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## **Futures Prices Responses to the USDA**

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by

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## FUTURES PRICE RESPONSES TO THE USDA COLD STORAGE REPORT

Phil L. Colling, Scott H. Irwin and Carl R. Zulauf\*

The effects of USDA statistical reports on commodity prices have been investigated extensively in recent literature.<sup>1</sup> A motivation for this research is an assessment of the efficiency (Fama) with which markets respond to these reports, which are generally considered to contain information of vital interest to both futures and cash markets. The rationality (Muth) of "pre-release estimates" of USDA reports has also been researched.<sup>2</sup> These pre-release estimates are analysts' forecasts of USDA reports and are released over news services two days prior the release of a report.

The USDA Cold Storage report (CSR) is released monthly and provides estimates of inventories of frozen agricultural commodities in storage. Included among the commodities listed in the CSR are pork bellies, for which there is a futures market. Knight-Ridder's MoneyCenter news service surveys analysts regarding their expectations of the amount of frozen pork bellies in storage, subsequently shown in the CSR. Knight-Ridder (KR) releases these expectations in the form of "pre-release estimates" two trading days prior to the release of the CSR. The fact that KR collects and releases these pre-release estimates suggests that KR believes that the information contained in the CSR is of value. Despite the increased interest in examining issues regarding USDA reports, no research has been conducted regarding the Cold Storage report and its effect on markets.

The purpose of this paper is twofold. First, the pre-release estimates are tested for unbiasedness, a necessary condition for rationality. This study is unique in that the estimates of each analyst are tested for bias, not just the mean of all of the analysts' estimates as previous research has done. This allows the performance of each analyst to be determined. It is also determined if estimating the mean expectation with the highest and lowest estimates

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<sup>1</sup>Gorham, Fackler, Milanos (1987 and 1993), Sumner and Mueller, French et al, Milonas (1987 and 1993) and Garcia and Leuthold examined the effects of USDA's Crop Production report on cash and futures prices. Hoffman, and Grunewald, McNulty and Biere investigated the effects of the Cattle on Feed report on cattle prices. Carter and Galopin (1989 and 1993), Colling and Irwin, Aradhyula, Kesavan and Holt, Hudson et al, Miller, USDA (1977), and Runkle analyzed the effects of USDA's Hogs and Pigs report on hog prices. Schroeder, et al investigated the effects of USDA's Cattle on Feed and Hogs and Pigs reports on live-cattle, feeder-cattle, and live-hog futures prices. Colling et al (1991) examined how all livestock and meat futures contract prices react to the Hogs and Pigs report.

<sup>2</sup>Grunewald, McNulty and Biere examined the rationality of pre-release estimates of Cattle on Feed reports. Colling and Irwin, and Colling et al (1992) examined the rationality of pre-release estimates of Hogs and Pigs reports.

deleted (a convention used by KR) is different from the mean estimate with all estimates included in the calculation. The second purpose of this research is to estimate the effects of the CSR on pork belly and live hog futures prices and to determine if those prices respond in a manner consistent with economic theory.

## DATA

All but three monthly USDA Cold Storage reports from January 1989 through December 1992 are examined.<sup>3</sup> The specific piece of information examined is frozen pork bellies in cold storage, usually located on page 5 of the report. Pre-release estimates are from Knight-Ridder's MoneyCenter news service. Closing pork belly and live hog futures prices the day of the report and opening and closing prices one and two days following the report are examined. The pork belly price corresponds to a futures contract which expires two to six months after a CSR is released. The reason for the wide range of time to expiration is that no pork belly contracts are traded during the months of September through January. Live hog futures contracts expire two to three months following the release of the CSR.

## TEST FOR UNBIASEDNESS IN PRE-RELEASE EXPECTATIONS

The rational expectations hypothesis states that expectations are formed based on all available and relevant information. A rational agent obtains information regarding the probability distribution of outcomes of the variable and analyzes that information with respect to the relevant economic theory to generate expectations of the variable (Shaw). If the agent uses information efficiently, the agent's expectation is identical to the mean of the distribution formed by the applicable economic theory. Therefore, a simple model of rational expectations formation can take the form

$$(1) \quad E_m(X_t | \Omega_{t-1}) = E(X_t | \Omega_{t-1})$$

where

$$\begin{aligned} X_t &= \text{the economic variable in question,} \\ \Omega_{t-1} &= \text{information available at time } t-1, \\ E(\dots | \Omega_{t-1}) &= \text{the expectation, as given by the relevant economic} \\ &\quad \text{theory, conditional on } \Omega_{t-1}, \text{ and} \\ E_m(\dots | \Omega_{t-1}) &= \text{the market's (or agent's) expectation (unbiased forecast)} \\ &\quad \text{conditional on } \Omega_{t-1} \text{ and assessed at time } t-1. \end{aligned}$$

Denoting the market's one-period-ahead forecast as  $X_t^c$  (that is  $X_t^c = E_m(X_t | \Omega_{t-1})$ ), then (1) implies

$$(2) \quad E(X_t - X_t^c | \Omega_{t-1}) = 0.$$

Equation (2) states that the forecast error of the economic variable  $X$  should be uncorrelated with any linear combination of information in  $\Omega_{t-1}$ . In other words, for expectations to be rational, forecast errors must not be explainable through readily-available and relevant information. Such an occurrence would indicate that the agent (or aggregate market) does not utilize that information in forming the prediction. Equation (2) also implies that rational expectations are unbiased.

<sup>3</sup>Pre-release estimates for the July 1989, January 1992 and July 1992 reports are not currently available.

To test the null hypothesis that expectations are unbiased, actual levels of the variable in question (pork bellies in storage from the CSR) are regressed on the expectations (pre-release estimates) as follows:

$$(3) \quad X_t = \beta_0 + \beta_1 X_t^e + \mu_t$$

Under the joint-null hypothesis, the constant equals zero and the slope equals one. From that regression, the error term is examined for autocorrelation under the null hypothesis of no serial correlation.

Results of the test for bias (equation 3) are presented in Table 1.<sup>4</sup> Few of the intercepts are different from zero and few of the slope coefficients are different from one at the five-percent level, either individually or jointly. This suggests that the forecasters in general are very good at forming their expectations and that their expectations are unbiased.

Three notable exceptions are firms B, D, and O. In these cases, and in other cases (though not necessarily indicated by "statistical significance"), the constants are greater than zero and the slopes are less than one as suggested by the joint F-test. These results suggest that those forecasters overall underestimate stocks of pork bellies (because most constants are positive). The fact that the slopes are less than one also suggests that bias exists. However, even in cases when the slope coefficients are "statistically" less than one, they are actually very close to one. For example, the slope coefficient for firm C is less than one at the five-percent level, but is 0.973, less than three-hundredths different from one.

The number of observations for each analyst, listed in the far right-hand column, shows that only firm M provided a forecast for every CSR. Most of the analysts provided twenty to forty forecasts. Some of the analysts stopped providing forecasts during the sample. These are firms A, D, G, O and P. In general, fewer analysts provide forecasts in the latter part of the sample as compared to the first half of the sample. One analyst, Firm L, started providing forecasts just prior to the mid-point of the sample. Another firm, which is not analyzed, provided forecasts for the November and December 1992 CSRs. Because only two observations existed with that firm, there are not enough degrees of freedom to estimate equation (3).

Equation (3) is estimated using the mean of all expectations (last row of Table 1). The equation is also estimated using the mean with the high and low expectations from each observation omitted (second to last row of Table 1), as KR reports the mean pre-release estimate. KR does not state why the high and low estimates are discarded. That action might stem from the belief that the high and low estimates tend to be "outliers." However, by omitting estimates in calculating the mean, information is lost. Results in Table 1 show that there is essentially no difference in the coefficient estimates using the two types of means. A test for the null hypothesis of no difference between the coefficients indicates that the null hypothesis is not rejected. Those results are not reported here but are available from the authors.

Results indicate that the mean pre-release estimate yields a slope coefficient from equation (3) that is "significantly" less than one at the five percent level. This is true for estimates with and without the high and low estimates removed. However, with coefficient estimates of 0.976 and 0.975 with and without the high and low estimates discarded, the coefficients are actually very close to one. In addition, the joint null hypothesis that the constant equals zero and the slope equals one is not rejected at the five-percent level. It is therefore concluded that the mean pre-release estimates are generally unbiased.

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<sup>4</sup>All of the data series were tested for stationarity and the presence of a unit root. Results indicated that the series were stationary and adequate for tests such as equation (3).



## EFFECTS OF THE COLD STORAGE REPORT ON FUTURES PRICES

The efficient markets hypothesis states that a price reflects all available information relevant to the formation of that price (Fama). Therefore, expected information, since that is known information, should be reflected in price. In the case of the Cold Storage report, the pre-release estimates should be reflected in pork belly and live hog prices once the estimates are released. Once the CSR is released, prices should respond to the report to the extent to which the information is unanticipated. In other words, prices should respond to the forecast error. The effects of the CSR on price changes is therefore modelled and estimated as:

$$(4) \quad P_t - P_t^e = \beta_0 + \beta_1(X_t - X_t^e) + \mu_t$$

where:

- $P_t$  = Price following a CSR,
- $P_t^e$  = Price expected to prevail following the CSR -- the closing price the day of the CSR,
- $X_t$  = Pork bellies in cold storage as given in the CSR, and
- $X_t^e$  = Market's expectation of the CSR as proxied by the mean of the pre-release estimates.

To obtain a coefficient estimate which represents a percentage change in price given a one percent difference between the CSR number and the market's expectation, price changes are calculated as differences in natural logs. The forecast error is calculated as the difference between the CSR number and the mean pre-release estimate (with the high and low numbers included) all divided by the mean pre-release estimate.

The efficient markets hypothesis suggests that prices adjust instantaneously to new information. Therefore, to estimate an "immediate" price response, the dependent variable is calculated as the difference between the opening price one day following the CSR and the closing price the day of the CSR. To determine if prices respond to the CSR after the immediate price response, price changes are calculated as differences between the closing price one day after the report and the closing price the day of the report, the opening price two days following the CSR and the close of the day of the report, and the closing price two days after the report and the closing price the day of the report.

Some previous research used the two-limit tobit model (Rosett and Nelson) to estimate equations such as (4). Colling and Irwin and Colling et al (1991) reported that over half of their live hog and pork belly futures prices the day following the Hogs and Pigs report went to the price limit imposed by the Chicago Mercantile Exchange. Those papers therefore used the two-limit tobit model to account for the limited dependent variable problem. Grunewald et al also used that estimation procedure. In this research, pork belly prices moved to the limit only one time the day following the CSR. Live hog prices never moved to the limit following the CSR. Ordinary least squares and White's consistent covariance matrix estimator are therefore used.

Results are presented in Table 2. The regression which estimates the price change from the close of trade the day of the CSR to the open of trade the following day (indicated by "Open Day 1" in the table) shows that prices respond to the report. The sign of the slope coefficient is negative and is significantly less than zero at the one-percent level. The coefficient is expected to be negative because if stocks of pork bellies are higher than expected, the price is expected to drop to reflect that larger-than-expected supply. Conversely, if stocks are lower than expected, the price is expected to rise. The slope coefficient estimate for the "Close Day 1" model (price changes the day of the report to the close of trade the following day) is also significantly less than zero at the five-percent level. This result suggests that the CSR has an influence on pork belly futures prices throughout the entire day following the report. However, by the second day, the CSR does not have an influence on those prices (as evidenced by the "Open Day 2" and "Close Day 2" models).

When compared to the results of Colling et al (1991), the results in the current research suggest that the Cold Storage report does not affect prices nearly as strongly as the Hogs and Pigs report. Colling et al find that a one-percent forecast error in breeding or market hogs leads to, in many cases, over a two-percent changes in pork belly futures prices. In contrast, the coefficient estimate from the "Open Day 1" model suggests that a one-percent bearish forecast error in frozen pork bellies leads to a 0.2 percent decrease in price. This means that although the CSR affects pork belly prices, the effect is less than one-tenth that of the Hogs and Pigs report in terms of the effects of an identical forecast error on price.<sup>5</sup>

The effects of the CSR on live hog futures prices (equation 4) are presented in the bottom half of Table 2. Results indicate that the CSR causes prices to move at the open of trade the day following the report (Open Day 1). The slope coefficient estimate is less than zero at the one-percent level. However, the coefficient suggests that a one-percent bearish forecast error leads to less than a one-twentieth percent drop in price. The coefficient is less than twenty-five percent that of pork bellies. This result is not surprising because the pork belly makes up much less than twenty percent of the dressed weight of a hog. The results also suggest that by the close of trade the day following the CSR, the information in the report is no longer relevant enough to influence hog futures prices. By that time, other information affects live hog prices sufficiently so that it is not possible to estimate the effects of the CSR on live hog futures prices.

## SUMMARY AND CONCLUSIONS

This study tests for bias in pre-release estimates of the USDA Cold Storage report (CSR) and examines the effects of information regarding pork bellies in cold storage in the report on pork belly and live hog futures prices. The CSR report is released monthly by National Agricultural Statistics Service of the USDA. The pre-release estimates, which are analysts' forecasts of the report, are collected by Knight Ridder's MoneyCenter news service and broadcast over their network two trading days prior to the release of the CSR.

Results indicate that some of the analysts provide expectations which are biased. There is a tendency to under-estimate pork bellies in storage in general. There is a specific tendency, although generally very slight, for analysts to overestimate pork bellies in storage when supplies are low and to underestimate stocks when supplies are high. Results from a test for bias indicate that the mean of the pre-release estimates is biased; a slope coefficient is statistically less than one at the five percent level. However, the coefficient is 0.975, which for practical purposes is very near to one. In addition, an F-test indicates that the joint null hypothesis that the constant equals zero and the slope equals one is not rejected at the five-percent level.

Price changes following the report are regressed on unexpected changes in pork bellies in cold storage. This is calculated as the percent difference between pork belly numbers in the CSR and the mean of the pre-release estimates. Pork belly and live hog futures prices respond to the CSR, suggesting that the report is of value to those markets. Results show

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<sup>5</sup>This result does not imply that the Cold Storage report is only one-tenth as valuable as the Hogs and Pigs report. The smaller impact on price from the CSR occurs possibly because the number of frozen pork bellies in cold storage is a small proportion of the total pork bellies produced. Therefore, if the CSR indicates that pork bellies in cold storage are one percent higher than expected, the total number of pork bellies is also higher than expected, but less than one-percent higher. In contrast, the Hogs and Pigs report estimates the total number of hogs in existence in the U.S. Therefore, if that report indicates that there are one-percent more hogs than expected, there indeed are one percent more hogs than expected and therefore one percent more potential pork bellies (assuming of course that the Hogs and Pigs report is accurate and that there is one pork belly per hog). In addition, pork bellies in cold storage is a very small proportion of the total amount of information found in the CSR.

however that the CSR does not affect futures prices nearly to the extent that the USDA Hogs and Pigs report affects prices, as evidenced by other research.

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**Table 1. Tests for Bias in Individual and Composite Forecasts of USDA Cold Storage Reports**

Firm	Intercept	Slope	F-Test (Constant=0 Slope=1)	Durbin Watson	Adjusted R-Square	Observations
A	1.103 (0.665)	0.979 (1.185)	1.192	1.994	0.994	21
B	3.970* (2.610)	0.949** (2.820)	3.978*	1.633	0.987	37
C	1.646 (1.979)	0.973* (2.457)	3.072	2.019	0.995	41
D	2.529 (1.869)	0.951** (2.956)	5.231*	2.015	0.991	32
E	1.405 (1.297)	0.978 (1.606)	1.340	2.236	0.992	41
F	1.107 (0.944)	0.991 (0.479)	0.737	2.357	0.991	29
G	14.339 (1.278)	0.861 (1.597)	3.406	1.662	0.942	7
H	0.988 (1.269)	0.981 (1.888)	2.118	1.929	0.996	42
I	1.391 (1.355)	0.982 (1.371)	0.989	1.519	0.994	35
J	-0.100 (0.133)	1.008 (0.842)	1.962	2.829	0.999	7
K	1.589 (1.804)	0.978 (1.971)	1.953	2.290	0.994	44
L	1.157 (0.978)	0.992 (0.398)	1.021	4.950	0.991	23
M	1.614 (1.874)	0.978 (1.959)	1.969	2.008	0.994	45
N	-1.936 (0.491)	0.989 (0.337)	4.499	2.196	0.992	7
O	6.234** (2.918)	0.946* (2.548)	4.394*	1.479	0.992	16
P	0.521 (0.193)	0.975 (0.881)	2.383	1.831	0.986	18
Composite (No High & Low)	1.563 (1.914)	0.976* (2.289)	2.640	2.032	0.995	45
Composite (All Estimates)	1.580 (1.904)	0.975* (2.318)	2.726	2.006	0.995	45

Note: t-statistics are presented in parentheses under the coefficients. The null hypothesis is that the constant equals zero and the slope equals one. Significance is represented at the one- and five-percent levels by two and one asterisks, respectively.

**Table 2. Pork Belly and Live Hog Futures Price Reactions to the USDA Cold Storage Report**

Time After Report	Constant	Forecast Error	Durbin Watson	Adjusted R-Square
--Pork Bellies; 2-6 months to expiration--				
Open Day 1	0.200 (1.155)	-0.196** (4.757)	1.525	0.341
Close Day 1	0.180 (0.595)	-0.136* (1.703)	2.090	0.056
Open Day 2	0.155 (0.444)	-0.070 (0.977)	2.083	-0.007
Close Day 2	-0.117 (0.344)	-0.061 (1.168)	2.162	-0.010
--Live Hogs; 2-3 months to expiration--				
Open Day 1	0.180* (2.318)	-0.046** (3.148)	2.452	0.110
Close Day 1	0.151 (1.010)	-0.010 (0.368)	2.048	-0.022
Open Day 2	0.166 (1.069)	0.017 (0.785)	2.168	-0.019
Close Day 2	-0.035 (0.199)	-0.023 (0.608)	1.666	-0.161

Note: t-statistics are presented in parentheses under the coefficients. Because the alternative hypothesis is that the slope parameter (forecast error) is less than zero, a one-sided test is performed on that coefficient. Significance is represented at the one- and five-percent levels by two and one asterisks, respectively.