Supply Response and Price Expectations:

An Analysis of the Fed-Beef Industry

by

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Beef cattle feeding represents the largest revenue producing industry in the U.S. livestock sector, with receipts totaling approximately $36.5 billion in 1988. Of all livestock industries, beef has probably been the most often analyzed as researchers have had varying objectives which have led to differing model specifications, methodologies, data sets, observation units, choices of variables, and foci of research attention to the market level. This analysis represents still a slightly different focus of the beef industry.

Because of the biological lags between the decision to produce and the subsequent delivery of livestock (particularly beef and pork) to slaughter, virtually without exception researchers investigating animal production have used some form of lagged price structure to reflect the price expectations formulation in supply response equations. The early works of Ezekiel and of Waugh formulated the "cobweb" model as a way to represent the manner in which producers respond to prices in past periods whereas consumers react to current prices in their purchasing decisions. The length of the cycle associated with these "cobweb" models depends in large part on the lag associated with the biological process of producing the animals. The decision to produce animals for later delivery to slaughter has been represented by lags in prices of varying length to represent expectations of future revenues.

The objectives of this paper include to:

1. develop a working model of the fed steer and heifer sector of the U.S. beef industry incorporating alternative price expectation formulations,

2. apply alternative goodness of fit and out of sample forecasts tests to these formulations to evaluate performance and test the expectations hypotheses,

3. draw conclusions regarding price expectations formulations in the fed beef industry.

The paper is organized to include a discussion of the theoretical and methodological considerations in formulating the structural model, followed by a more detailed discussion of the expectations formulation. Estimations provide an empirical basis for comparing the alternative expectation formulations. A few conclusions close the analysis.

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Model Specifications

A complete model of the beef feeding industry would require more equations and variables than would be allowable given the number of observations available and the estimation procedures to be used in the analysis. For example, the beef component of a USDA livestock model (Stillman) involves eleven behavioral equations plus numerous other identities and technical relationships. The current FAPRI model includes sixteen behavioral equations and eleven identities. As a result, this analysis investigates the behavior of only one component of the vertical beef market, the feedlot sector. Thus, while we recognize at the outset that several decisions are made at the cow-calf component and beyond the meat packing component that affect feedlot operations, this analysis focuses attention only on the decisions of the feedlot. Even with this reduced model size, several additional simplifying assumptions (to be discussed) are required to keep the model tractable.

Specification begins with feeder cattle to be placed on feed by the feedlot operator as a response to the profitability incentives in the industry. Because of the biological lag associated with even this simple action, two equations are required for first and second half calendar year placements in order to reasonably predict production for a particular calendar year. Cattle slaughter and ultimately beef production follow from the initial decision to place animals on feed. The derived demand for beef (by the packer) includes components from the retail level of the market channel.

The structural model of the fed-beef industry is characterized in this analysis by five behavioral equations and an identity.

1. $CATPL132_t = a_o + a_1PROF^*_t + a_2CATPL132_{t-1} + U_{1t}$

2. $CATPL134_t = b_o + b_1PROF^*_t + b_2CATPL134_{t-1} + U_{2t}$

3. $SAHSLT_t = c_o + c_1CATPL132_t + c_2CATPL134_{t-1} + U_{3t}$

4. $BEEFSUP_t = d_o + d_1TOTSLT_t + d_2Y^*_tTOTSLT_t + d_3RET_t + U_{4t}$

5. $BEEFCON_t = e_o + e_1DOMAHA_t + e_2DPORK_t + e_3DBRLR_t + e_4DINC_t + e_5Z_t + U_{5t}$

6. $BEEFSUP_t = BEEFCON_t$

where $CATPL13x_t$ is cattle placed on feed in thirteen states during the first and second calendar quarters ($x = 2$) and third and fourth calendar quarters ($x = 4$); $PROF^*_t$ is expected deflated profit per hundredweight for feedlot operations measured as 10.5 multiplied by $OMAHA_t$ (price of 900-1100 pound choice steers at the Omaha terminal market) minus 6.5 multiplied by $KC600_t$ (feeder cattle price per hundredweight) minus 56 multiplied by $CORNP_{t-1}$ (lagged corn price per bushel) minus 270/2000 multiplied by $SOY44_{t-1}$ (lagged soybean meal price per ton) and all price variables are deflated by the producer price index, WHE_t; $SAHSLT_t$ is U.S. fed paid for choice steers. As such, it would not include factors affecting the behavior of the packing industry on the farm-retail margin. While substantial seasonal influences are known to affect margins throughout the calendar year, the average year to year variation in these margins is expected to be small. A trend variable, Z_t, was included to capture other exogenous factors affecting the demand for beef. In one sense, this could be interpreted as a reflection of any demand shifts which may have been occurring over time. Substantial discussion of meat demand structure is already available in the literature (see Buse and especially Chavas for a review).

An identity equating production with consumption closes the model. A more realistic representation would include beginning and ending stocks, military consumption, and import and export levels. However, these have not varied substantially over time (imports have increased in the past fifteen years). They could be treated as endogenous variables to the model but would adversely affect the available degrees of freedom for estimation (discussed in the next section).

Expectations Formulation

Two alternative expectations hypotheses are investigated in this analysis. As shown in equations (1) and (2), these expectations occur in the cattle placements equations. Producers purchase 600-700 pound feeder animals to be placed on an intensive feeding program in order to generate a 400-500 pound weight gain as efficiently as possible. At the time of the decision to feed animals, however, the output price to be received at the time of product delivery (slaughter) is unknown. As such, producers must use an expectation of the output price.

The most commonly used variable in previous research to explain price expectations has been some form of past price distribution. These range from naive (Ezekiel, Waugh) to adaptive expectations (Nerlove 1958). Numerous examples are available in the literature (summarized by Askari and Cummings up to 1976). Much of the available livestock modeling to date has utilized past prices to represent future expectations (e.g., Martin and Zwart, Breimyer, Dean and Heady, Heien). Nerlove (1979, p. 877) has noted with respect to livestock models that "various combinations of current and lagged prices are used but rarely has much specific attention been devoted to the problems of expectations formation."

An alternative to the distributed lag price formation as representative of future expectations is the rational expectations model introduced by Muth. The rational expectations hypothesis (REH) asserts that economic information available from the structure of an industry is not wasted in forming price expectations, that is, price expectations are essentially the same as the predictions of the relevant economic theory. Although this concept was introduced in 1961, empirical applications of rational expectations in agriculture have been rather limited; analyses by Huntzinger, Goodwin and Sheffrin, and Shonkwiler and Emerson are rare exceptions.

Rational expectations is based on the assumption that industry participants have thorough knowledge of the structural nature of their industry, that is, that steer and heifer slaughter; $CATNFSLT_t$ is U.S. nonfed cattle slaughter (includes nonfed steers and heifers, cows, bulls, and stags, beef and dairy); $TOTSLT_t$ is total U.S. cattle slaughtered measured by $SAHSLT_t$ plus $CATNFSLT_t$; $BEEFSUP_t$ is domestic beef production (carcass weight); $Y*_t TOTSLT_t$ is a trend on total slaughter to account for the increased efficiency of different cattle breeds (Y_t is a trend variable, 1961=1, 1962=2, ...); RET_t is measured as 10.5 multiplied by $OMAHA_t$ minus 56 multiplied by $CORNP_{t-1}$ minus 270/2000 multiplied by $SOY44_{t-1}$; $BEEFCON_t$ is per capita beef civilian consumption in the U.S.; $DPORK_t$ is the deflated retail price of pork; $DBRLR_t$ is the deflated retail price of broilers, $DINC_t$ is deflated per capita income, and Z_t is other exogenous factors (represented as a trend variable, 1977=1, 1978=2, ...) designed to capture shifts in beef consumption over time.

Producers place cattle on feed ($CATPL132_t$ and $CATPL134_{t-1}$)[1] based on an expected but uncertain profit (measured in this analysis as gross returns less costs of the feeder animal, corn, and soybean meal). In addition, the feedlot operator has some ability to adjust placements from one period to the next but that dramatic changes may be costly as a result of substantial fixed obligations. As such, a partial adjustment approach (Nerlove 1958) is incorporated through the inclusion of the lagged dependent variable.

The fed steer and heifer slaughter ($SAHSLT_t$) equation directly results from the weight gain associated with the animals placed on feed during the first six months of the current calendar year and the latter six months of the previous calendar year. Unusually high or low slaughter levels in particular years may be explained through additional dummy variables.

The beef production ($BEEFSUP_t$) equation results from converting slaughter animals to carcass weight. In addition to fed animals, the equation must account for nonfed animals. While nonfed slaughter and production would very likely be endogenous variables in a more comprehensive model of the beef cattle industry, attention here is restricted to the feedlot operation. Thus, nonfed slaughter of beef and dairy is considered exogenous to this model. A trend variable with total slaughter reflects the changes that have occurred in the beef cattle industry over time. Slaughter carcass weights have increased with the shift to the larger, "exotic", breeds. A returns (RET_t) variable, measured as gross returns minus corn and soybean meal costs, is included to examine the short run decision by the feedlot operator to feed to heavier or lighter weights based upon current output and input prices. Because of the relatively long unit length of observation (annual), this variable may or may not reflect this decision process very well.

Beef consumption ($BEEFCON_t$) largely reflects a retail demand for beef. Deflated retail prices for pork and chicken and per capita income are included as exogenous regressors. Beef price, however, is reflected through the farm level price

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[1]Cattle placements for the second half of the calendar year are lagged in order to predict production for the current year. Thus the endogenous variable is lagged placements.

they understands supply and demand interactions at all relevant levels of the market channel and any dynamic feedback processes operating within the system. Shonkwiler and Emerson's example of the Florida winter tomato industry reflects in their own words (p. 636) "a small geographic area, which implies that producers face similar economic and climatic environments. The highly commercial and concentrated nature of the Florida tomato industry may produce a situation more conducive to the use of rational expectations by producers." The authors (p. 636) also noted that growers are familiar with Mexican imports and regulatory provisions and that "information collection and dissemination services of the Florida Tomato Committee provide growers with historical information and likely trends, which growers may take into account when making production decisions." In both the Huntzinger and the Goodwin and Sheffrin analyses, the U.S. broiler industry was investigated. This industry has become substantially more concentrated over time in terms of production location and number of participants. The fed beef industry in the United States is much more diverse in terms of geographic location and much more complex in terms of the vertical market channel than the previously cited examples. To assume that producers possess an extensive knowledge of the structural workings of the beef industry may be irrational on the part of the authors. In any case, a test of the REH will be conducted in the empirical section to follow.

The REH assumes that the decision maker can incorporate all of the information from the structural model available at the time the expectation is formed into the price expectations variable. Wallis has shown that the expected price can be expressed as a function of the structural parameters of the model and the forecasts of the exogenous variables. That suggests that equations (1) - (6) can be solved to obtain the reduced form of the 900-1100 pound choice steer price (OMAHA):

7. $$OMAHA^*_t = f(KC600_t, CORNP_t, SOY44_t, DPORK^*_t, DBRLR^*_t, DINC^*_t, Z_t, CATNFSLT^*_t, CATPL132_{t-1}, CATPL134_{t-2}, WHE^*_t)$$

where asterisks on the right hand side variables indicate expectations of the exogenous variables. Equation (7) represents a simplified version of the actual reduced form equation used in this analysis. When deflators, population, components of the nonfed slaughter variable, and other factors are taken into account, the reduced form includes 26 structural parameters.

It is assumed that the price of inputs (corn, soybean meal, and feeder animals) is known with certainty at the time of animals are placed in the feedlot. The other exogenous variables are unknown and thus must be forecast (Wallis). Huntzinger and Nerlove (1977) recommend using time series models to specify the stochastic processes governing the exogenous variables. However, the relative low number of observations used in this analysis prohibits the use of Box-Jenkins type processes. We use the simple procedure used by Shonkwiler and Emerson to forecast the values of all the expected exogenous variables except for $CATKSNF^*_t$ (a more complete representation was included to forecast $CATKSNF^*_t$ in which structural information believed to influence the variable was included in the estimation):

$$Y_{it} = g_{io} + g_{i1}Y_{it-1} + v_{it}.$$

Alternatives to the rational expectations formulation are a naive or an adaptive price expectations process. In both cases, a lagged price is substituted for the expected price in the cattle placement equations. Adaptive expectations carries with it the lagged dependent variable. Since the lagged cattle placement variables are already included to represent production adjustment from year to year, the adaptive expectations hypothesis cannot be easily tested.

Estimation

The estimation process first required that the exogenous variables be forecast. The time period used in the analysis was from 1961 to 1985. Three observations, 1986-88, were saved for out of sample forecast testing. As might be expected, the explanatory power of lagged observations to predict current observations was very high for most variables, with R^2s of .947 (retail pork price), .999 (income), .990 (deflator), .999 (population), .877 (retail broiler price), .878 (cow slaughter), and .825 (steer and heifer nonfed slaughter). The predictions get substituted into the price expectations equation (7). Substituting equation (7) into equations (1) and (2) (for the expected price in the profit variable) results in a six equation system of equations.

The system of equations under the rational expectations hypothesis is highly nonlinear in the parameters. Additionally, parameter restrictions exist across equations. Shonkwiler and Emerson and Goodwin and Sheffrin use a full information maximum likelihood estimator because of the cross equation restrictions. Huntzinger suggests a two-stage instrumental variables procedure can be used to obtain consistent estimators. Intriligator (p. 412) recommends the full information or system estimator because, in addition to the estimators being consistent, they are asymptotically efficient. That is, information contained in the error terms of the equations can be incorporated into the parameter estimates. However, a shortcoming of the system estimator, particularly appropriate to this analysis, is the degrees of freedom issue. The relatively small sample size severely restricts the use of three stage least squares or full information maximum likelihood estimation. Because of these small sample concerns and the nonlinearity of the model, a nonlinear two stage least squares procedure was used to estimate the parameters under REH. Under the naive price expectations hypothesis, equations (1), (2), and (3) form a recursive set of equations. Equations (4), (5), and (6) are simultaneously estimated using two stage least squares.

The estimation of the REH model was extremely complex and laborious even though only nonlinear inteactive two stage least squares estimation was used. Three stage least squares estimation was attempted in some of the preliminary investigations. However, even with high speed computers, computer estimation time was substantially longer with little, if any, noticeable improvement in the results. Some concern was raised with respect to the possibility of equation misspecification. Full system estimators are very sensitive to both specification error and measurement error and require larger sample size than the limited information (e.g., 2SLS) estimators. Adding more observations to the early years of the sample may reduce much of this latter concern, however, some of the variables may have to be "manufactured" since USDA does not report cattle placements in the early 1950s.

The results of these two models are given in Table 1. In three of the equations dummy variables were introduced in the naive model to address problems of outliers and other one time intercept shifters. A first order autoregressive parameter was fit for the equation $SAHSLT_t$ since the Durbin-Watson from preliminary OLS estimation detected first order correlation. In order to minimize the difference in the two systems, these same dummy and autoregressive variables were added to the rational expectations model.

Table 1 reveals several similarities between the two approaches as one would expect. In almost all cases, the coefficients are of the same sign. Many of the coefficients are of similar magnitude, but a few are different enough to deserve further discussion.

First, the expected profit coefficients in the placement equations are substantially different between the two models. In both equations the REH coefficients are more significant asymptotically than the naive coefficients. The naive coefficient (.939) in the second half (calendar year) placements equation is not significantly different from zero suggesting that feedlot producers do not look at last year's price as a good forecast of expected price in the year ahead. However, the REH coefficient for the expected profitability variable is highly significant and indicates that producers do use more information than past prices to formulate expectations of profit.

Also in the placement equations, the adjustment coefficient associated with lagged placements are similar between the two models for first half placements. However, the second half adjustment coefficient is different for the two models with the naive coefficient being closer to one, indicating that feedlot operators make very little adjustment from year to year in placements. Whereas, in the REH model,adjustment from year to year is greater.

The slaughter equations indicate that all of the animals placed on feed during the first six months of a year are delivered to slaughter during the calendar year. Upon first inspection, the coefficient being greater than one might look suspect, but the coefficient should be greater than one since the equation is regressing a U.S. fed slaughter number on a thirteen state placement number. About 57 percent of those animals placed in the previous last half of a calendar year get slaughtered in the subsequent year.

The coefficient associated with total slaughter (fed steer and heifer and the nonfed cattle variables) in the production equations should reflect the yield of these slaughter animals in terms of carcass weight per head. Both of the models show about 518 pounds per head to which a trend was added which increases the pounds per head by about four pounds per year. This trend was included to capture among other things the development of more efficient breeds of cattle over time which allows feedlot operators to feed to heavier weights. A returns variable was added to the production equations since one might expect that as profitability from feeding cattle to a heavier weight increases, either because of a higher output (OMAHA steer) price or a lower input (CORN) price (or both), production should also rise. However, previous researchers have shown that profits may lead to reduced production in the short run due to producers' expectations of higher longer run profits (Reutlinger, Nelson and Spreen). This coefficient was highly significant in both models.

The demand equations gave similar results. The negative sign (implying complementarity) associated with retail broiler prices in both equations was unexpected, however, Wohlgenant reports similar results and offers some reasoning for this situation. The coefficient on the trend variable (1977=1, 1978=2, ...) is negative in both models and statistically significant. It suggests a substantial decline in the demand for beef since 1977. (Other years to begin the sequence were investigated but 1977 appeared to fit the data better.)

Table 2 provides further comparison of the performances of the two expectation approaches to explain feedlot behavior. The R^2s and Durbin-Watson statistics provide some measure of the ability of the explanatory variables to predict the endogenous variables in each equation and some measure of the degree of autocorrelation in the errors terms in each equation. (The reader must keep in mind that both placement equations involved lagged dependent variables and because of the simultaneous estimation procedure used, these terms are only an approximation of performance.)

In only two of the five equations did the REH model perform better than the naive model and even in those equations the differences were slight. Second half cattle placements displays the largest difference between approaches as measured by the R^2 statistic. After correcting the fed slaughter equations for autocorrelation, there appear to be no other potential autocorrelation problems.

Within sample root mean squared errors reveal only marginal differences between the two models. The REH model outperforms the naive model in all equations but the differences are rather small.

Out of sample (1986-88) forecasting performance shows that the REH shows a marginal improvement in all of the equations except for the consumption equation, but again only minor differences occur between the two models.

Implications

One point is clear from the analysis. Empirical testing of the rational expectations hypothesis is very labor intensive, and time consuming, and places tremendous demands on the computer. Even with the model as small as five behavioral equations and one identity, the computer program (SAS) had considerable difficulty in both estimating and simulating (for out of sample forecasting) the results.

The results suggest marginal but significant differences between the rational expectations approach and the naive approach with respect to price expectations in the producer supply response equations. The coefficients associated with the REH appear to fit the data better than those of the naive model. Thus, the analysis suggests that feedlot operators are rational in their use of available economic information in planning production.

A cautionary comment is necessary. An insufficient number of observations do not allow the model to completely test the rational expectations hypothesis through a more appropriate complete system estimator (FIML or 3SLS). Thus, one cannot say conclusively that all information (e.g., error term structure) was included in the estimation procedure. Further effort on this is necessary.

Further research would include an evaluation of the REH approach on the cow-calf stage of the beef industry. This segment is even more disaggregated and dispersed than the feedlot sector. Thus one may not be surprised to find that producers of calves are less aware of and therefore unable to incorporate all available current information in their planning process.

TABLE 1 ESTIMATES OF STRUCTURAL PARAMETERS OF THE FED BEEF INDUSTRY

Equation	Parameter	Variable	REH Model		Naive Model	
Cattle Placements (January-June)	a_o		.519		.928	
	a_1	$PROF^*_t$	1.328	(.890)[a]	.455	(.609)
	a_2	$CATPL132_{t-1}$	.938	(.084)	.923	(.066)
	a_3	DUM74[b]	-1.560	(.912)	-1.477	(.746)
	a_4	DUM78	1.452	(.872)	1.522	(.760)
	a_5	DUM80	-1.157	(.873)	-1.244	(.731)
Cattle Placements (July-December)	b_o		.761		.657	
	b_1	$PROF^*_t$	1.990	(.913)	.939	(.706)
	b_2	$CATPL134_{t-1}$	.884	(.102)	.951	(.099)
	b_3	DUM76	2.540	(1.110)	2.210	(.930)
Fed Steer and Heifer Slaughter	c_o		7.767		7.621	
	c_1	$CATPL132_t$	1.008	(.165)	1.069	(.181)
	c_2	$CATPL134_{t-1}$	.572	(.148)	.538	(.161)
	c_3	DUM69	.793	(.494)	.824	(.541)
	c_4	DUM75	-1.607	(.518)	-1.708	(.563)
	c_5	AR(1)[c]	.795	(.147)	.797	(.155)
Beef Production	d_o		.190		-.075	
	d_1	$SAHSLT_t$	.518	(.027)	.517	(.030)
	d_2	Y_t (1961=1) * $SAHSLT_t$	.004	(.0004)	.004	(.0004)
	d_3	RET_t	.776	(.251)	.893	(.284)
Beef Consumption	e_o		74.629		73.140	
	e_1	$DOMAHA_t$	-165.350	(14.801)	-164.100	(17.53)
	e_2	$DPORK_t$	3039.470	(790.450)	3193.850	(906.1)
	e_3	$DBRLR_t$	-34.928	(12.497)	-33.640	(14.1)
	e_4	$DINC_t$	2860.290	(222.010)	2845.730	(248.4)
	e_5	Z_t (1977=1)	-4.030	(.303)	-3.979	(.342)

[a]Estimated asymptotic standard errors are in parentheses.

[b]DUMXX implies a dummy variable for calendar year 19XX.

[c]First order autoregressive parameter from GLS estimation.

TABLE 2. GOODNESS OF FIT EVALUATION FROM ALTERNATIVE EXPECTATION HYPOTHESES

	In Sample						Out of Sample	
	R^2		D.W.		Root Mean Squared Error		Root Mean Squared Error	
	REH	N	REH	N	REH	N	REH	N
					percentage			
Cattle Placements January-June	.94	.93	2.54	2.33	5.72	6.60	6.01	6.27
Cattle Placements July-December	.90	.86	1.83	1.83	5.71	7.18	4.41	6.66
Fed Slaughter	.97	.98	1.94	1.96	4.30	5.70	1.60	1.90
Beef Production	.98	.98	2.24	2.36	2.71	3.13	.37	.42
Choice Steer Price[a]	.98	.98	2.23	2.27	8.06	9.19	16.26	15.54

[a]R^2 and Durbin-Watson (D.W.) came from the quantity dependent consumption equation.

References

Askari, H., and J.T. Cummings, Agricultural Supply Response: A Survey of the Econometric Evidence, New York: Praeger Publishers, 1976.

Breimyer, Harold F. "Emerging Phenomenon: A Cycle in Hogs." J. Farm Econ. 41(1959): 760-8.

Buse, Rueben C. (editor), The Economics of Meat Demand, Department of Agricultural Economics, University of Wisconsin, 375 pp., 1989.

Chavas, Jean Paul. "On the Structure of Demand for Meat." In The Economics of Meat Demand (Rueben C. Buse, editor), pp. 125-38, Department of Agricultural Economics, University of Wisconsin, 1989.

Dean, Gerald W. and Earl O. Heady. "Changes in Supply Response and Elasticity for Hogs." J. Farm Econ. 61(1959): 845-60.

Goodwin, Thomas H. and Steven M. Sheffrin. "Testing the Rational Expectations Hypothesis in an Agricultural Market." Rev. Econ. Stat. 64(1982): 658-67.

Heien, Dale. "An Econometric Model of the U.S. Pork Economy." Rev. Econ. Stat. 57(1975): 370-75.

Huntzinger, R. LaVar. "Market Analysis with Rational Expectations." J. Econometrics 10(1979): 127-45.

Martin, Larry and Anthony C. Zwart. "A Spatial and Temporal Model of the North American Pork Sector for the Evaluation of Policy Alternatives." Amer. J. Agr. Econ. 57(1975): 55-66.

Muth, John F. "Rational Expectations and the Theory of Price Movements." Econometrica 29(1961): 315-35.

Nelson, Glenn and Thomas Spreen. "Monthly Steer and Heifer Supply." Amer. J. Agr. Econ. 60(1978): 117-25.

Nerlove, Marc. The Dynamics of Supply: Estimation of Farmers' Response to Price. John Hopkins Press, 1958.

Nerlove, Marc. "The Dynamics of Supply: Retrospect and Prospect." Amer. J. Agr. Econ. 61(1979): 874-88.

Reutlinger, Shlomo. "Short Run Beef Supply Response." Amer. J. Agr. Econ. 48(1966): 909-19.

Shonkwiler, J. Scott and Robert D. Emerson. "Imports and the Supply of Winter Tomatoes: An Application of Rational Expectations." Amer. J. Agr. Econ.

64(1982): 634-41.

illman, Richard P. "A Quarterly Model of the Livestock Industry." USDA-ERS, Tech. Bul. #1711, Washington, DC, 1985.

allis, Kenneth F. "Econometric Implications of the Rational Expectations Hypothesis." Econometrica 48(1980): 49-74.

ohlgenant, Michael K. "Effects of the Changing Composition of Beef Consumption on the Elasticities for Beef and Poultry." In The Economics of Meat Demand (Rueben C. Buse, editor), pp. 179-86, Department of Agricultural Economics, University of Wisconsin, 1989.

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