On the Relation Between Futures Price Movements and USDA Reports

by

Paul L. Fackler

Suggested citation format:

ON THE RELATION BETWEEN FUTURES PRICE MOVEMENTS AND USDA REPORTS

Paul L. Fackler

Introduction

The economic analysis of the information processing function of markets has received much attention in the theoretical literature in recent years. While providing interesting insights, this analysis has had few empirical applications, particularly in agricultural markets. One reason for this is the difficulty in reconciling the abstract notion of information as a signal with the data, reports and market analyses that real agents use. This difficulty has led many researchers to conduct studies which lack an explicit model of the role of information in determining market behavior. However, this lack has made the results of such studies difficult to interpret and evaluate.

In this paper I shall address the issue of the relationship between USDA crop production reports and futures price behavior in the corn and soybean markets. The nature of this relationship is important in evaluating both the efficiency of the markets in utilizing information and in assessing the value of the information contained in the reports. The efficiency issue has two parts. The first is whether the market price accurately

Paul L. Fackler is a graduate research assistant in the Department of Agricultural and Applied Economics at the University of Minnesota, Saint Paul, Minnesota. The author would like to thank Reynold Dahl for his helpful comments.
incorporates all available information, in the sense that, following an initial price adjustment, the use of a specific piece of information will not enhance profits (or utility). The second issue concerns the speed with which that initial price adjustment occurs. Addressing the question of the value of crop reports raises welfare issues that will not be addressed in this paper, but also requires a careful examination of the way in which those reports are used by market participants.

A common method used to address these issues has been to examine price behavior before and after the release of a set of reports. This price data, together with the data contained in the reports themselves, is used to test various hypotheses and/or to quantify the relationship between the two variables. Examples of such studies in agricultural commodity markets are Gorman, Pearson and Houck, Miller, and Koontz et al. Of these, the first two examine grain markets, while the latter two the hog market.

In what follows these studies will be reviewed, with particular attention paid to their characterization of market response to information. Then an explicit model of market reaction to reports will be developed. This will be followed by an empirical examination of the corn and soybean futures markets and then by a section summarizing the results.
Previous Studies

All four of the studies mentioned in the first section share a common hypothesis which figures prominently in both their design and in the interpretations placed on their findings. This hypothesis is found in the following passage from Pearson and Houck:

If traders guess correctly what the reports will say, then the market price adjusts before the release date. The price may not change much at all after the report is distributed. The only time a sizeable price adjustment will be observed is when the traders' expectations are wrong. The basic hypothesis is that price and quantity are negatively related; an increase in forecast quantity from one month to the next should lead to a decrease in price, and vice versa. (pp. 5-6)

This hypothesis is echoed in Gorman, who constructs the following example:

Assume that a wheat crop forecast is made on the 10th of July, and that the market accepts this as the best available at that time. As the month progresses and rainfall becomes lighter than expected, private-information providers will adjust the July USDA forecast downward. To the extent that this downward adjustment is off the mark and the market is surprised by the new USDA forecast of August 10, the surprise will show up only in the August 11 price change. (p. 33)

In discussing his results Gorman suggests that an insignificant coefficient in a regression of the price change on the change in forecast production indicates that the "market does a very good job in anticipating changes in the soybean forecast," while a significant and negative coefficient indicates that the market does "a considerably poorer job in anticipating changes in the corn harvest" (p. 34). In Miller it is stated that "a futures price change opposite in direction from the change in production
estimates between the new and the immediately preceding reports would be expected with the release of the new report" in the event that the report contains "surprises" (p. 68). Finally, in Koontz et al. this hypothesis provides the rationale for classifying reports as bullish, bearish or neutral, and for the conclusion that "[f]ailure to find a slope in the price change series for bullish (bearish) reports would indicate the markets to have already incorporated the information" (p. 5).

In both studies of the hog market evidence was found to support the hypothesized inverse relationship. In the grains the evidence was mixed, with a strong relationship existing in corn, a somewhat weaker one in wheat, and no significant relationship in soybeans.

While all four studies share this hypothesis, a few other issues were also investigated. Pearson and Houck contains a second hypothesis concerning the size of price fluctuations. They state:

[O]ne can visualize a market filled with uncertainty in the days before a report is released....In this decision-making environment, the potential for price fluctuation is very great. However, after the report is released, uncertainty is reduced. Traders once again have a common point of reference in the quantity figures supplied by the report, so the range of expectations concerning the true location of the supply curve is narrowed....The price level may go up or down after distribution of the report, but it seems plausible to suppose that the degree of price fluctuation might be lessened for several days afterward. (p. 6)

Interestingly, this is the only discussion in any of the four papers on the size, as opposed to the sign of price movements.
They found, however, that the absolute size of price changes following the release of a report seems to increase.

Finally, two of the studies mentioned the question of the speed with which prices adjust to information in the reports. Koontz et al. state that "serial dependence on price changes around the release date of the reports would be expected if a report is a surprise and therefore contains new information. A series of price changes in the same direction would be required to adjust to a significant change in information." (p. 4). There was, however, little evidence of such serial dependence. Miller suggests "the possibility that constraints prevent immediate and complete futures price adjustments upon release of [a report]" (p. 68), and claimed his results provided evidence that such constraints do in fact exist.

A Model of Market Reaction to Information

In this section I will argue that the conclusions drawn in the studies discussed above are not as intuitively obvious as they might at first seem and may be somewhat misleading. The problem seems to stem from a lack of clarity about how the reports are used in the price adjustment process. A basic assumption of this paper is that the impact of a production report on price depends mainly on the extent to which traders adjust their expectations about production following the release of the report. Unfortunately, even if we assume that all traders believe that the report is correct, we cannot observe their beliefs prior to the report. The only information we have about
what these expectations were is what is contained in the price record.

In order to utilize this record it is important to recognize that a report can influence traders' expectations in a number of possible ways, depending on what information was available prior to the release of a report and how this information had been used. This paper will concentrate on two such possibilities. The first is that the report contains new information that was not previously available, while the second is that traders make mistakes in their analysis of previously available information, which are corrected by the release of the report. Both of these possibilities will be explicitly modeled in order to derive hypotheses about the way in which readily observable variables, i.e., prices and production estimates, are related.

The model developed here will represent information as signals which traders observe and which influence their subjective expectations about price movements. A kind of efficiency in the market will be assumed, namely that an equilibrium price is established each day. However, the model will allow traders to make systematic mistakes in interpreting the impact on production of the information they receive between the release of crop reports.

Specifically, in this model the market is composed of identical traders, all with access to the same information set. We will define

\[ p_t = \ln(\text{price}_t/\text{price}_{t-1}) \quad \text{and} \]

\[ r_t = \ln(\text{E}_t[\text{production}]/\text{E}_{t-1}[\text{production}]). \]
The time subscripts denote a single trading day, and expectations are subjective. Capital letters will correspond to the cumulative sum of a variable over the period beginning two days after the last report was released. For example, if a report is released on July 10 and \( t \) refers to July 25, then \( P_t \) will be the log of the ratio of the July 25th price to the July 11th price.

Each day traders receive signals about forthcoming production and about other factors affecting price. For our purposes we can view the establishment of a new price expectation as occurring in two stages. In the first, traders revise \( r_t \) while in the second they adjust price according to the rule

\[
p_t = A r_t + e_t
\]

where \( e_t \) is a random variable that can be thought of as the effect on price of the non-production related signal, while \( A < 0 \) and can be interpreted as a kind of price flexibility.

The information traders receive about production will take the form of two zero mean, serially uncorrelated signals, \( u_t \) and \( v_t \). The first of these is received daily while the second is contained in the production report and is independent of \( u_t \). This signal may be interpreted as the news contained in the report. We will assume that, on the day following the release of a report, traders’ production expectations coincide with those of the report. Thus if \( t \) represents such a day then \( u_t \) is identically zero, while on any other day \( v_t \) is identically zero, and \( u_t \) has some positive, constant variance. The cumulative variable, \( U_t \), is defined as above. We will assume that the signals are defined so that \( R_t = U_t + v_t \) if \( t \) represents a day following a report release.
to overestimate the effect on production of the news received.

First, let us examine the relationship between $R^2$ and $\vartheta$. This expectation need not be negative, indeed, it will be if $\vartheta$ is positive. If two conditions are met: first, if there is a tendency that $\vartheta$ will be negative, which has been a focus of inquiry in previous studies. We see

\[ E[R^2] = \alpha(\vartheta^2) + (1-\vartheta)(U'U) \]

which follows that

in turn, be used to analyze relationships between observable

where $E$ is the cumulative associated with $\vartheta$. These results may,

\[ P^{-1} = \alpha(U'U) \]

\[ P = \alpha(\vartheta^2 + U'U) \]

\[ \vartheta = \alpha \left( 1 - \vartheta \right) \]

where $\vartheta$ is the centered and centered second moments are identical. From the report, second, all variables have mean zero and, therefore, will refer to a day following the release of a crop. This model, while simple, is sufficient to generate a number of interesting results. In the discussion that follows, it will be

are understimating this impact. Therefore, the impact of $U$ on production will be if $\vartheta > 0$. They

consensus reached is that $R^2 U$. If $\vartheta > 0$, then traders are

on production. However, this will not be true. We will allow

254
is an indication that markets don't adjust in a day and that the
Hence, any significant relationship between these two variables
\[ \sigma^2[p_i] = 0. \\
\]
report releases. In our model
effectively incorporated into practice on the day following the
This should indicate whether the information in the report is
is by examining the relationship between \( p_i \) and \( p_{i+1} \), \( i=1,2, \ldots \), etc.
assumption is not a good one. One way which this can be addressed
It is possible, of course, that the market clearing
mistakes are made in expectations.
Clearing errors every day, but we have the possibility that systematic
particular kind of tractability. By assumption markets are
be indicated by a positive relationship. In either case we have a
between these two variables, while an under-response
respond then we would expect to see an inverse relationship
\( u_i \) is not degenerate. Thus, if traders systematically over-
the sign of which will depend only on the sign of \( i-c \), given that
\[ \sigma^2[p_i] = 4 \sigma^2(i-c)(\lambda - i)^2. \]
relationship between \( p_i \) and \( p_{i+1} \). We see that
over or under-response to information we may examine the
To see whether there is a systematic tendency for traders to
tendency to under-response to information.
the report contains news. It may signal instead that there is a
negative sign is no assurance that \( \sigma^2[p_i] \) is large, i.e. that
contained in the report \( \sigma^2(p_i)\), \( \sigma^2(p_{i+1}) \), etc. Furthermore, a
the amount of such news is large enough relative to the news
between releases of the production reports (c<1) and second, if

Regression of \( R \) on \( R^2 \) provides an estimate of \( \alpha \). Furthermore, the coefficient of the cumulative price change, which is accounted for by the change in the proportion of the proportion of the correlation coefficient with various parameters by examining the relationship between \( p \) and \( p^2 \), will provide a measure of the proportion of the variance of the report was useful in the price adjustment process. Finally, we may gain some insight into the relative size of the variance following a report release. Indicating that the

\[
\text{Var}(u_i^2) = \text{var}(e_i^2) + \text{var}(\gamma u_i) + \text{var}(\gamma^2 u_i^2)
\]

for nearby days, this variance is given by

\[
\text{Var}(p_i^2) = \text{var}(e_i^2) + \text{var}(\gamma u_i) + \text{var}(\gamma^2 u_i^2)
\]

within the framework of the model the best overall indicator which will be non-zero when \( c \) does not equal 1.

\[
\sum_{i=1}^{t} \sum_{j=1}^{t} u_{ij} = \text{var}(1-C(1-C)\text{var}(u_{ij})^2)
\]

on the other hand, will depend on \( c \), specifically, features of the market. The relationship between \( p \) and \( p^2 \) model is not adequate in capturing all of the interesting
following report releases were nearly 2.5 times its usual size. The other day, the overall means for the 10 days prior to report
is over half again as large as the largest of the variances of
in the soybean and corn markets, respectively. In both cases this
larger than usual, the sample variance of ρ is 5.86 and 4.54.
Evidence that price changes following report releases tend to be
of ρ=1 for ρ=0.0; these are given in Table 1 and provide
the first statistics calculated are the sample variances

uncentered sample averages.

In the following presentation, all results on second moments are
variables defined above have mean zero by assumption. Therefore,
furthermore, it should be noted that all the
interpretation and because they are then interpretable as
small they have been multiplied by 100 for ease of
i=10.4...3. Because the magnitudes of these variables are rather
soybeans on the variables R and P as well as θ
set with 24 observations for corn and 27 observations for
first to contain production estimates. This results in a data
soybeans and for corn in 1974 and 1982 the August report is the
November crop production reports from 1974 through 1982 (for
November soybean futures markets. The data cover the July through
we shall examine these relationships in the December corn and
discussed that can be investigated empirically. In this section
in the previous section a number of relationships were

Empirical Results
Although this evidence does not constitute a formal test, it strongly suggests that traders find the reports quite useful. In adjusting their production expectations, they may be responding to variances in corn and soybean prices that are not significant individually but, when combined, provide strong evidence of significant market behavior.

### Table 1. Estimated Variances for Log Relative of Soy and Corn

<table>
<thead>
<tr>
<th></th>
<th>Corn</th>
<th>Soybeans</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.74</td>
<td>4.15</td>
<td>1.31</td>
</tr>
<tr>
<td>2.45</td>
<td>2.72</td>
<td>1.41</td>
</tr>
<tr>
<td>3.28</td>
<td>2.93</td>
<td>1.53</td>
</tr>
<tr>
<td>3.98</td>
<td>3.54</td>
<td>1.72</td>
</tr>
<tr>
<td>4.78</td>
<td>4.34</td>
<td>2.02</td>
</tr>
<tr>
<td>5.34</td>
<td>4.97</td>
<td>2.36</td>
</tr>
<tr>
<td>5.70</td>
<td>5.57</td>
<td>2.55</td>
</tr>
<tr>
<td>5.82</td>
<td>6.03</td>
<td>2.76</td>
</tr>
<tr>
<td>6.03</td>
<td>6.40</td>
<td>2.93</td>
</tr>
<tr>
<td>6.20</td>
<td>6.73</td>
<td>3.09</td>
</tr>
<tr>
<td>6.37</td>
<td>7.25</td>
<td>3.23</td>
</tr>
<tr>
<td>6.54</td>
<td>7.76</td>
<td>3.36</td>
</tr>
<tr>
<td>6.70</td>
<td>8.28</td>
<td>3.48</td>
</tr>
<tr>
<td>6.85</td>
<td>8.80</td>
<td>3.58</td>
</tr>
<tr>
<td>7.00</td>
<td>9.30</td>
<td>3.67</td>
</tr>
</tbody>
</table>

For a description of the data used see note to Table 2.
Figure 1. Scatterplots for selected variables.

For a description of the data used see note to Table 2.
Sample contains 34.

The soybean sample contains 27 observations, while the corn

The samples used cover the period 1974-1982.

The estimates from the previous report

$R = log$ relative of the current estimate of production to

Release of the last report

$P = cumulative of P_t$ since the period since the

Release of a crop production report

The following day follows

Data Definitions:

<table>
<thead>
<tr>
<th>p_{t-1}</th>
<th>p_{t}</th>
<th>p_{t-1}</th>
<th>p_{t}</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>8</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>9</td>
<td>0.01</td>
<td>0.75</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>9</td>
<td>1.25</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>1.12</td>
<td>1.15</td>
</tr>
</tbody>
</table>

Table 2. Frequencies of sign pairs for selected variables

The normal approximation to the binomial distribution was
equal to the probability that they don’t. Using the sign test and
probability of both variables of the pair having the same sign is
were conducted with these figures. The first is that the
relationships, which are given in Table 2. Two hypothesis tests
of the frequency of sign pairs in each of the three
These graphic impressions are reinforced by an examination
relationship, as would be expected.

Second plot is for $P_{t-1}$ for corn, which suggests an inverse
that traders may overreact to news between report releases. The
for the signs of the two variables to be opposite, which suggests
relationship. The plot for $P_{t-1}$ for soybeans shows a tendency
For a description of the data used see note to Table 2.

<table>
<thead>
<tr>
<th>CORN</th>
<th>SOYBEANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.34</td>
<td>5.68</td>
</tr>
<tr>
<td>-0.17</td>
<td>-0.37</td>
</tr>
<tr>
<td>0.21</td>
<td>-0.70</td>
</tr>
<tr>
<td>-0.33</td>
<td>-0.43</td>
</tr>
<tr>
<td>-0.32</td>
<td>-0.59</td>
</tr>
<tr>
<td>0.94</td>
<td>-0.81</td>
</tr>
<tr>
<td>1.52</td>
<td>4.32</td>
</tr>
</tbody>
</table>

Table 2: Correlations of Selected Variables

Correlations as well as the soybean pair R_11'p_2 has a correlation higher than 0.1. The other pairs all have significance levels of 0.05 or more except for the corn pair R_11'p_2 which has a correlation of 0.2 which is significant at the 0.05 level. The other pairs again all have significance levels of 0.1 or more except for the corn pair R_11'p_2 which has a correlation of 0.2 which is significant at the 0.05 level.

The results indicate that there is a significant relationship between the variables. The values are also given in Table Z.

Table Z presents the sample covariances and correlations of the pairs of variables. These are calculated with the zero mean restriction. The same two pairs stand out as being related by restriction.

A test of independence of the null hypothesis of independence, now at 1 degree of freedom, again, for the soybean pair p_11'p_2 we can reject the null hypothesis. Again, the chi-square test is equal to 1.37 which is less than 2.0 and we can reject it.

A 2x2 contingency table also shows a significant relationship at the 0.05 level between the variables. Viewing the four quadrants as a 2x2 contingency table, we may also conduct a chi-square test of independence with 1 degree of freedom.

These values are also given in Table Z.

The conclusion is that there is a significant relationship between the variables when using a significance level of 0.05. This result is consistent with the findings of other studies.

The results are consistent with the findings of other studies.
Table 4. Regression Results

<table>
<thead>
<tr>
<th>p on P-1</th>
<th>p on R-l</th>
<th>p on R-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0574</td>
<td>0.0297</td>
<td>0.1630</td>
</tr>
<tr>
<td>-0.1743</td>
<td>0.0240</td>
<td>0.8172</td>
</tr>
<tr>
<td>-0.2142</td>
<td>0.0257</td>
<td>0.8572</td>
</tr>
<tr>
<td>-0.2805</td>
<td>-0.2977</td>
<td>-0.3277</td>
</tr>
<tr>
<td>-0.3545</td>
<td>-0.3520</td>
<td>-0.3725</td>
</tr>
<tr>
<td>-0.447</td>
<td>-0.474</td>
<td>-0.507</td>
</tr>
</tbody>
</table>

The findings of previous studies also, the soybean pair R-l, and in keeping with the corn pair R-1 cannot be dismissed. Here the significance level is under 0.05 and the R is 0.2. This is to be related with a significance level of less than 0.05.

The most clearly related of these pairs using this method is the corn R-1, pair with a significance level of less than 0.01 and an R of nearly 0.3. Again, the soybean pair R-l, pair.

The regressions provide a simple, widely used significance test based on the t-distribution, as well as a measure of the amount of the variance of the regressand that can be explained by the regressors. These provide a simple, widely used significance test based on the t-distribution, as well as a measure of the amount of the variance of the regressand that can be explained by the regressors.

Also presented, in Table 4, are the results of three regressions. The coefficient is 0.47. The coefficient of 0.21 is while for the corn pair R-1, and this is a weakly significant relationship, with an R of about 0.1.
Table 5. Covariance and Correlation of Log Relative Futures Prices Following a Drop Report with Prices on Surrounding Days

<table>
<thead>
<tr>
<th>CORN</th>
<th>SOYBEANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0049</td>
<td>0.0113</td>
</tr>
<tr>
<td>0.2206</td>
<td>-0.5627</td>
</tr>
<tr>
<td>0.3058</td>
<td>-0.9577</td>
</tr>
<tr>
<td>1.0</td>
<td>4.5411</td>
</tr>
<tr>
<td>-0.2222</td>
<td>-0.3836</td>
</tr>
<tr>
<td>-0.1872</td>
<td>-0.3531</td>
</tr>
<tr>
<td>0.2222</td>
<td>0.8240</td>
</tr>
<tr>
<td>0.1365</td>
<td>0.4471</td>
</tr>
<tr>
<td>0.0816</td>
<td>0.1894</td>
</tr>
<tr>
<td>0.2311</td>
<td>0.5854</td>
</tr>
<tr>
<td>0.0504</td>
<td>0.3474</td>
</tr>
<tr>
<td>-0.2054</td>
<td>-0.1525</td>
</tr>
<tr>
<td>-0.2788</td>
<td>-0.7968</td>
</tr>
<tr>
<td>0.1385</td>
<td>0.4660</td>
</tr>
</tbody>
</table>

Investigating that the market clearing assumption need be further formal tests were conducted, there is no compelling evidence discernible or interpretable patterns to these results, while no clearing each day. In neither market is there any clearly result would provide one check of the assumption that markets are for 10°, while they will have the same sign as I for 10°. This it was noted that our model predicts that these will equal zero p, and if the z's are presented in the previous section. Finally, in Table 5, the covariances and correlations of...
other evidence. First, the variance of the price change is higher on the soybean market, on the other hand, this strong relationship does not exist. However, the conclusion that the reports contain little information is not supported by the reports themselves. There is a large news component to the reports, and the price following the release of the reports suggests that an inverse relationship between the reports and the price changes in the soybean market. Thus, the strong relationship between the releases of production reports and the price changes in the soybean market is no evidence that traders systematically misjudge the information that they receive differently. In the corn market there is no evidence that markets respond to the crop production reports in somewhat the same way.

The evidence indicates, however, that the corn and soybean reports are large price adjustments do occur. In response to approximately 2.5% in both of the markets examined, indicating that the variance at other times. It was found that this ratio is the impact of crop reports on the market is the ratio of the variance of the price change following the release of the report. It has been argued here that the single best measure of how they correct misjudgments of other available information, provide new information to market participants and the second is which the reports impact on the market. The first is that they questions. What is suggested here is that there are two ways in which the market price is an important part of answering such questions continually arising and finding the proper way to measure their summary and conclusions, the value of USDA reports are.

Summary and Conclusions
of a report.

Production estimates and the change in price following the release
only examine the relationship between the change in the
information for the soybean market and that it is sufficient to
make in previous studies that USDA crop reports contain little
information. However, there is sufficient evidence to counter the implication
the evidence presented indicates that traders act irrationally.
It would be unwise to jump to the hasty conclusion that
speculators about crop conditions.

would tend to be less well informed than large hedgers and
has had a relatively large proportion of small speculators, who
possibility explanation may lie in the fact that the soybean market
question as to why the soybean market behaves as it does. A
information contained in crop reports. It is, however, an open
have seen, this market seems to adjust prices quickly to the
mysterious or even that it is, in general, inefficient. As we
This does not imply that the soybean market is somehow
adjustment to occur when a report becomes available.
release between the release of reports, requiring a larger price
that traders systematically over-respond to information that they
Furthermore, the negative relation between P and P-I suggests
alone suggests that traders are responding to the reports.
255
REFERENCES