\ &+ b_{11} M^{a}_{i,t-12} + b_{12} M^{p}_{i,t} + u_t \end{aligned}$$

(28)
$$\begin{aligned} P^{*}_{i+n,t} &= b_0 + b_1 P^{e}_{i-2,t} + b_2 P^{a}_{i,t-1} + b_3 P^{a}_{i,t-12} + b_4 P^{p}_{i-7,t} \\ &+ b_5 NR_{i,t-12} + \varepsilon_t \end{aligned}$$

(29)
$$\begin{aligned} M^{*}_{i+n,t} &= b_0 + b_1 M^{e}_{i-2,t} + b_2 M^{a}_{i,t-1} + b_3 M^{a}_{i,t-12} + b_4 M^{p}_{i-7,t} \\ &+ b_5 PDL1_{i,t-4} + b_6 PDL2_{i,t-4} + \xi_t \end{aligned}$$

where all right hand side variables have been explained in section 4.5.2, and $u_t, \varepsilon_t,$ and ξ_t have zero mean conditional on $\phi_{i-2,t}$. Out-of-sample forecasts of final

[5] For an explanation of why this approach must be taken, see section 3.5.3, chapter 3.

revised cattle on-feed, placements and marketings were generated for the period 1990:02 through 1994:12, and evaluated using root mean square error evaluation. The ability of out-of-sample predictions to predict final revised figures were compared relative to Knight-Ridder industry survey forecasts. Table (13) shows the results.

Table 13. Forecast evaluation: RMSE Comparison

	KR Survey Forecasts	Econometric Model
On-feed	189.04	338.11
Placements	103.30	96.67
Marketings	57.91	55.52

Results indicate the econometric placements and marketings forecasting models out-predicted Knight-Ridder industry survey forecasts. The relatively poor cattle on-feed forecasts can be explained by the fact that model (27) exhibited first order auto-correlation in the errors. However, this cannot be corrected out-of-sample because the econometrician does not have access to final revised data at the time the forecasts are made. This results in biased parameter estimates and thus biased out-of-sample forecasts. Models (28) and (29) did not exhibit auto-correlation. Thus, the difference in RMSE between preliminary estimates and optimal forecasts of placements and marketing may be attributed to sampling error. This is further analyzed in chapter 5 using futures prices.

4.5.1.4 Summary of section 4.5.1

Based on tests of unbiasedness and efficiency, and root mean square error forecast evaluation, we conclude the Knight-Ridder survey forecasts of placements and marketings are not strong form rational. This implies these Knight-Ridder forecasts do not optimally reflect available public and private information. Therefore, it is possible incorrect inference can result on the part of the econometrician when forecasting cattle supply, testing the rational expectations hypothesis, and testing for announcement effects and market efficiency, if Knight-Ridder forecasts of placement and marketings are used. However, we conclude Knight-Ridder forecast of cattle on-feed are strong-form rational despite the fact they failed unbiasedness and efficiency tests. We reach this conclusion based on RSME evaluation.

It is possible that incorrect inference can result on the part of the econometrician when forecasting cattle supply, testing the rational expectations hypothesis, and testing for announcement effects and market efficiency, if Knight Ridder pre-release industry survey forecasts of placements and marketings are used. This is the topic of chapter 5.

4.5.2 Analysis of the Knight-Ridder individuals' forecasts

Results from unbiasedness and root mean square error analysis conducted for Knight-Ridder survey forecasts appear in table (14). We report only the statistical significance of the F-test for unbiasedness and the forecasts' root mean square error. We reject unbiasedness in every case except for analyst 12's cattle on-feed forecasts. We did test analyst 12's cattle on-feed forecasts for efficiency. We reject the null hypothesis at the 5% level. The conclusion is none of the individual Knight-Ridder forecasts are weak form rational. What is particularly interesting about these results is that using PCC's raw feedlot data, we out-forecasted PCC's forecasts of marketings and placements, and the industry marketings forecasts over the sample period. Moreover, we tested the individual PCC Knight-Ridder forecasts for efficiency: results suggest PCC is not optimally using their own data to forecast cattle on-feed, placements, or marketings.

The fact we tested the individual forecasts for unbiasedness and efficiency using final revised estimates suggests the individual cattle on-feed forecasts failed this test for the reason discussed earlier. Cattle on-feed estimates exhibit auto-correlated errors, which is impossible to correct for since final revisions are not available on a regular basis. It is unclear whether all the individual forecasts are strong form rational. However, we can conclude each set individual placements and marketings forecasts are not strong from rational as final revised estimates of placements and marketings do not exhibit serial correlation and that we out-forecasted each of them wide a wide margin.

Table 14. Properties of the Knight-Ridder individuals' forecasts

		Unbiasedness			Root Mean Square Errors		
Analyst	Obs.	F	P	M	F	P	M
1[6]	108	0.5E-2	0.6E-4	0.1E-6	152.08	214.26	97.37
2	92	0.5E-2	0.1E-1	0.1E-6	161.01	195.25	102.25
3	108	0.7E-3	0.1E-3	0.1E-6	163.89	214.80	99.97
4	72	0.1E-1	0.9E-2	0.6E-3	226.11	214.65	80.04
5	101	0.6E-3	0.7E-3	0.1E-6	155.73	209.31	96.83
6	90	0.4E-2	0.3E-2	0.1E-6	169.80	203.69	105.96
7	104	0.2E-1	0.3E-3	0.1E-6	167	195.88	91.25
8	74	0.5E-1	0.2E-2	0.1E-6	173.02	187.09	110.36
9	105	0.2E-4	0.9E-4	0.1E-6	172.88	199.40	99.94
10	89	0.1E-1	0.3E-1	0.1E-6	183	182.03	98.65
11	74	0.1E-1	02E-1	0.3E-5	195.74	185.29	101.11
12	64	0.2	0.3E-4	0.1E-4	183.36	213.02	90.33
13	78	0.1E-1	0.2E-1	0.1E-6	184.83	177.18	106.58
Industry	108				189.04	103.30	57.91
A.R.[a]	24				338.11	96.67	55.52

[a] denotes auto-regressive forecasts.

[6] 1. PCC 2. Western Cattle Consultants 3. Cargill Investor Services 4. Farmer's Grain and livestock Corp. 5. Refco Research 6. Shearson Lehman Bros. 7. Merrill Lynch Futures 8. Linnco Futures 9. A.G. Edwards and Sons Inc. 10. Dean Witter Rynolds 11. DEC Futures 12. Packers Trading Co. 13. A.R. Ring and Assoc.

4.6 Implications For Other Research

In this section, we briefly consider the implications of our results which indicate USDA preliminary estimates and Knight-Ridder survey forecasts of placements and marketings may be biased and inefficient forecasts of USDA final revised figures on tests of announcement effects and tests of market efficiency.

4.6.1 Tests of announcement effects

To test whether the *COF* report contains new information for the formation of live cattle futures price, a vector of price changes occurring one day following the report's release can be regressed on a vector of unanticipated information contained in the report. If the report contains new information, the coefficient of unanticipated information should be significantly different than zero. Previous studies have defined unanticipated information has the difference between the preliminary estimate and the survey forecast (see Pearce and Roley (1985), Colling and Irwin (1990), Grunewald, McNulty and Biere (1993), and Colling, Irwin and Zulauf (1996,1997) for examples). However, if USDA preliminary estimates and survey forecasts are non-optimal forecasts of final revised figures, this approach will lead to a non-optimal forecasts of unanticipated information. Since agents may be able to generate optimal linear forecasts of final revised placements, the following model can be estimated to test for announcement effects and compared to results from the existing Pearce and Roley (1985) model:

(30)
$$p_{i+1,t} - p_{i,t} = b_0 + b_1\left(F^a_{i,t} - F^e_{i-2,t}\right) + b_2\left(P^f_{i,t} - P^{\tilde{f}}_{i-2,t}\right) + b_3\left(M^f_{i,t} - M^{\tilde{f}}_{i-2,t}\right) + \varphi_t$$

where $p_{i+1,t} - p_{i,t}$ is the change in close-to-close live cattle futures prices one day following the *COF* report. This model assumes agents are completely rational, in the sense they understand preliminary estimates of cattle on-feed cannot be improved due to auto-correlation in the USDA revisions, but that optimal linear forecasts of final revised placements and marketings can be generated.

4.6.2 Tests of market efficiency

Previous studies have turned a model such as (30) into a test of the efficient market hypothesis by including the survey forecasts as explanatory variables (see Pearce and Roley (1985) and Colling and Irwin, (1990)). The efficient market hypothesis asserts that information available before the release of a government inventory report should already be reflected by prices, and thus not useful for the prediction of the price change following the report (Fama, 1970). Again, since agents may be able to generate optimal linear forecasts of final revised placements, and marketings the following model can be estimated to test whether the market's response to new information released in the *COF* report is efficient and compared to results from the existing Pearce and Roley (1985) model:

$$p_{i+1,t} - p_{i,t} = b_0 + b_1\left(F_{i,t}^{a} - F_{i-2,t}^{e}\right) + b_2\left(P_{i,t}^{f} - P_{i-2,t}^{\tilde{f}}\right) + b_3\left(M_{i,t}^{f} - M_{i-2,t}^{\tilde{f}}\right) + b_4 F_{i-2,t}^{e} + b_5 P_{i-2,t}^{\tilde{f}} + b_6 M_{i-2,t}^{\tilde{f}} + \varphi_t \tag{31}$$

Market efficiency implies that $b_4 = b_5 = b_6 = 0$. This implies that price changes occurring one day following the release of the USDA *COF* report cannot be significantly explained by information available summarized by the Knight-Ridder cattle on-feed survey forecasts and the optimal placements and marketings forecasts. If biased and inefficient estimates of unanticipated information are used to estimate model (31), parameter estimates will be relatively inefficient, rendering *t*- and F-tests less reliable. This is analyzed in chapter 5.

4.7 Conclusion

We find that Knight-Ridder individual analysts' forecasts of placements, and marketings are not strong form rational forecasts of USDA final revised figures, conditional on available public and private information. Likewise, we find that Knight-Ridder industry survey forecasts of placements and marketings, calculated as the average of individuals represented in each monthly Knight-Ridder survey, are not strong form rational forecasts. The efficiency of Knight-Ridder survey forecasts of placements and marketings can be improved by conditioning on a larger set of available information. In the case of the placements industry survey forecasts, we find that Knight-Ridder placements, lagged preliminary placements estimates, and current and lagged private placements are important for explaining the industry survey forecast error. In the case of the industry marketings survey forecasts, we find that Knight-Ridder marketings, current private marketings, and lagged preliminary placements estimates are important for explaining the industry forecast errors. Results also suggest Professional Cattle Consultants don't use their own private data optimally to form the forecasts of placements and marketings which they provide Knight-Ridder. In the case of cattle on-feed, the source of bias and inefficiency of Knight-Ridder forecasts as predictors of final revised estimates to due to auto-correlated errors, not available data. This implies the econometrician is unable to improve Knight-Ridder cattle on-feed forecasts as the final revised data are not available at the time forecasts of final revisions are made.

The conclusion is Knight-Ridder industry survey forecasts of placements and marketings are not the optimal forecasts of the market's subjective expectation of actual placements, and marketings. This has implications on how tests of announcement effects and tests of the efficient market hypothesis should be specified. An alternative approach to conducting these tests is presented which uses optimal forecasts of final revised USDA figures to measure unanticipated information. This will improve the efficiency of these tests and make *t*-tests and F-tests more reliable.

MARKET EFFICIENCY IN THE US BEEF CATTLE INDUSTRY

CHAPTER 5

5.1 Introduction

Several recent studies have used survey forecasts to distinguish between anticipated and unanticipated information contained in USDA inventory reports to investigate announcement effects and to test the efficient markets hypothesis (Barnhart, Colling and Irwin, Grunewald, McNulty, and Biere, and Colling, Irwin, and Zulauf). However, the true anticipated and unanticipated components of a government report are unobservable. The conventional approach introduced by Pearce and Roley, is to define anticipated information as a survey forecast conducted prior to the report's release, and unanticipated information as the difference between the actual report numbers and the pre-release survey forecast. This approach has led to very useful research analyzing whether USDA inventory reports fulfill their primary public policy objective of providing new information to market participants and testing whether the futures market's respond efficiently to information released in USDA reports. However, none of the existing studies have tested whether USDA preliminary estimates (i.e. the information released in the report) are rational forecasts of final revised numbers provided later, after more information has become available. If the USDA revises preliminary estimates in a predictable way, and/or if survey forecasts are not unbiased and efficient forecasts of the final revised USDA figures, then the convential tests of announcement effects and the efficient market hypothesis (EMH) may lead to incorrect inference. This is because, in these circumstances, the conventional approach fails to properly decompose information into components that can be predicted (anticipated) and another that cannot (unanticipated).

In this chapter, two contributions are made. First, we develop a procedure for testing announcement affects and market efficiency when *survey forecasts* are not unbiased, efficient, forecasts of *final revised* USDA numbers, and/or when USDA *preliminary estimates* are not unbiased, efficient, forecasts of *final revised* USDA numbers. Second, we show how private information, not publically available, can be included in the analysis and used to shed light on announcement effects and market efficiency. The procedures are illustrated by applying them to test for forecasting accuracy, announcement effects, and strong form market efficiency in the US beef cattle industry.

Section 5.2 presents a brief description of market efficiency. Section 5.3 presents the conventional approach for testing for announcements effects and market efficiency. Section 5.4 discusses limitations of the conventional approach. Section 5.5 presents and alternative approach for testing for announcement effects and market efficiency. And section 5.6 presents conclusions.

5.2 Market Efficiency

In this section we formally introduce Fama's models of market efficiency. The definitional statement that in an efficient market prices "fully reflect" available information is so general that it has no empirically testable implications. To make the model testable, the process of price formation must be specified in more detail. Below we briefly present Fama's definition of weak, semi-strong, and strong form market efficiency.

5.2.1 Weak form efficiency: the random walk model

Weak form tests of market efficiency are concerned with whether successive one-period returns are independent, and whether successive one-period returns are identically distributed. The two hypotheses together constitute the random walk model. The random walk model can be specified as follows:

$$\ln p_i - \ln p_{i-1} = b_0 + b_1\left(\ln p_{i-1} - \ln p_{i-2}\right) + \varsigma_i \tag{32}$$

where $\ln p_i - \ln p_{i-1}$ is the rate of return in period *i* calculated as the difference between the logarithm of price in period *i* and period *i-1*; b_0 and b_1 are a constant and slope parameter, respectively; ς_i is a random error term with zero auto-correlation. Weak form efficiency requires that the coefficients in model (32) may be restricted to $b_0 = b_1 = 0$, and residuals display zero auto-correlation. The restriction $b_0 = 0$ implies there is zero opportunity cost of trading as margin requirements can be satisfied through investment in government T-bills. The restriction $b_1 = 0$ is implies the current period's returns cannot be predicted on the basis of information reflected in the previous period's return.

5.2.2 Semi-strong form test of market efficiency

Semi-strong form tests of the efficient markets model are concerned with whether current prices "fully reflect" all obviously publicly available information. This implies that successive one-period returns cannot be predicted on the basis of publically available information or last period's return. The model is specified as follows:

$$\ln p_i - \ln p_{i-1} = b_0 + b_1\left(\ln p_{i-1} - \ln p_{i-2}\right) + \beta' \ln W_{i-1} + \varsigma_i \tag{33}$$

where $W_{i-1} \in \phi_{i-1}$ is a vector of available public data at time i-1 and ϕ_{i-1} denotes all available information at time i-1; b_0 and b_1 are a constant and slope parameter, respectively; β' is a vector of slope parameters. Semi-strong form market efficiency requires that coefficients in model (33) may be restricted to $b_0 = b_1 = \beta = 0$, and residuals display zero auto-correlation.

5.2.3 Strong form test of market efficiency

Strong form tests of the efficient markets model are concerned with whether all available information is fully reflected in prices in the sense that no individual has higher expected trading profits than others because he has monopolistic access to some information. This implies that successive one-period returns cannot be predicted on the basis of private information, publically available information, or last period's return. The model is as follows:

(34) $$\ln p_i - \ln p_{i-1} = b_0 + b_1\left(\ln p_{i-1} - \ln p_{i-2}\right) + \beta' Z_{i-1} + \varsigma_i$$

where $Z_{i-1} \in \phi_{i-1}$ is a vector of available public and private data at time i-1 and ϕ_{i-1} denotes all available information at time i-1; b_0 and b_1 are a constant and slope parameter, respectively; β' is a vector of slope parameters. Strong form market efficiency requires that coefficients in model (34) may be restricted to $b_0 = b_1 = \beta = 0$, and residuals display zero auto-correlation.

5.3 Conventional Approach

Consider the conventional model for testing the EMH applied to investigate the price response to the *Cattle on Feed* (*COF*) report . The model is as follows:

$$
\begin{aligned}
(35)\quad \ln p_{i+1,t} - \ln p_{i,t} &= b_0 + b_1\left(\ln F^a_{i,t} - \ln F^e_{i-2,t}\right) + b_2\left(\ln P^a_{i,t} - \ln P^e_{i-2,t}\right) + b_3\left(\ln M^a_{i,t} - \ln M^e_{i-2,t}\right) \\
&+ b_4\left(\ln p_{i,t} - \ln p_{i-1,t}\right) + b_5 \ln F^e_{i-2,t} + b_6 \ln P^e_{i-2,t} + b_7 \ln M^e_{i-2,t} + v_t
\end{aligned}
$$

where $\ln p_{i,t}$ is the natural log of the closing live cattle futures price on day *i*, the day which the report for month *t* is released; $\ln F^a_{i,t}, \ln P^a_{i,t}$ and $\ln M^a_{i,t}$ are the natural log of USDA preliminary estimates of cattle on-feed, placements and marketings, respectively, for month *t* released on day *i*; $\ln F^e_{i-2,t}, \ln P^e_{i-2,t}$ and $\ln M^e_{i-2,t}$ are the natural log of survey forecasts of cattle on-feed, placements and marketings, respectively, for month *t* released on day *i-2* (two days before the official report is released); and v_t is a random error term uncorrelated with information known at the close of the trading day *i*. Model (35) is typically estimated in logarithms to minimize non-stationarity caused by increased price dispersion at higher price levels (Grunewald et al.). Model (35) implicitly assumes cattle on-feed survey forecasts are unbiased and efficient implying,

$F^e_{i-2,t} = E\left(F^a_{i,t} \middle| \phi_{i-2,t}\right)$; where $\phi_{i-2,t}$ denotes all available information at the time the survey forecast is released two days before the *COF* report release. Likewise for placements and marketings survey forecasts. So, under the EMH b_4, b_5, b_6 and b_7 should all be zero and v_t should be serially uncorrelated, because all available (anticipated) information, $\phi_{i-2,t}$, should already be reflected by day *i* prices. If the report contains new information, then at least one of b_1, b_2, b_3 should be different from zero. Model (35) is estimated separately using near-term, first-deferred, and second-deferred contract prices over the sample period March 1990 through December 1994. Cattle are on feed approximately four to five months so one would expect near-term contract price changes to have a positive relationship with unanticipated shocks to marketings, and deferred contract prices to have a negative relationship with unanticipated shocks to placements (more placements means more supply and lower prices in four to five months). Each variable was tested for stationarity, and no evidence of a unit root was detected. Residuals from model (35) were tested for heteroscedasticity including ARCH effects, and none was detected. Previous studies have estimated model (35) using the two-limit tobit model to account for limit price moves. Over our sample period, the near-term contract recorded just 4 limit moves, and the first- and second-deferred contracts recorded zero limit moves. The degree of inefficiency due to four limit price moves is expected to be negligible, thus model (35) is estimated using OLS for each contract horizon.

Parameter estimates and hypotheses test results for market efficiency appear in tables (16) and (17), respectively. In general, results indicate failure to reject the EMH: survey forecasts are not useful for predicting price changes occurring one, two and three days following the release of the *COF* report for each contract horizon at conventional significance levels. Results indicate the only possible exception is a rejection for second-deferred price changes one day following the *COF* report release at the 10% level, but not at the 5% level. The conclusion is that prices do not respond to information already known when the *COF* report is released, which is consistent with the EMH.

Table 15. Definitions of variables

$F^{*}_{i+n,t}$	USDA final revised cattle on-feed
$P^{*}_{i+n,t}$	USDA final revised placements
$M^{*}_{i+n,t}$	USDA final revised marketings
$F^{a}_{i,t}$	USDA preliminary estimate of cattle on-feed (lagged values only)
$P^{a}_{i,t}$	USDA preliminary estimate of placements (lagged values only)
$M^{a}_{i,t}$	USDA preliminary estimate of marketings (lagged values only)
$F^{p}_{i-7,t}$	private PCC cattle on-feed
$P^{p}_{i-7,t}$	private PCC placements
$M^{p}_{i-7,t}$	private PCC marketings
$F^{e}_{i-2,t}$	Knight-Ridder survey on-feed forecast
$P^{e}_{i-2,t}$	Knight-Ridder survey placements forecast
$M^{e}_{i-2,t}$	Knight-Ridder survey marketings forecast
$F^{f}_{i,t}$	optimal linear forecast of actual revised cattle on-feed at time ***i,t***
$P^{f}_{i,t}$	optimal linear forecast of actual revised placements at time ***i,t***
$M^{f}_{i,t}$	optimal linear forecast of actual revised marketings at time ***i,t***
$F^{\tilde{f}}_{i-2,t}$	optimal linear forecast of actual revised cattle on-feed forecasts at time ***i-2,t***
$P^{\tilde{f}}_{i-2,t}$	optimal linear forecast of actual revised placements forecasts at time ***i-2,t***
$M^{\tilde{f}}_{i-2,t}$	optimal linear forecast of actual revised marketings forecasts at time ***i-2,t***

Table 16. Results from test of semi-strong efficiency using the Pearce and Roley methodology

	Coefficient Estimates										
	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7	ε_{t-3}	$\bar{R}^2$	DW
	Price change on the first trading day after *Cattle on Feed* release										
Near-term	0.18	0.14	-0.03	0.07**	0.11	0.005	-0.003	-0.03		0.11	1.96
	(0.24)	(0.08)	(0.02)	(0.03)	(0.23)	(0.02)	(0.005)	0.02			
First-deferred	0.13	0.07	-0.04**	0.05*	-0.005	0.004	-0.001	-0.02		0.11	1.92
	(0.22)	(0.08)	(0.02)	(0.15)	(0.01)	(0.005)	(0.02)	(0.016)			
Second-deferred	0.08	0.05	-0.04**	0.03	-0.35*	0.005	-0.001	-0.015		0.14	2.08
	(0.16)	(0.06)	(0.015)	(0.02)	(0.18)	(0.01)	(0.004)	(0.01)			
	Price change on the second trading day after *Cattle on Feed* release										
Near-term	-0.06	-0.007	0.015	-0.01	0.004	-0.001	-0.003	0.01		-0.08	1.67
	(0.23)	(0.08)	(0.02)	(0.03)	(0.14)	(0.005)	(0.02)	(0.13)			
First-deferred	-0.14	-0.03	0.01	-0.005	0.03	-0.004	0.001	0.02		-0.03	1.81
	(0.2)	(0.07)	(0.02)	(0.02)	(0.13)	(0.13)	(0.004)	(0.01)			
Second-deferred	-0.10	-0.04	0.01	-0.01	-0.03	-0.001	-0.002	0.02		-0.01	1.95
	(0.15)	(0.05)	(0.01)	(0.02)	(0.13)	(0.01)	(0.003)	(0.01)			
	Price change on the third trading day after *Cattle on Feed* release										
Near-term	-0.24	0.002	0.03	0.005	0.06	0.015	0.002	0.012	-0.4**	0.07	1.98
	(0.21)	(0.07)	(0.02)	(0.03)	(0.14)	(0.01)	(0.006)	(0.15)	(0.15)		
First-deferred	-0.1	0.006	0.02	-0.006	0.15	0.01	0.0003	-0.003	-0.31**	0.04	1.96
	(0.2)	(0.07)	(0.02)	(0.02)	(0.15)	(0.01)	(0.005)	(0.014)	(-0.31)		
Second-deferred	-0.17	0.03	0.02	-0.02	-0.1	0.01	0.003	0.004	-0.36**	0.05	2.01
	(0.16)	(0.06)	(0.02)	(0.02)	(0.17)	(0.01)	(0.005)	(0.01)	(0.15)		

Notes: Std. errors in parentheses, [b] Asterisk (*) denotes significance at 10 percent level, (**) at the 5percent level.

Table 17. Hypotheses test results for the Pearce and Roley semi-strong form efficiency test

	Tests for the first trading day after *Cattle on Feed* release	F-stat	P-value
Near-term	$H_0: b_4 = b_5 = b_6 = b_7 = 0$	1.27	0.30
First-deferred	$H_0: b_4 = b_5 = b_6 = b_7 = 0$	1.04	0.40
Second-deferred	$H_0: b_4 = b_5 = b_6 = b_7 = 0$	2.31	0.07
	Tests for the second trading day after *Cattle on Feed* release		
Near-term	$H_0: b_4 = b_5 = b_6 = b_7 = 0$	0.33	0.86
First-deferred	$H_0: b_4 = b_5 = b_6 = b_7 = 0$	1.17	0.33
Second-deferred	$H_0: b_4 = b_5 = b_6 = b_7 = 0$	1.22	0.31
	Tests for the third trading day after *Cattle on Feed* release		
Near-term [a]	$H_0: b_4 = b_5 = b_6 = b_7 = b_8 = 0$	1.69	0.16
First-deferred [a]	$H_0: b_4 = b_5 = b_6 = b_7 = b_8 = 0$	1.12	0.36
Second-deferred [a]	$H_0: b_4 = b_5 = b_6 = b_7 = b_8 = 0$	1.33	0.27

[a] Model was corrected for third order auto-correlation, and this parameter was additionally tested equal to zero.

Next we imposed the EMH, ($b_4 = b_5 = b_6 = b_7 = 0$), and tested for announcement effects ($b_1 = b_2 = b_3 = 0$). Parameter estimates and hypotheses test results for announcement effects appear in tables (18) and (19), respectively.

Table 18. Results from test of announcement effects using Pearce and Roley's methodology

	Coefficient Estimates					
	b_0	b_1	b_2	b_3	$\bar{R}^2$	DW
	Price change on the first trading day after *Cattle on Feed* release					
Near-term	-0.001	0.11	-0.024	0.078**	0.14	1.75
	(0.001)	(0.078)	(0.023)	(0.028)		
First-deferred	0.0004	0.051	-0.038*	0.062**	0.15	1.70
	(0.001)	(0.069)	(0.02	(0.025)		
Second-deferred	-0.0007	0.038	-0.029*	0.035*	0.11	2.01
	(0.0008)	(0.055)	(0.016)	(0.019)		

Notes: Std. errors in parentheses, [b] Asterisk (*) denotes significance at 10 percent level, (**) at the 5percent level.

Table 19. Hypotheses test results for announcement effects from Pearce and Roley model

	Tests for first trading day after *Cattle on Feed* release	F-stat	P-value
Near-term	$H_0: b_1 = b_2 = b_3 = 0$	3.01	0.04
First-deferred	$H_0: b_1 = b_2 = b_3 = 0$	3.23	0.03
Second-deferred	$H_0: b_1 = b_2 = b_3 = 0$	2.25	0.09

Placements and marketings parameter estimates have expected signs and individual explanatory power. Results suggest the *COF* report does provide new information to the near-term and first-deferred contracts. For these contract prices we reject the null hypothesis below the 5% level, but not the 1% level. However, in the case of the second-deferred contract we reject the null hypothesis below the 10% level, but not the 5% level. The latter result suggests the *COF* report may provide less information relevant to longer term prices.

5.4 Limitations of the Existing Methodology

Model (35) may generate inefficient parameter estimates and incorrect inference if the following two conditions are not satisfied: $F^{a}_{i,t} = E\left(F^{*}_{i+n,t} \middle| \phi_{i,t}\right)$ and

$F^{e}_{i-2,t} = E\left(F^{*}_{i+n,t} \middle| \phi_{i-2,t}\right)$, where $F^{*}_{i+n,t}$ is the final revised USDA estimate of cattle on-feed in month t, determined on day $i+n$.

We test USDA preliminary estimates and Knight-Ridder survey forecasts for rationality by conducting tests of unbiasedness and direct tests of efficiency relative to public and private information. We conclude USDA preliminary estimates and KR survey forecasts of cattle on-feed, placements and marketings may not be rational estimates of final revised numbers. One interesting aspect of our efficiency tests is the use of private data provided by Professional Cattle Consultants (PCC). PCC conducts a feedlot survey prior to the release of each monthly *COF* report, and returns compiled cattle on-feed, placements and marketings responses to each feedlot in a newsletter format approximately one week before the *COF* report release. Our sample of PCC data spans from January 1986 through December 1994. Over this sample period, the PCC survey represents between 1.3 and 2.2 million head of cattle each month; approximately 20 % of all cattle on-feed, placed and marketed from the seven largest cattle feeding states each month. The PCC data is divided by feedlot capacity to eliminate variation due to feedlots entering and exiting the survey over the sample period. Furthermore, no evidence of a unit root was detected in any of the data series.

5.5 An Alternative Approach

Next we consider whether a model of market efficiency can be specified which optimally reflects unanticipated and anticipated information. Following Mankiw et al., define the optimal linear (minimum variance) forecast of final revised cattle on-feed, $F^{*}_{i+n,t}$, conditional on information available at time (i,t),

$\left\{F^{a}_{i,t}, F^{e}_{i-2,t}, F^{p}_{i-7,t}, P^{p}_{i-7,t}, M^{p}_{i-7,t}\right\}$, to be:

$$(36) \qquad F^{f}_{i,t} = \hat{b}_0 + \hat{b}_1 F^{a}_{i,t} + \hat{b}_2 F^{e}_{i-2,t} + \hat{b}_3 F^{p}_{i-7,t} + \hat{b}_4 P^{p}_{i-7,t} + \hat{b}_5 M^{p}_{i-7,t}$$

where all variables have been defined previously. Model (36) is estimated over the period January 1986 through December 1988. To obtain optimal linear forecasts of final revised cattle on-feed figures conditional on information at time (i-2,t), $F^{\tilde{f}}_{i-2,t}$, model (36) was simply estimated without $F^{a}_{i,t}$. The same procedure is used for placements and marketings. Define the optimal linear minimum variance forecasts of placements and marketings conditional on information available at time (i,t) as follows:

$$(37) \qquad P^{f}_{i,t} = \hat{b}_0 + \hat{b}_1 P^{a}_{i,t} + \hat{b}_2 P^{e}_{i-2,t} + \hat{b}_3 P^{p}_{i-7,t}$$

(38) $$M^{f}_{i,t} = \hat{b}_0 + \hat{b}_1 M^{a}_{i,t} + \hat{b}_2 M^{e}_{i-2,t} + \hat{b}_3 M^{p}_{i-7,t}$$

To obtain optimal linear forecasts of final revised placements and marketings figures conditional on information at time (*i*-2,*t*), $P^{\tilde{f}}_{i-2,t}$ and $M^{\tilde{f}}_{i-2,t}$, models (37) and (38) were simply estimated without $P^{a}_{i,t}$ and $M^{a}_{i,t}$, respectively. Parameter estimates from econometric models are presented in table (20). The parameter estimates from each model are used to predict cattle on-feed over the period February 1990 through December 1994, and placements and marketings over the period January 1990 through December 1994, using updated data. This approach was necessary because the USDA released final revised estimates for the period January 1984 through December 1988 in January 1990, and not again until January 1995. F-test results indicate the econometric models generate more efficient in-sample forecasts of cattle on-feed, placements and marketings than USDA preliminary estimates and Knight-Ridder survey forecasts of each over the period January 1986 through December 1988. Note that if auto-correlation is detected in any of the econometric models, it cannot be used to improve forecasting because final revised data are not available at the time out-of-sample forecasts are made starting February 1990. Based on the durbin watson statistics we can conclude parameter estimates from the cattle on-feed

Table 20. Parameter estimates and statistics from econometric forecasting models

Independent Variables	Econometric Models Conditional on Information (i,t)			Econometric Models Conditional on Information (i-2,t)		
	$F^{*}_{i+n,t}$	$P^{*}_{i+n,t}$	$M^{*}_{i+n,t}$	$F^{*}_{i+n,t}$	$P^{*}_{i+n,t}$	$M^{*}_{i+n,t}$
Constant	-24.11	21.54	13.83	862.89*	-19.79	283.75**
s.e.	(143.84)	(21.75)	(66.13)	(454.44)	(72.52)	(132.52)
$F^{a}_{i,t}$	1.12**					
s.e.	(0.063)					
$P^{a}_{i,t}$		0.96**				
s.e.		(0.052)				
$M^{a}_{i,t}$			0.93**			
s.e.			(0.085)			
$F^{e}_{i-2,t}$	-0.09			1.01**		
s.e.	(0.063)			(0.04)		
$P^{e}_{i-2,t}$		0.074			0.86**	
s.e.		(0.047)			(0.07)	
$M^{e}_{i-2,t}$			0.005			0.69**
s.e.			(0.08)			(0.11)
$F^{p}_{i-7,t}$	201.59			-641.99		
s.e.	(130.54)			(409.60)		
$P^{p}_{i-7,t}$	-390.04**	-302.75		1127.05**	1530.31**	
s.e.	(173.31)	(184.77)		(507.52)	521.55	
$M^{p}_{i-7,t}$	-61.29		547.63**	-1145.53		1189.18**
s.e.	(274.24)		(230.31)	(901.14)		(480.75)

Table 20. Parameter estimates and statistics from econometric forecasting models

$\overline{R}^2$	0.99	0.99	0.96	0.96	0.95	0.82
F - $stat$	1950.33	2389.58	269.66	207.61	304.06	73.84
p - $value$	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
DW	0.74	1.90	1.87	1.52	1.86	2.01

Notes: Std. errors in parentheses, [b] Asterisk (*) denotes significance at 10 percent level, (**) at the 5percent level.

econometric models conditional on information at time (i,t) and (i-2,t) are unbiased but inefficient. Thus, an agent can determine *ex-ante* that out-of-sample forecasts from both cattle on-feed models will not be minimum variance forecasts. However, econometric models for placements and marketings conditional on information at time (i,t) and (i-2,t) do not exhibit significant auto-correlation. T-tests from these models indicate PCC marketings data is useful for predicting final revised marketings at time (i,t) and (i-2,t), and that PCC placements data is useful for predicting final revised placements at time (i-2,t). We can reasonably conclude that a rational agent would use out-of-sample forecasts of final revised placements and marketings from the econometric models conditional on information at time (i,t) and (i-2,t). Based on these results it follows that unanticipated and anticipated placements and marketings, as defined in model (35) using USDA preliminary estimates and KR survey forecasts, may be non-optimal estimates of unanticipated and anticipated information. An optimal model of market efficiency is as follows:

$$
\text{(39)} \quad \begin{aligned} \ln p_{i+1,t} - \ln p_{i,t} = {} & b_0 + b_1\left(\ln F^a_{i,t} - \ln F^e_{i-2,t}\right) + b_2\left(\ln P^f_{i,t} - \ln P^{\tilde{f}}_{i-2,t}\right) + b_3\left(\ln M^f_{i,t} - \ln M^{\tilde{f}}_{i-2,t}\right) \\ & + b_4\left(\ln p_{i,t} - \ln p_{i-1,t}\right) + b_5 \ln F^e_{i-2,t} + b_6 \ln P^{\tilde{f}}_{i-2,t} + b_7 \ln M^{\tilde{f}}_{i-2,t} + v_t \end{aligned}
$$

where $\ln P^f_{i,t}$ and $\ln M^f_{i,t}$ are the natural log of optimal forecasts of final revised placements and marketings, respectively, *conditional only on available information at the time the COF preliminary report numbers are released*; $\ln P^{\tilde{f}}_{i-2,t}$ and $\ln M^{\tilde{f}}_{i-2,t}$ are the natural log of optimal forecasts of final revised placements and marketings, respectively, *conditional only on available information at the time the KR survey forecasts are released*; and all other variables have been previously defined. Proceeding, model (39) is estimated to test for market efficiency in precisely the same manner as model (35). We test the null hypothesis that coefficients on available information, b_4, b_5, b_6 and b_7, are jointly equal to zero. Parameter estimates and hypotheses test results appear in tables (21) and (22), respectively. First, we reject the EMH for near-term and first-deferred contract prices at the 10% level, but not the 5% level. Second, we reject the EMH for second-deferred contract prices one day following the *COF* report at the 5% level, but not the 1% level. The latter result is consistent, yet stronger, than our result from model (35); it implies second-deferred price changes one day following the *COF* report are not consistent with the strong form of the EMH. It is important to note that risk adjusted profits must be generated on the basis of the optimal forecasts of placements and marketings before we can definitively conclude the live cattle futures market is inefficient.

Table 21. Results from test of strong efficiency

	Coefficient Estimates										
	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7	ε_{t-3}	$\bar{R}^2$	DW
	Price change on the first trading day after *Cattle on Feed* release										
Near-term	0.4	0.1	-0.02	0.08**	0.12	0.003	-0.005	-0.005**		0.10	2.01
	(0.28)	(0.08)	(0.02)	(0.03)	(0.23)	(0.02)	(0.005)	(0.023)			
First-deferred	0.38	0.03	-0.03*	0.06*	-0.05	-0.00001	-0.002	-0.05**		0.09	2.00
	(0.25)	(0.07)	(0.02)	(0.03)	(0.15)	(0.01)	(0.005)	(0.02)			
Second-deferred	0.26	0.02	-0.03*	0.03	-0.33*	0.002	-0.002	-0.04**		0.11	2.12
	Price change on the second trading day after *Cattle on Feed* release										
Near-term	-0.14	-0.01	0.02	-0.01	-0.002	-0.0004	-0.002	0.02		-0.07	1.67
	(0.26)	(0.07)	(0.02)	(0.03)	(0.13)	(0.14)	(0.005)	(0.02)			
First-deferred	-0.21	-0.05	0.02	-0.006	0.04	-0.005	0.001	0.03*		-0.02	1.80
	(0.02)	(0.06)	(0.02)	(0.03)	(0.13)	(0.01)	(0.004)	(0.02)			
Second-deferred	-0.21	-0.05	0.02	-0.02	-0.02	-0.0002	-0.001	0.03		0.02	1.92
	(0.17)	(0.05)	(0.01)	(0.02)	(0.12)	(0.01)	(0.003)	(0.015)			
	Price change on the third trading day after *Cattle on Feed* release										
Near-term	-0.36	0.06	0.02	-0.002	0.03	0.02	0.002	0.02	-0.40**	0.07	1.96
	(0.24)	(0.07)	(0.02)	(0.03)	(0.16)	(0.14)	(0.006)	(0.02)	(0.15)		
First-deferred	-0.2	0.05	0.02	-0.01	0.12	0.02	0.0004	0.006	-0.31*	0.03	1.89
	(0.2)	(0.07)	(0.02)	(0.03)	(0.16)	(0.013)	(0.006)	(0.02)	(0.16)		
Second-deferred	-0.3	0.06	0.01	-0.03	-0.11	0.016	0.003	0.02	-0.36**	0.05	1.95
	(0.18)	(0.06)	(0.02)	(0.02)	(0.17)	(0.01)	(0.005)	(0.016)	(0.16)		

Notes: Std. errors in parentheses, [b] Asterisk (*) denotes significance at 10 percent level, (**) at the 5percent level.

Table 22. Hypotheses test results for strong form efficiency test

	Tests for the first trading day after *Cattle on Feed* release	F-stat	P-value
Near-term	$H_0: b_4 = b_5 = b_6 = b_7 = 0$	2.35	0.07
First-deferred	$H_0: b_4 = b_5 = b_6 = b_7 = 0$	2.29	0.07
Second-deferred	$H_0: b_4 = b_5 = b_6 = b_7 = 0$	3.07	0.02
	Tests for the second trading day after *Cattle on Feed* release		
Near-term	$H_0: b_4 = b_5 = b_6 = b_7 = 0$	0.53	0.71
First-deferred	$H_0: b_4 = b_5 = b_6 = b_7 = 0$	1.36	0.26
Second-deferred	$H_0: b_4 = b_5 = b_6 = b_7 = 0$	1.90	0.13
	Tests for the third trading day after *Cattle on Feed* release		
Near-term [a]	$H_0: b_4 = b_5 = b_6 = b_7 = b_8 = 0$	1.73	0.15
First-deferred [a]	$H_0: b_4 = b_5 = b_6 = b_7 = b_8 = 0$	0.99	0.43
Second-deferred [a]	$H_0: b_4 = b_5 = b_6 = b_7 = b_8 = 0$	1.53	0.20

[a] Model was corrected for third order auto-correlation, and this parameter was additionally tested equal to zero.

However, the *ex-ante* predictability of price movements found here is a necessary (but not sufficient) condition for the existence of arbitrage opportunities.

Next, we impose the EMH on model (39), $b_4 = b_5 = b_6 = b_7 = 0$, and test the null hypothesis that parameter estimates on unanticipated information, b_1, b_2 and b_3, are jointly equal to zero using near-term and first-deferred contract prices. In the case of second-deferred contract prices we test the same null hypothesis, but without imposing the EMH on model (39) since available information was found to be jointly significant for predicting these price changes. Failure to reject the null hypothesis indicates the *COF* report does not contain new information for market participants. Parameter estimates and hypotheses test results for announcement effects appear in tables (23) and (24), respectively.

Table 23. Results from test of announcement effects using Pearce and Roley's methodology

	Coefficient Estimates					
	b_0	b_1	b_2	b_3	$\bar{R}^2$	DW
	Price change on the first trading day after *Cattle on Feed* release					
Near-term	-0.001	0.03	0.007	0.05	0.008	1.69
	(0.001)	(0.07)	(0.02)	(0.03)		
First-deferred	0.0005	-0.03	-0.01	0.04	0.002	1.66
	(0.001)	(0.06)	(0.02)	(0.03)		

Notes: Std. errors in parentheses, [b] Asterisk (*) denotes significance at 10 percent level, (**) at the 5percent level.

Table 24. Hypotheses test results for announcement effects

	Tests for the first trading day after *Cattle on Feed* release	F-stat	P-value
Near-term	$H_0{:}b_1 = b_2 = b_3 = 0$	1.15	0.34
First-deferred	$H_0{:}b_1 = b_2 = b_3 = 0$	1.05	0.38
Second-deferred	$H_0{:}b_1 = b_2 = b_3 = 0$	2.35	0.08

Two results are strikingly different than those found using the conventional approach; we fail to reject the null hypothesis that unanticipated information is not useful for the prediction of near-term and first-deferred contract prices. Finally, we reject the null hypothesis using second-deferred contract prices at the 10% level, but not the 5% level.

5.6 Conclusions

From these results we can reach two important conclusions. First, this evidence suggests the *COF* report may not provide new information to agents with optimal linear forecasts of final revised estimates of placements and marketings. Second, this evidence also suggests that agents with optimal forecasts of *COF* final revised report numbers (which use PCC data and other data) may be able to predict some price movements after the preliminary *COF* report numbers are released.

CONCLUSION

CHAPTER 6

6.1 Conclusion

The purpose of this study was to help policy makers, econometricians and market analysts evaluate the usefulness of information regarding the USDA Cattle on Feed report, as well as private information and other public information reported by the USDA. We analyzed several interrelated questions related to the rational expectations hypothesis to determine whether the USDA and market agents optimally use available public and private information to form expectations of the supply of cattle on-feed, placements and marketings. We also analyzed several interrelated questions related to the efficient markets hypothesis to determine whether live cattle futures price changes occurring one, two, and three days following the release of the *COF* report optimally reflect available public and private information

In chapter 2 of this study, *Does the Cattle on Feed Report Still Provide New Information to Market Participants*?, first and second moments of release day live cattle futures price changes were compared to those of non-release days. The objective was to determine whether release day live cattle futures price changes have greater mean and variance than non-release days. We concluded that release day price changes over the period January 1990 through May 1998 have greater mean and variance than non-release day price changes. This evidence suggests the Cattle on Feed report is fulfilling one of its public policy objectives which is to provide to new information for the formation of live cattle futures prices.

In chapter 3, *Are Preliminary Estimates in the USDA Cattle on Feed Report Rational Forecasts of USDA Final Revised Estimates*?, we tested whether USDA preliminary estimates of cattle on-feed, placements, and marketings are strong form rational forecasts of USDA final revised figures by conducting tests of unbiasedness and efficiency relative to available public and private information. We concluded that USDA preliminary estimates of each component may not be strong form rational relative to available public and private information. However, a root mean square error forecast competition indicated that preliminary estimates of each component could not be out-forecasted by conditioning final revised numbers on available public and private data suggesting USDA preliminary estimates may be optimal estimates of final revised numbers Finally, we discussed the implications of using biased and inefficient USDA preliminary estimates to conduct tests of the rational expectations hypothesis, tests of announcement effects, and tests of the efficient market hypothesis.

In chapter 4, *Are Knight-Ridder Pre-Release Survey Forecasts of the USDA Cattle on Feed Report Rational Forecasts of USDA Final Revised Estimates*?, we tested whether Knight-Ridder Financial News industry survey forecasts are strong form rational forecasts of USDA final revised figures using the same approach used in chapter 3. After conducting tests of unbiasedness and efficiency, we concluded that Knight-Ridder industry survey forecasts of cattle on-feed, placements and marketings may not be strong form rational forecasts, and thus may not be useful for approximating an average expectation of the market as a whole. Results from a root mean square forecasting competition suggest Knight-Ridder cattle on-feed forecasts cannot be beaten by conditioning final revised numbers on available public and private information, but that Knight-Ridder placements and marketings forecasts can be beaten. Next, we tested whether a private firm's forecasts of cattle on-feed, placements and marketings, as reported by Knight-Ridder, are strong form rational relative to private data the firm collects itself. We concluded the private firm may not optimally use their own data. Finally, we discussed the implications of using biased and inefficient survey forecasts to conduct tests of announcement effects, and tests of the efficient market hypothesis.

Finally, in chapter 5, *Market Efficiency in the US Beef Cattle Industry*, we introduced an alternative approach for conducting tests of announcement effects and tests of the efficient market hypothesis in the presence of biased and inefficient survey forecasts and preliminary USDA estimates. The methodology was employed to determine whether live cattle futures prices respond to the release of the USDA *Cattle on Feed* report in accordance with the strong form of the efficient market hypothesis, and to test whether the report contains new information. Then results were compared to those generated using the conventional approach. Results from the conventional approach and the alternative approach are quite different. Results from the conventional approach suggest prices are efficient relative to available public data, and the *COF* report provides new information to agents with expectations similar to Knight-Ridder survey forecasts and USDA preliminary estimates of cattle on-feed, placements and marketings. However, the alternative approach indicates the *COF* report may not provide new information to agents with optimal linear forecasts of final revised estimates of placements and marketings. And finally the evidence also suggests that agents with optimal forecasts of *COF* report numbers (which use PCC data and other data) may be able to predict some price movements after the *COF* report is released.

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