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Phil L. Colling and Scott H. Irwin

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THE RATIONALITY OF HOGS AND PIGS INVENTORY EXPECTATIONS

Phil L. Colling and Scott H. Irwin[1]

Prior to 1961, models of expectation formation of economic variables assumed that those expectations were based primarily on past values of the variable in question. The most utilized and well known model was, and perhaps still is, that of adaptive expectations. In 1961, John Muth introduced the rational expectations hypothesis which states that expectations are based on all available, relevant information. However, it was not until the 1970's, with the publication of the seminal papers by Sargent and Wallace, that considerable debate and discussion surrounding the rational expectations hypothesis commenced.

A topic of key importance regards the extent to which expectations of key economic variables, as formed by "experts," are constructed in a manner consistent with the rational expectations hypothesis. First, as has been argued by Shaw, it is possible that expectations of the experts become the expectations of the laymen. In addition, as Muth noted, "the character of dynamic processes is typically very sensitive to the say expectations are influenced by the actual course of events" (p.316). Therefore, knowing how events shape expectations is important. Finally, parameter estimates of econometric models might be biased when those models utilize observed expectations as explanatory variables. This argument is particularly compelling to firm believers of the rational expectations hypothesis. Therefore, it is important to investigate the rationality of survey expectations. And although expectations of financial and macroeconomic variables have been examined to determine their rationality, little research regarding the rationality of expectations of agricultural supply variables has been conducted.

Prior to the quarterly release of USDA Hogs and Pigs report (HPR), commodity news organizations survey brokerage firms, commodity organizations and market analysts regarding their expectations of hogs and pigs inventories. The expectations data typically are made public one or two business days before the HPR is released. The surveyed firms and individuals typically have the capability to devote considerable resources to form their expectations concerning hogs and pigs inventories. In addition, they are thought to be competent in constructing their anticipations.

If the survey expectations do not reflect all available information, then market participants should be cautious in using the mean of survey expectations as their own expectation. In addition, evidence of non-rationality raises questions regarding whether the survey mean is an accurate proxy of the market's expectation. And finally, indications that the survey

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[1]Graduate Research Fellow and Associate Professor, Department of Agricultural Economics and Rural Sociology, Ohio State University. The authors are grateful to Doug Harper and Anthony Dryak for providing the hogs and pigs inventory expectations.

data are not rational brings into question their appropriateness in empirical research.[2]

This paper investigates the rationality of expectations of hogs and pigs inventories subsequently reported in HPRs. The forecasts are obtained by a survey conducted by Futures World News. Results indicate that the expectations are indeed rational in the sense of being unbiased predictors and of incorporating all available, relevant information.

THE RATIONAL EXPECTATIONS HYPOTHESIS

The theory of rational expectations was first introduced by John F. Muth. Under the rational expectations hypothesis, "(1) Information is scarce, and the economic system generally does not waste it. (2) The way expectations are formed depends specifically on the structure of the system describing the economy. (3) A 'public prediction' ,..., will have no substantial effect on the operation of the economic system (unless it is based on inside information)" (Muth, p. 316). Quoting directly from Muth's paper:

> Expectations, since they are informed predictions of future events, are essentially the same as the predictions of the relevant economic theory... expectations of firms (or more generally the subjective probability distribution of outcomes) tend to be distributed for the same information set, about the prediction of the theory (or the 'objective' probability distribution of outcomes (p. 316).

In other words, a rational agent obtains information regarding the probability distribution of outcomes of the variable in question and analyzes that information with respect to the relevant economic theory to generate expectations regarding the variable (Shaw). If the agent uses information efficiently, the agent's expectation will be identical to the mean value of the distribution formed by the applicable economic theory. Therefore, a simple model of rational expectations formation can take the form

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

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[2]Colling and Irwin used pre-release estimates of HPRs to proxy market expectations of breeding and market hog inventories to construct "unanticipated" changes in those inventories. Those changes were then used as explanatory variables in models to determine live-hog futures price changes.

where

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

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

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

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

The rational expectations hypothesis does not maintain that predictions are perfect. This is because available information is incomplete. The hypothesis also does not imply that all agents possess the same expectation. In addition, it is not necessary for agents to know the true model of the economy generating the variable in question. However, it is required that they construct their expectations in the aggregate as if they do know the model.

To test the null hypothesis that expectations are unbiased, a necessary condition for rationality, actual levels or changes of the variable in question are regressed on the expectations under the joint-null hypothesis that the constant equals zero and the slope equals one. From that regressio the error term is examined for general-order autocorrelation under the null hypothesis of no serial correlation. These are often referred to as weak-fo tests of the rational expectations hypothesis. To test that the expectation are strong-form rational, or that they incorporate all available, relevant information, forecast errors are regressed on the relevant information set under the null hypothesis that the coefficient estimates are equal to zero. This test is implied by (2).

PREVIOUS RESEARCH

The rationality of survey expectations of macroeconomic and financial variables has been investigated and debated considerably in the literature. The Livingston survey expectations are the most widely known and researched Since 1946, Joseph A. Livingston, a financial columnist for the Philadelphi Bulletin, has twice-yearly canvassed leading economists regarding their forecasts of levels of fourteen economic variables six and twelve months

beyond mid-year and year-end. Generally, about fifty to sixty economists respond to the survey. The Livingston expectations of levels of the consumer price index have been the most widely researched (Turnovsky; Pesando; Carlson; Mulleneaux; Pearce, 1979; Brown and Maital; Figlewski and Wachtell, 1981; Dietrich and Joines; Figlewski and Wachtell, 1983). Evidence on the rationality of those data is mixed, and the discrepancies in the results stem largely from different assumptions about the timing of the data, the appropriate use of the data, and from different statistical tests. The rationality of the Livingston expectations of levels of the Standard and Poor stock price index have also been widely investigated (Lakonishok; Brown and Maital; Pearce, 1984; Dokko and Edelstein). Again, the conclusions regarding the rationality of these data are mixed, but in general these data seem to be more rational than expectations of the consumer price index. Brown and Maital investigated the rationality of various Livingston series. While some of the series showed some evidence of rationality, the authors concluded that the Livingston data generally were not rational.

Since September 1977, Money Market Services has surveyed economists regarding their expectations of various economic variables. These surveys are conducted weekly and monthly, depending on the variable in question, and the expectations are of a duration much shorter than those of the Livingston expectations (generally, a week or less). The rationality of those expectations has been researched extensively (Grossmam; Hafer; Pearce and Roley; Pearce, 1987; Simon). In general, the results of those works support the notion of rationality, at least in the sense of being unbiased predictors of the variables.

Friedman investigated the rationality of six survey expectations series of the Goldsmith-Nagan Bond and Money-Market Letter, a bi-weekly publication circulated among professional financial market participants. Since September 1969, the letter has conducted a quarterly survey of the interest rate expectations of a panel of roughly fifty of its subscribers. The study provided mixed results with respect to the rationality of the data. Results varied across the interest rates, forecast horizons, and tests used to evaluate the data.

Lovell reviewed several studies of the rationality of survey expectations. Those studies utilized expectations for several different variables, with some of the expectations variables not being of economic nature.[3] Across those studies, results regarding the rationality of expectations was mixed. However, Lovell concluded that in general the survey data do not reflect rationality, and he therefore concluded that forecasters in general do not form expectations rationally.

Colling and Irwin examined some aspects of the rationality of pre-release estimates of Hogs and Pigs reports. Results indicated that the means of the data were, on average, unbiased predictors of breeding and market hog inventories and the forecast errors were not found to be first-order autocorrelated. In addition, forecast errors were not explainable by lagged values of HPR information. And finally, the means of the survey data were

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[3]For example, Lovell reviewed a study in which EPA gasoline mileage estimates were examined to determine their rationality.

better predictors, in the root mean-square error sense, of HPR information than forecasts constructed from time-series forecasting models. While these characteristics of the survey data are necessary for rationality of expectations, they are not sufficient. This is because rational expectations are based upon all available relevant information. Therefore, forecast errors must be uncorrelated with the entire relevant information set available to the forecaster at the time the forecast is made. In addition, forecast errors must be n-th order uncorrelated. This issue was also not addressed by Colling and Irwin.

DATA AND PROCEDURES

Data

In this study, market analysts' expectations of changes in breeding and market hog inventories from year-ago levels are utilized. These data are collected in a survey by Futures World News. Specifically, about fifteen analysts are surveyed regarding their anticipations of changes in hog inventories. Survey results are released after the close of trade of the live-hog futures contract and two days before the USDA Hogs and Pigs report is announced. Subsequent actual changes in breeding and market hog inventories from year-ago levels are published in the quarterly HPR. The sample runs from the September 1981 HPR to the September 1989 HPR, providing thirty-three observations.

The relevant information set known to forecasters at the times in which they made their forecasts could include any number of economic variables. However, because of limitations in the sample size, only those thought to be most relevant to the determination of hog inventories are utilized. These include lagged values of sows farrowing, the hog-corn ratio, cattle slaughter, eggs hatched for broilers, and disposable income. These data are from various USDA inventory reports and business condition reports.

Procedures and Results

To determine if forecast errors are n-th order uncorrelated, and to determine if means of the survey data are unbiased predictors of hogs and pigs inventories, the following equations are first estimated:[4]

$$(3) \quad BRD_t^a = \beta_0 + \beta_1 BRD_t^e + \mu_t \text{ and}$$

$$(4) \quad MKT_t^a = \beta_0 + \beta_1 MKT_t^e + \mu_t$$

[4]These are the same equations estimated in most studies of the rationality of survey data. They are also the same equations estimated by Colling and Irwin. However, the current study uses five more observations than that of Colling and Irwin and tests for higher order autocorrelation.

where BRD denotes changes in breeding hog inventories from the year-ago level, MKT denotes changes in market hog inventories from the year-ago level, a superscript e denotes expected information, a superscript a denotes actual information, and a subscript t denotes the HPR release date. A paired F-test is performed to test the null hypothesis of unbiasedness (H_0: $\beta_0 = 0$, $\beta_1 = 1$) for both breeding and market hogs. Individual t-statistics for the same hypotheses are also performed. The null hypothesis of unbiasedness is not rejected for equations (3) and (4) (Table 1). In addition, the Durbin-Watson statistics do not indicate the presence of first-order serial correlation of the error terms (forecast errors). These results are consistent with those of Colling and Irwin. The Von Neuman ratios and the residual correlograms do not indicate the presence of general order autocorrelation. And since rationality of expectations requires independence of all forecast errors, these results further strengthen the evidence of the rationality of the pre-release estimates of HPRs beyond that found by Colling and Irwin.

For expectations to be fully rational, forecasts errors should be orthogonal to relevant information known to the forecasters at the time the forecasts are made. Therefore, forecast errors of breeding and market hogs are regressed on the relevant information set (as previously mentioned) with lags which are thought to be most appropriate to the prediction of hogs and pigs supplies and which is known to the forecasters at the times which they made their forecasts. The estimated models are:

$$(5)\quad BRDERROR_t = \beta_0 + \beta_1 SF_{t-1} + \beta_2 HC_{t-1} + \beta_3 CSLT_{t-1} + \beta_4 HATCH_{t-1} + \beta_5 LNY_{t-1} + \mu_t \text{ and}$$

$$(6)\quad MKTERROR_t = \beta_0 + \beta_1 SF_{t-1} + \beta_2 HC_{t-2} + \beta_3 CSLT_{t-2} + \beta_4 HATCH_{t-2} + \beta_5 LNY_{t-2} + \mu_t$$

where BRDERROR = forecast error in the breeding herd, MKTERROR = forecast error in the market herd, SF = sows farrowing, HC = the hog-corn ratio, CSLT = the commercial cattle slaughter in millions of pounds, HATCH = eggs hatched for broilers (billion eggs), and LNY = logarithm of total disposable income (billion dollars). The subscripts refer to quarterly lags. The lagged information is known to the forecasters at the time they made their forecasts. Under the null hypothesis that the forecast errors are orthogonal to relevant information, the estimated coefficients should not be different from zero, both jointly and individually.

The null hypothesis of orthogonality of forecast errors to relevant and known information was also not rejected (Table 2). This was true for both equations (5) and (6) and for both joint and individual hypothesis tests. And although the equations did not incorporate all available information that the forecasters might have used (this is impossible due to a lack of degrees of freedom), the results indicate that the survey data are strong-form rational, or that they efficiently incorporate that information which was investigated.

SUMMARY AND CONCLUSIONS

For expectations to be rational in the sense of Muth, they must fully incorporate all relevant information known to the forecasters at the time they made their forecasts. Survey expectations have been investigated for their rationality quite often with often mixed results. The current study investigates the rationality of pre-release estimates of USDA Hogs and Pigs reports to a stronger degree than that done by Colling and Irwin.

Non-rationality of survey expectations casts doubt on the rational expectations hypothesis. In addition, for firm believers in that hypothesis, it casts doubt on the assumption that the survey data reflect market expectations. In the macroeconomic and financial literature, these results are quite mixed and the debate on the issue is considerable.

While the Colling and Irwin study indicated that the survey data were rational in a weak-form sense, the current investigation shows that the data are in fact rational in a full- or strong-form sense. That is, they efficiently incorporate all available information known to the forecasters at the time they made their predictions. This strengthens the notion that forecasters in that market are indeed rational in forming their expectations.

Table 1. Tests for Unbiasedness of the Survey Data and Autocorrelation of the Forecast Errors

Report Figure of:	Coefficient Estimates		Summary Statistics[a]			H_0: $\beta_0 = 0$, $\beta_1 = 1$
	β_0	β_1	Adj R^2	D.W.	V.N.	F(2,31)
Breeding Hogs	.619 (0.073)	.987 (0.146)	.80	1.89	1.95	0.665
Market Hogs	7.326 (1.487)	.930 (1.395)	.92	2.08	2.14	1.982

Note: t-statistics appear in parentheses below the estimated coefficients for the null hypotheses $\beta_0 = 0$ and $\beta_1 = 1$.
[a]Adj R^2 = adjusted R^2; D-W = Durbin-Watson d; V.N. = Von Neuman ratio.

Table 2. Regression Coefficients for the Orthogonality of Forecast Errors to Relevant Information

Forecast Error of:	Coefficient Estimates						Adjusted R^2	H_0: β_i i = 1,...,5 F(5,(26,27))[a]
	β_0	β_1	β_2	β_3	β_4	β_5		
Breeding Hogs	-13.30 (0.17)	-0.01 (0.45)	-0.05 (0.58)	-0.21 (0.10)	3.52 (0.21)	1.86 (0.14)	-0.10	0.416
Market Hogs	-25.97 (0.57)	-0.01 (0.24)	0.01 (0.34)	0.75 (0.56)	-6.02 (0.60)	3.46 (0.45)	-0.10	0.474

Note: t-statistics appear in parentheses below the estimated coefficients for the null hypotheses $\beta_i = 0$, i = 0,...,5.

[a]There are twenty-five and twenty-six denominator degrees of freedom for the market and breeding hog models, respectively.

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