THE RESPONSE OF FUTURES PRICES TO NEW MARKET INFORMATION: THE CASE OF LIVE HOGS

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Writing about empirical tests of stock market efficiency, Fama et al. [2, p. 1] noted that

> ". . . the usual procedure has been to *infer* market efficiency from the observed independence of successive price changes. There has been very little actual testing of the speed of adjustment of prices to *specific kinds* of new information."

The present state of knowledge about futures market efficiency is much like that for stock market efficiency prior to the work of Fama et al. Numerous tests of the random walk hypothesis have been conducted for futures markets in both grains [e.g., 1, 10] and livestock [e.g., 1, 7]. Larson [4] analyzed corn futures prices and concluded that 80 percent of the appropriate price response to *general kinds* of a new supply and demand information was accomplished within a day. However, research related to how future prices respond to *specific kinds* of new information is scarce. The only known research in this area is that of Pearson and Houck [9] and Gorman [3], who examined the response of grain prices to the release of USDA production reports. To the writer's knowledge, no previous analysis has been made of the response of livestock futures prices to *specific kinds* of new information. The results of research pertaining to the forecasting efficiency of livestock futures indicate the need for such an analysis. Leuthold [5, 6] found that live cattle futures were biased downward and were less reliable than cash prices as forecasts beyond 15 weeks in the future. Leuthold and Hartman [8] showed that a simple econometric model using only public information was more efficient in a forecasting role than was the live hog futures market. A question raised by these findings is whether livestock futures have responded to market information which might be used in assessing future supply and/or demand conditions. To address this question, the adjustments of live hog futures prices to the release of the USDA's *Hogs and Pigs Report* are examined.

BACKGROUND AND METHOD

Trading in live hog futures contracts often commences more than a year before their respective delivery dates. At regular intervals during the life of such a contract, information becomes available to the public about the potential supply of slaughter hogs near the delivery date of the contract. This information is contained in the *Hogs and Pigs Report* of the USDA, hereafter denoted *HPR*. The *HPR* is issued near the 20th of March, June, September, and December. Contained in the *HPR* are data on breeding and market inventories (by weight groups) as of the first of these months, the number of sows farrowed in the previous quarter, and producers' farrowing intentions for the next two quarters. Because of space limitations, attention is confined here to the farrowing information.

Consider the supply of slaughter hogs in quarter i + 2. The *HPR* released at the outset of quarter i - 1 contains data on sows that producers intend to farrow in quarter i, SFW^i_{i-1}, and thus provides information on the supply of hogs in quarter i + 2.[1] Additional Information about this supply is provided in the *HPR* released at the outset of quarter i by the data on farrowing intentions for that quarter, SFW^i_i. Data on the number of sows actually farrowed in quarter i, SFW^i_{i+1}, contained in the *HPR* released at the outset of quarter i + 1 provides more information about this supply. Only on rare occasions does $SFW^i_{i-1} = SFW^i_i$, or $SFW^i_i = SFW^i_{i+1}$. Explanations for the variability in the data on SFW^i between quarters i = 1 and i + 1 include differences in the sample, unexpected conception rates, death losses, and other factors.

Now consider a live hog futures contract that matures in quarter i + 2. Let trading in this contract begin prior to the outset of quarter i − 1. Following Leuthold [6], assume that the futures price reflects a consensus of what futures traders expect the cash price to be at

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[1]The superscript for SFW refers to the quarter in which the sows farrow, or are expected to farrow, and the subscript refers to the quarter in which the information is provided to the public by the *HPR*.

maturity; i.e., the futures price is a result of expected supply and demand conditions. The *HPR*'s released at the outset of quarters i − 1, i, and i + 1 provide new information about expected supply in quarter i + 2.

How might the futures market respond to this new information? With respect to grain futures markets, Gorman [3] suggests two possibilities. One is that the private sector anticipates accurately USDA production estimates. That is, the private sector is proficient in evaluating conditions (weather, pests, etc.) affecting crop production between the release dates of the USDA reports, the result being that the USDA reports contain no surprises. In this case, the release of the USDA reports would not be expected to elicit a response from the futures market. The second possibility is that the USDA reports contain surprises; i.e., the private sector has not anticipated their contents. In this case, 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. If an analogy is drawn between crop production reports and *HPR*'s, either of these cases might describe the response of the live hog futures market to the release of the *HPR*'s. A third possibility is suggested by the findings of Leuthold and Hartman [8]. The futures market may not respond to the new information contained in the *HPR*'s because of inefficiencies in that market.

Simple partial adjustment models were used to ascertain the response of live hog futures to the release of *HPR*'s. Such models allow for the possibility that constraints prevent immediate and complete futures price adjustments upon release of *HPR*'s, one possible constraint being exchange-imposed limits on price changes.

The partial adjustment models follow.

(1) $FP_t^{3-4,*} = B_{10} + B_{11}\, CSF_{1,t-1} + E_{1,t}$

and

(2) $FP_t^{6-7*} = B_{20} + B_{21}\, CSF_{2,t-1} + E_{2,t}$

where FP_t^{3-4*} (FP_t^{6-7*}) = the desired percentage price change between days t and t−1 for the futures contract maturing 3−4 (6−7) months later; $CSF_{1,t-1}$ ($CSF_{2,t-1}$) = the new information contained in the *HPR*'s released after the close of trading on day t−1 pertaining to the expected supply of slaughter hogs 3−4 (6−7) months later, specifically, the percentage change between SFW_i^{i-1} and SFW_{i-1}^{i-1} (SFW_i^i and SFW_{i-1}^i); and $E_{1,t}$ ($E_{2,t}$) = an error term. Also,

(3) $FP_t^{3-4} = \gamma_1\,(FP_t^{3-4,*} - FP_{t-1}^{3-4})$

and

(4) $FP_t^{6-7} = \gamma_2\,(FP_t^{6-7,*} - FP_{t-1}^{6-7})$

where FP_t^{3-4} (FP_t^{6-7}), FP_{t-1}^{3-4} (FP_{t-1}^{6-7}) = observed percentage price changes between days t and t−1, and t−1 and t−2, respectively, of the contract maturing 3−4 (6−7) months later; and γ_1 (γ_2) = the coefficient of adjustment, $0 < \gamma_1\ (\gamma_2) \leqslant 1$. Manipulation of equations 1 and 3 and equations 2 and 4 yields

(5) $FP_t^{3-4} = B_{10}\gamma_1 + B_{11}\gamma_1\, CSF_{1,t-1} + (1-\gamma_1)\, FP_{t-1}^{3-4} + E'_{1,t}$

and

(6) $FP_t^{6-7} = B_{20}\,\gamma_2 + B_{21}\gamma_2 CSF_{2,t-1} + (1-\gamma_2)\, Fp_{t-1}^{6-7} + E'_{2,t}$

respectively. Obviously ignored in this formulation is the arrival of new information about other supply and/or demand determining variables which would affect hog prices in the future; presumably this information arrives randomly.

Estimated regression coefficients for equations 5 and 6 would provide evidence of the futures market's response to new information. A significant and negative coefficient for $CSF_{k,t-1}$, k = 1, 2 would indicate that the futures market responds to new information pertinent to future supply, and that the market does not anticipate that new information correctly. If the response to this new information is not completed by day t, a significant and positive coefficient for FP_{t-1}^j, j = 3−4, 6−7 would be expected. If the response is instantaneous, FP_{t-1}^j would be expected to have an insignificant coefficient.

Interpretation of an insignificant coefficient for $CSF_{k,t-1}$ is not as straightforward. This result would be expected if either (1) the futures market anticipates correctly the contents of the *HPR*'s or (2) the futures market does not make use of this information. However, in the first case, a negative relationship would be expected between $CSF_{k,\ t-1}$ and futures price changes prior to the release of the new *HPR*. No relationship would be expected in the second case.

Data, Methods, and Estimation Results

The data used for analysis covered the period from September 1970 through June 1978. Thirty-six *HPR*'s were issued during that period.[2] The partial adjustment models were estimated via ordinary least squares (OLS). OLS

[2]Prior to 1973, the sow farrowing data are for 10 states: Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, Nebraska, Ohio, South Dakota, and Wisconsin. From 1973 on, the data are for the same 10 states plus Georgia, Kentucky, North Carolina, and Texas.

applied to partial adjustment models yields consistent parameter estimates provided that the error terms are not serially correlated. If serial correlation is present, OLS estimates are inconsistent.

It was reasoned that the contemporaneous errors of the models for k = 1 and k = 2 might be correlated. For example, allow some new information about an expected demand shifter to reach the futures market coincidentally with the release of an *HPR*. It is possible that expected demand both 3−4 and 6−7 months later would be affected, and the errors for both partial adjustment models would reflect this "shock." To account for this possibility, the partial adjustment models were also treated as seemingly unrelated regressions (SUR's) and were estimated accordingly. Estimation via SUR methods results in efficiency gains if, in fact, the errors across models are contemporaneously correlated.

The OLS estimation results follow.[3]

$$(7)\quad \hat{FP}_t^{3-4} = \underset{(.49)}{.38} - \underset{(.11)^*}{.37}CSF_{1,t-1} + \underset{(.31)^{**}}{.50}\,FP_{t-1}^{3-4};\ R^2 = .33;\ SEE = 2.91$$

and

$$(8)\quad \hat{FP}_t^{6-7} = \underset{(.56)}{.30} - \underset{(.15)^{**}}{.25}\,CSF_{2,t-1} + \underset{(.34)^*}{.85}\,FP_{t-1}^{6-7};\ R^2 = .22;\ SEE = 3.29.$$

Nonparametric runs tests of the residuals of both equations resulted in the failure to reject, at the 5 percent level, null hypothesis that the residuals were random. None of the estimated coefficients in equations 7 and 9 had anomalous signs, and all were significant below the 10 percent level by one-tailed t-tests. Implied parameter estimates from equations 7 and 9 are summarized in Table 1.

The cross-correlation of the residuals from equations 7 and 8 was 0.84, foretelling possible efficiency gains from SUR estimation. The results of that estimation follow:[4]

$$(9)\quad \tilde{FP}_t^{3-4} = \underset{(.49)}{.47} - \underset{(.07)^*}{.14}CSF_{1,t-1} + \underset{(.23)^{**}}{.36}FP_{t-1}^{3-4}$$

and

$$(10)\quad \tilde{FP}_t^{6-7} = \underset{(.55)}{.33} - \underset{(.10)^{**}}{.13}CSF_{2,t-1} + \underset{(.25)^*}{.62}FP_{t-1}^{6-7}$$

As was the case with equations 7 and 8, no anomalous signs appeared in equations 9 and 10. Though the standard errors of the coefficients in equations 9 and 10 were lower than their counterparts in 7 and 8, there was also a general decrease in the absolute values of the coefficients between equations 7 and 9 and equations 8 and 10. The consequence was that t-ratios were generally lower in 9 and 10 than in 7 and 8, respectively. Implied parameter estimates from equations 9 and 10 are summarized in Table 1.

Similar conclusions about the futures market's response to the *HPR*'s can be drawn from the OLS and SUR estimates in Table 1. First, the significant coefficients for CSF indicate that the futures market is surprised by the *HPR* data on sow farrowings. The positive signs for these coefficients indicate that the futures prices respond in the expected direction to this new information. Next, significant coefficients for the lagged dependent variables indicate that the futures market does not respond instantaneously to the new *HPR* data. The implied estimates of the coefficient of adjustment for futures contracts 3-4 months from delivery range from .50 to .64. Average lags calculated from these estimates range from .56 to 1.00, indicating that one-half or more of the response is completed within one day of the *HPR* release. With respect to the more distant contracts, the implied estimates of the coefficient of adjustment range from .15 to .38. The average lags based on these estimates range from 1.63 to 5.67, the implication being that one-half of the price response occurs in less than a week. Normally, the more distant hog contracts are less actively traded than those nearer maturity. Less liquidity in the

TABLE 1. IMPLIED PARAMETER ESTIMATES, BY ESTIMATION TECHNIQUE

	Implied Parameter Estimates	
	Technique	
	OLS	SUR
Parameter		
γ_1	.50	.64
γ_2	.15	.38
B_{11}	-.74	-.22
B_{21}	-1.67	-.34
Average Lags		
$(1-\gamma_1)/\gamma_1$	1.00	.56
$(1-\gamma_2)/\gamma_2$	5.67	1.63
Lag Distributions' Variances		
$(1-\gamma_1)/\gamma_1^2$	2.00	.88
$(1-\gamma_2)/\gamma_2^2$	37.70	4.29

[3]Standard errors are shown in parentheses. Also, * and ** denote significance at the 5 and 10 percent levels, respectively.

[4]Note that t-tests and related probability statements are only approximate in the case of SUR estimation.

more distant contracts in relation to the nearer contracts may explain the apparently slower adjustment of the more distant contracts to new information.

Although the preceding analysis shows that the futures market has responded to new information contained in *HPR*'s, it does not show that these responses were the most appropriate in the light of other available expected supply and demand information. That is, the futures market may have over- or underreacted to the farrowing information. To address that problem, one could use the general approach in [8] and construct an econometric model based on information available to the public before the release of an *HPR* to forecast hog prices in the future. This model could be used to estimate price flexibilities. Then observed futures price changes after release of *HPR*'s could be compared with price changes implied by the price flexibilities.

Several areas for further research are suggested by the foregoing results. First, the partial adjustment models used here are naïve in that they impose a geometric lag structure. More sophisticated lag functions should be tested for their ability to explain the price response. Next, the futures market's response to other data in the *HPR* could be examined. Nearer term contract prices could be analyzed to ascertain their response to market hog inventory information; more distant contract prices could be examined to determine their response to breeding inventory information.

SUMMARY AND CONCLUSIONS

Previous research [5, 6, 8] has indicated that livestock futures markets may not make full use of information pertinent to future supply and/or demand conditions. This study was undertaken to analyze the response of the hog futures market to the release of new market information about sow farrowings, and thus expected supply conditions, in the USDA's *Hogs and Pigs Report (HPR).*

Changes in sow farrowing numbers between *HPR*'s and lagged futures price changes were used to explain futures price changes after the release of the *HPR*'s within the context of partial adjustment models. Empirical results indicate the hog futures prices do respond to the new sow farrowing information in the *HPR*'s; contracts 3-4 months from delivery make one-half of their response within one day and contracts 6-7 months from delivery make one-half of their response within one week. The question of whether the futures market's responses to this new information have been the most appropriate in the light of other publicly available information awaits further research.

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