To the Graduate Council:

I am submitting herewith a thesis written by David Donald Asbridge entitled "A Regression Model for Predicting Broiler Prices." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

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A REGRESSION MODEL FOR PREDICTING BROILER PRICES

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee

David Donald Asbridge

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ABSTRACT

The primary purpose of this study was to develop and test a prediction equation for broiler prices eleven weeks in the future using currently known weekly data.

The method used to develop this model was to use multiple regression in a modified demand equation for broilers. The modifications were necessary because the values of all explanatory variables had to be known 11 weeks prior to the price being predicted (the dependent variable). Eleven weeks were used since there is usually an eleven week period between egg set and marketing the product.

Several modifications of the equation were tried with the following model being chosen as the one to be used for prediction:

PBR = 82.364 + .289 Y - 275.77 1/FH -1.246 EST - .107 CST + WD + HD

Where:

PBR = price of broilers in cents per pound

Y = average weekly income in dollars for blue-collar workers in the U. S.

FH = futures price of hogs, 11 weeks forward, in cents per pound

EST = egg set in millions of eggs weekly

CST = cold storage in millions of pounds of frozen broiler meat

WD = weekly dummy variables with week 52 left out to prevent a singular matrix

HD = holiday dummy variables with non-holiday periods left out to prevent a singular matrix

The predictions of this model were not acceptable as compared to the futures market estimates for broilers, therefore, the most current known residual, or difference between actual and predicted

prices, was added to the predictions. However, since these predictions still had wild fluctuations, the two-week, three-week, and four-week moving averages were taken in order to smooth out the peaks and troughs. These predictions along with the futures market estimates were then compared to the actual cash prices for 1974. The results of these comparisons were that the model's predictions and the futures market estimates were not significantly different from each other but that all of the estimates were significantly different from the actual broiler prices for the same time period.

The one central conclusion of this study is that if broiler producers wish to have a reasonable estimate of a price to expect for their product, there is no known vehicle to arrive at expected broiler price more accurate than the report in the newspaper of futures market prices 11 weeks hence.

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CHAPTER I

INTRODUCTION

Prior to World War II, poultry meat production was much different from the "broiler industry" of today. In the 1940's, farm chicken production was largely a sideline to egg production (5, p. 396). Production was nonspecialized and general with 3.5 million farms raising chickens for sale in 1939 (1, p. 84). Despite the large number of farms, production was low (two pounds per person per year in 1940) and poultry meat was a "luxury product" (5, p. 396). Not only was production vastly different from today, the marketing arrangements for inputs and outputs also differed. Fertile eggs, day old chicks, live farm chickens as well as the dressed bird were bought and sold with prices determined in a competitive market. In short, the structure of the sector was horizontal, atomistic, nonspecialized by farm or by geography with an output which was "high-priced" and nonstandardized.

The structure of the broiler industry has changed dramatically since World War II. Technological developments in genetics, feeding, disease control, housing, and mechanization have helped to develop a healthier, more standardized bird raised using mass production techniques (1, p. 205). The organization has changed to one which is vertically integrated from the laying flock to the processed bird ready for market. Now there are prices only for the day old chicks which become the laying flock and for the processed broiler. These developments resulted in lower costs and lower broiler prices such that broilers became competitive

with ever increasing prices of red meat (7, p. 8). These changes as a whole, have resulted in a huge increase in consumption to over 37 pounds per person per year in 1974 (10, p. 21). During these 20-30 years of rapid technological change, the industry also became geographically concentrated in the South.

The features that account for the ease of broiler integration are also causing problems in the industry today. Being a uniform product helps in the mass production of broilers, but it also hurts the industry. There are no other uses for the product or for the equipment used to produce it. Furthermore, the equipment and buildings needed for broiler production amount to a very high investment for the producers. "Good" markets cause integrators to overbuild which in turn causes overproduction. Too many broilers cause the price to drop and losses occur. These losses cause firms to drop out of the industry either by means of being taken over by other firms or by bankruptcy (1, pp. 205-206). One indication of what the broiler producer has been facing is the net returns on production. In the 12 quarters of 1972, 1973, and 1974, the net returns per pound were positive only five of the 12 quarters (10, p. 25).

Another problem that confronts the "little man" in broiler production is the fact that economies of scale do exist (11, pp. 412-413). The more feed that is mixed and the more broilers that are processed, the less each bird cost on an individual basis. This tends to reduce the number of firms producing broilers.

The profit and loss fluctuations which have occurred have caused many firms to exit from the industry. The number of processors has

decreased from 286 processors in 1960 to only about 140 processors in 1975 while the number of broilers processed has gone from 1.5 billion broilers per year to 2.9 billion broilers per year (8, p. 6). Thus, the rapidly expanding industry has become more highly concentrated. Monopoly power becomes a concern.

One way that the exodus from the industry could be retarded is for the integrator to have some reasonable idea of what price to expect for his output before the fertile eggs are put into the incubator. This could help him to ascertain when to cut production to avoid large financial losses. If all producers cut production, then the losses will not occur and exodus from the industry would be slowed. The iced broiler futures market on the Chicago Board of Trade is a device that the producer can use now to get some idea of what price to expect. For example, at the time the fertile eggs are to be placed in the incubator for hatching, the producer could look in the paper for the quoted price on the futures market for the month close to 11 weeks in the future when the birds will be sold. The producer could then compute expected profits or losses and act accordingly. However, discussions with some of the National Broilers Marketing Association personnel seemed to indicate that the futures market was not used in this manner by producers. Apparently, what the producers want is a more accurate, or at least a more believable, price predictor than the futures market.

I. REVIEW OF LITERATURE

No prior research on broiler price prediction could be found, but other works relating to demand analysis for broilers and other farm

products were of some help in setting up a prediction equation.

Thompson, Sprott, and Callen (13, p. 246) developed a demand equation for broilers using price, quantity, income, and price of red meat. They used ordinary least squares, two-stage least squares, and the jack-knife method to compare how the standard errors were related. A main point of this study was that nine of 11 econometric analyses reviewed by them showed that supplies were predetermined.

This was backed up by a study by Karl Fox (4, p. 50) in which he found that production of broilers could be used as a predetermined variable when using units of observation of four months or less.

Farris and Darley (3, p. 849) did a study in 1964 to find out if broiler demand was affected by different months of the year. They used zero-one variables for the months along with the usual continuous variables. They found that the estimated values for the months were significantly different from each other with December at the lowest level. The level of demand went up until July, then back down during the fall months.

Another study of a similar nature was done by McManus and Daniel (9, p. 30). Their finding was that the highest average monthly price received for broilers in the 1963-1972 time period was in July while the lowest price received was in December.

Another factor of broiler demand was brought out in a study by Smith (12, pp. 10-15). His study showed how some holidays affected the buying habits of consumers. He found out that July Fourth was probably the most important holiday for chicken purchasing in relation to other types of meat purchases, with an average of 44.38 percent of

the people serving chicken compared to 28.04 percent serving pork, the next most frequently served meat.

II. OBJECTIVE OF THE STUDY

The objective of this study is to build and test a regression model using currently known data to predict the price of broilers in the eleventh week following the prediction. This 11-week lead is to give producers an idea of the price that they can expect when they market the broilers at the time that the fertile eggs are put in the incubator.

The criterion for testing the model will be the comparison of the price estimates of the model versus the futures market as to closeness of each to the actual cash prices 11 weeks in the future. The testing period will cover the one-year period beyond the data used to estimate the model.

CHAPTER II

SPECIFICATION OF THE MODEL

I. THEORETICAL FRAMEWORK

Traditionally in agricultural demand analysis, the price of the good has been used as the dependent variable. The other variables used are set out in demand theory as the quantity consumed, consumers' tastes and preferences, the number of consumers under consideration, consumers' income, the prices of related goods, and the range of goods available to consumers (6, p. 29).

Since the quantity of broilers is taken to be predetermined in a short time span of 11 weeks, the price of the broilers must seek that level where the quantity supplied clears the market; that is, price will be the dependent variable with quantity supplied and the demand shifters as explanatory variables.

While the objective of this study is to estimate a model to be used in prediction, the specification of the model conforms to that of standard demand curve analysis. However, since prediction required that the values of the explanatory variables be known at the time of the prediction, many of the explanatory variables have to be replaced with proxies known 11 weeks prior to the price of broilers being explained; that is, the price of broilers data is the price of broilers 11 weeks in the future to all of the explanatory variables.

The quantity of broilers supplied could not be used since it would not be known when the prediction is made 11 weeks ahead of time.

Therefore, another variable had to be used to approximate the supply of broilers. The variable used is weekly eggs set in 21 commercial broiler producing states. This number is readily available to producers and is highly correlated with the quantity of broilers produced from these fertile eggs 11 weeks in the future. That is, these fertile eggs will become day old chicks which will be moved to the feeding houses. After approximately eight weeks, the fed broiler will be processed and shipped to the market as an ice-packed product. Chick placement is usually about 80-82 percent of egg set, and slaughter is usually about 94 percent[1] of placement. This shows that the amounts are not the same, but they have a reasonably stable relationship to each other.

Although consumers' tastes and preferences are not quantifiable, there needed to be some variable to indicate how this could affect broiler prices. Farris and Darley had showed that certain months of the year affected demand with the level of demand building to a peak in July then falling back to the low in December (3, p. 849). Smith showed how different holidays caused people to alter their buying habits in preference to different types of meat (12, pp. 10-15). In order to estimate the seasonal differences in these tastes and preferences, one series of zero-one variables was used for each week of the year[2] while one series was used for the holidays.

The holidays used were the days that the Chicago Mercantile Exchange was closed throughout the year except for weekends. These

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[1]Calculated from statistics in Poultry and Egg Situation.

[2]The last week of the year was omitted to avoid singularity.

holidays were Washington's Birthday, Good Friday, Memorial Day, Independence Day, Labor Day, and Thanksgiving. Two other holidays, Christmas and New Year's, were not included since they fell on the same week each year and hence were included in the weekly dummy variables. The weeks before and after each holiday were also used to see what effect these might have on prices.

Consumers' income is not reported weekly, but data on the gross average weekly earnings of production or nonsupervisory workers on private nonagricultural payrolls are available monthly. These data are in current dollars and are used for the entire month; that is, it was repeated in four or five consecutive weeks until data for the next month were appropriate.

Pork and beef are probably the two closest substitutes for broilers; therefore, the prices of each would normally be used for the prices of related goods in a demand analysis. Since these prices cannot be known 11 weeks in the future, the futures market price for these red meat animals were used instead.

Using the prices on the futures market posed some problems because of the nature of that market. There is, of course, no specific futures quotation for 11 weeks into the future. Instead there are quotations for selected months of the year which often are not even the month desired. For example, the first set of observations for the first week of 1973 were values of the explanatory variables known on Tuesday, January 2, 1973. The "prediction" made on January 2 was made for 11

weeks in the future which was the week of March 19-23, 1973.[3] Thus a March futures was indicated; there is, however, no March contract available for fed cattle and hogs. April was used instead. Thus, the prices of hogs and cattle for this one observation of the first week of 1973 were the closing futures market quotations on January 2, 1973, for April, 1973, cattle and hogs. On those occasions where the "prediction" was made for before the fifteenth of any month and futures contracts were not available for the appropriate month, the quotation for the previous month was used.[4]

On those few occasions where a Tuesday was a holiday for the futures markets, then the nearest preceding day's quotations were used. In the previous example, if the market was closed on January 2, then the quotation would come from Friday's market of the previous week since the market would be closed on Monday, New Year's Day, 1973. Usually Monday's closing quotation was used if Tuesday was a holiday.

The range of goods available to the consumer is assumed to be unlimited. This means that all people have access to purchase any good that they have the means to purchase.

II. THE GENERALIZED MODEL

Using the variables that were discussed in the previous section, the general model can be constructed.

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[3]The dependent variable was the cash price of broilers for the March 19-23 week.

[4]For fed cattle and hogs, contract months never omit more than one month.

PBR = (EST, HD, WD, Y, FH, FC)

where:

PBR = actual nine-city weighted cash price of broilers 11 weeks in the future, cents per pound

EST = current eggs set in millions of eggs per week

HD = 18 zero-one holiday dummy variables

WD = 52 zero-one weekly dummy variables

Y = current income in dollars per week

FH = current futures price of hogs in cents per pound

FC = current futures price of cattle in cents per pound

CHAPTER III

THE SPECIFIC MODEL ESTIMATED

The data for the statistical model covered the period from the first week of 1969 through the forty-first week of 1973 for a total of 249 weekly observations. The last 11 weeks of 1973 were not used in order to reserve the whole 52 weeks of 1974 for the testing of the model; the dropping of the last 11 weeks of 1973 was necessary because the cash price of broilers in the last week of 1973 was the dependent variable in the forty-first week of 1973. This separated the data used in the estimation process from the data used to test the model.

The specification of the model to be used was accomplished by trial and error methods within the framework of the generalized demand equation of Chapter II. The first criteria for selecting the variables to be left in the model were the basic statistical tools of R^2 and the significance or "t" tests. The models which were deemed satisfactory based on these two criteria were then used to predict prices for 1974. These predictions were compared to actual cash prices for broilers to determine the efficacy of each of the models. Then, for the most efficacious model, more trial and error methods were employed testing different forms of some variables and the inclusion of one explicit variable which was formerly a part of the quantity variable proxy. The model chosen was the one which was the most accurate in predicting broiler prices 11 weeks in the future.

The basic model was the one presented in Chapter II with all the

variables in linear form. Several modifications were tried: adjusting price data, nonlinear variables, and adding and/or dropping variables.

One of the first modifications tried was that of adjusting the price data by dividing it by the Consumer Price Index (CPI) with a base year of 1967. This was done to bring all the price data into the same dollar terms for the entire period of the model. But, it was determined by looking at the simple correlation table and the significance tests that the CPI caused the variables that it was used on to become more highly correlated with each other. This led to using raw data as Farris and Darley had done in their study (3. p. 850).

Another modification was to drop the beef variable from the model. This was done since the price data for pork and beef were highly correlated with the result that the R-square of the model which included both variables was only slightly better than the R-square for the models with either pork or beef alone. The pork variable was left in the model since it resulted in a slightly larger R-square than the beef variable alone. This statistical result supports the a priori belief that pork is a closer substitute for broilers than beef.

Another change made during the preliminary attempts was the form of the equation. Originally, all explanatory variables were linear; but the predictions made for the end of the test period were considerably higher than the actual cash prices, so other forms were tried. The most useful was the reciprocal form applied to the price of pork variable. This allows for the hypothesis that the impact of the price of pork on the price of broilers increases at a decreasing rate as the price of pork rises rather than having a linear effect. When this form was used

in the equation, it tended to reduce the predictions toward the end of the test period when hog futures were high. Other variables were also tried as reciprocals, but pork alone seemed to give at least as good a set of prediction results as when other variables were used in the reciprocal form.

A new variable was added to the equation. This new variable was the cold storage stock (CST) of frozen broiler meat on hand at the beginning of each month. Since this is reported only monthly for the weekly model, it had to be repeated for the number of weeks in the month, just as was done with income. This variable seemed to improve the predictions of the model for 1974.

This trial and error method resulted in the inclusion of 74 explanatory variables: 52 weekly dummy variables, 18 dummy variables representing the week before, week of, and week after the six holidays already mentioned, and the four continuous variables of income, reciprocal of futures price of hogs, eggs set, and cold storage stock.

I. RESULTS

The variables, their coefficients, and their test of significance are listed in Table I. The income (Y) coefficient of .289 shows that as Y increases by one dollar per week, the price of broilers will increase by .289 cents per pound. The positive sign is consistent with demand theory in that as a person's income increases, this should shift his demand curve to the right causing a higher price for the same quantity of the good that is demanded.

The 1/FH variable is the reciprocal of the futures price of hogs

TABLE I

THE VARIABLES, COEFFICIENTS, AND t VALUES FOR THE PREDICTION EQUATION

Variable[a]	Coefficient	t Value
a	82.364	
Y	.289	7.142
1/FH	-275.770	3.755
EST	-1.246	7.772
CST	-.107	1.718
WO1	9.313	2.905
WO2	12.593	3.730
WO3	14.347	4.184
WO4	13.991	4.130
WO5	14.880	4.329
WO6	14.713	4.297
WO7	15.523	3.268
WO8	11.329	2.038
WO9	16.050	3.008
W10	17.185	4.879
W11	16.613	4.952
W12	16.924	4.966
W13	18.572	5.097
W14	15.487	4.407
W15	19.217	5.367
W16	19.672	5.582
W17	19.845	5.752
W18	20.696	5.834
W19	21.411	5.939
W20	23.892	6.391
W21	23.700	4.686
W22	23.406	3.982
W23	23.914	4.277
W24	24.826	6.332
W25	25.216	6.488
W26	26.667	5.109
W27	27.819	4.643
W28	28.906	5.137
W29	26.907	6.861
W30	24.337	6.420
W31	26.350	6.875
W32	29.030	7.554
W33	26.327	6.876
W34	25.102	6.632
W35	21.960	5.258

TABLE I (continued)

Variable[a]	Coefficient	t Value
W36	19.642	3.946
W37	18.132	3.711
W38	18.756	4.986
W39	16.800	4.857
W40	15.311	4.458
W41	14.778	4.334
W42	14.132	4.259
W43	12.959	3.940
W44	11.258	3.489
W45	8.757	2.783
W46	7.239	2.149
W47	5.662	1.259
W48	9.779	2.084
W49	10.145	2.667
W50	4.958	1.649
W51	-1.719	.603
W52	0.000	0.000
BWB	-.568	.126
WB	.251	.048
AWB	.554	.123
BGF	.992	.396
GF	-1.748	.679
AGF	1.731	.692
BMD	.857	.197
MD	-.443	.088
AMD	-.449	.103
BID	-1.988	.456
ID	-2.068	.411
AID	-1.721	.395
BLD	-5.972	1.634
LD	-1.757	.425
ALD	.798	.224
BTH	-6.564	1.801
TH	-6.116	1.471
ATH	-.349	.098

R^2 = .726
Se = 4.50

TABLE I (continued)

[a]Variable definitions:

a = intercept value

Y = average weekly income for blue-collar workers in the U. S. in dollars

1/FH = reciprocal of the futures price for hogs, 11 weeks forward, in cents per pound

EST = egg set in millions of eggs weekly

CST = cold storage in millions of pounds of frozen broiler meat

BWB, WB, AWB = dummy variables representing the weeks before, during, and after Washington's birthday with the non-holiday period deleted to avoid singularity

BGF, GF, AGF = dummy variables representing the weeks before, during, and after Good Friday with the non-holiday period deleted to avoid singularity

BMD, MD, AMD = dummy variables representing the weeks before, during, and after Memorial Day with the non-holiday period deleted to avoid singularity

BID, ID, AID = dummy variables representing the weeks before, during, and after Independence Day with the non-holiday period deleted to avoid singularity

BLD, LD, ALD = dummy variables representing the weeks before, during, and after Labor Day with the non-holiday period deleted to avoid singularity

BTH, TH, ATH = dummy variables representing the weeks before, during, and after Thanksgiving with the non-holiday period deleted to avoid singularity

WOI, W52 = weekly dummy variables with week 52 left out to prevent a singular matrix

R^2 = coefficient of determination

Se = standard error of the estimate

(FH), and was used to flatten out the predictions for the period of historically high hog prices of 1974. The negative value of 1/FH shows that as FH increases, the price of broilers will increase. For example, increasing FH from 40 to 45 cents per pound, the value of 1/40 times the -275.77 of Table I is -6.89 cents while 1/45 times -275.77 is -6.13. Therefore, if the futures price of hogs rises from 40 to 45 cents per pound, the price of broilers rises .76 cents per pound. This increase in price of broilers due to an increase in the price of hogs is consistent with demand theory which indicates that the relationship between the price of substitutes should be positive.

The negative value of 1.246 for egg set (EST) shows that as the number of eggs set decreases by one million eggs per week, the price of broilers should increase by 1.246 cents per pound in the eleventh week following the reduction. This one million egg decrease makes up 1.4 percent of the average egg set of 73 million eggs. This should be of particular interest to broiler producers in that this is the only variable over which they can exert control (in the aggregate); if the outlook is for financial losses because of low broiler prices, then some of these fertilized eggs can be sold as breaking eggs instead of hatched. This control over production has been pointed out by Wunderle (14, p. 38).

The negative value of .107 for the weekly level of cold storage stock (CST) shows that as the level falls by one million pounds of frozen meat, the price should increase by .107 cents per pound.

The values of the coefficients of the weekly dummy variables in Table I indicate an extremely wide seasonality of price reflecting aggregate consumer preference. These results are discussed later in

this chapter. Briefly, these values indicate what the observed prices would have been had all other variables been held constant.

The holiday dummy variables were not significant, but they did point to some relative information. The weeks before, during, and after Independence Day and Thanksgiving were all negative values with as high as a 6.5 cent effect on the price of broilers compared to non-Independence Day and non-Thanksgiving periods, respectively. This could help to show producers that prices are depressed for these times and that perhaps production should be cut back previous to these weeks to help bolster sagging prices due to these holidays. The other weeks of holidays were not consistent in that the effects of these weeks were of mixed signs. The only other noticeable week was the week before Labor Day with a negative effect of 5.9 cents.

II. TESTING THE MODEL

The test for the predictive powers of the model was made relative to the iced broiler futures market quotations (FBR) for the price of broilers 11 weeks in the future; that is, the predictive price for each week 11 weeks hence will be compared to the futures market price derived from the month's quotation for 11 weeks in the future.

The method of obtaining these estimates for the future prices was the same as for the future prices of hogs discussed in the previous section. These estimates were made beginning with the January, 1974, futures market close as of Tuesday, October 16, 1973. An estimate was made using the closing price of the market every week in 1974, 11 weeks in the future. Fifty-two estimates were made for 1974.

One of the predictions using the model was for the fourth week in January, 1974. The data for November 6, 1973, on current income, futures price of hogs, eggs set, and cold storage stock level were multiplied times their respective coefficients to obtain the first step in the price prediction for the fourth week of 1974. Next, the intercept value, a, and the value for the week four dummy were added. No holiday value was appropriate since there was no holiday during that fourth week of 1974 that had been included in the holidays previously mentioned. For the prediction of week January 22, 1974, the process was as follows:

Variable	Current Value	x	Coefficient	=	Product
a	1		82.364		82.36
Y	148.00		.289		42.82
1/FH	1/43.50		-275.770		-6.34
EST	72.78		-1.246		-90.64
CST	32.8		.107		-3.50
WO4	1		13.991		13.99
Prediction					38.69

Similar computations were performed for each week of 1974.

When this was done, it could be seen by comparing the predictions and the futures estimates to the actual cash prices of broilers in 1974 that the model's predictions were not nearly as close to the actual cash prices as were the futures market. This caused the implementation of correcting the predicted values by adding to the current prediction, the most recently known "residual."

This operation is cumbersome to explain and is best presented in a time frame of January 22, 1974. On January 22, 1974, the values of all the explanatory variables are known. The sum of these values times their respective estimated coefficients yields a prediction for April 9,

1974. There is, however, one other piece of information. On November 6, 1973, a similar prediction was made for January 22, 1974. The actual cash value for January 22, 1974, is also known, so the magnitude of the error of the November 6, 1973, prediction is now known. This error term is used to adjust the prediction being made for April 9, 1974. The arithmetic for the January 22, 1974, prediction is:

January 22, 1974, prediction of price April 9, 1974, using model.	44.09
Actual cash price January 22, 1974. .	42.21
November 6, 1973, prediction of price January 22, 1974, using model .	38.69
Difference.	3.52
Adjustment to January 22, 1974, prediction of price April 9, 1974	3.52
New prediction (PBR1)	47.61

Similar computations were done to adjust each week's prediction with the most recent, known error.

After this was done for all 52 weeks, the new predicted broiler prices of Model 1 (PBR1) were compared to the actual cash prices and futures prices, and it was seen that the futures prices were still closer to the actual cash prices than were the new predictions. It was also noted that there were some wide weekly fluctuations in the predicted prices using Model 1 (PBR1). To reduce the amplitude of these fluctuations, two-week, three-week, and four-week moving averages of the new predictions were computed. These estimates are presented in Table II.

The test that was used on these estimated and actual prices was the paired "t" test (2, p. 655). This was used since it would compare

TABLE II

ACTUAL AND ESTIMATED VALUES FOR PRICE OF BROILERS, BY WEEK, 1974[a]

Week	Cash	FBR	PBR1	PBR2	PBR3	PBR4
	----------	----------	CENTS PER POUND	----------	----------	----------
1	38.87	35.15	41.36			
2	34.66	36.50	34.70	38.03		
3	39.27	35.40	38.71	36.71	38.26	
4	42.21	36.25	36.68	37.70	36.70	37.86
5	38.04	37.05	39.45	38.06	38.28	37.39
6	43.43	38.20	37.08	38.27	37.74	37.98
7	39.22	37.95	36.19	36.64	37.57	37.35
8	36.96	39.90	42.06	39.12	38.44	38.69
9	40.24	41.30	39.85	40.95	39.37	38.80
10	40.17	42.05	40.92	40.39	40.94	39.76
11	37.70	42.15	41.68	41.30	40.82	41.13
12	37.34	41.75	39.23	40.46	40.61	40.42
13	38.17	43.10	37.54	38.39	39.48	39.84
14	35.33	43.55	39.25	38.40	38.67	39.43
15	38.05	43.50	47.61	43.43	41.47	40.91
16	35.95	42.50	40.99	44.30	42.62	41.35
17	33.99	40.60	42.70	41.85	43.77	42.64
18	35.87	42.15	38.03	40.37	40.57	42.33
19	37.71	41.55	32.70	35.37	37.81	38.61
20	35.50	41.95	40.12	36.41	36.95	38.39
21	33.50	38.60	41.76	40.94	38.19	38.15
22	35.51	37.90	37.72	39.74	39.87	38.08
23	34.44	39.00	37.25	37.49	38.91	39.21
24	31.79	38.90	37.92	37.59	37.63	38.66
25	34.47	39.15	37.36	37.64	37.51	37.56
26	37.67	39.50	36.43	36.90	37.24	37.24
27	38.05	39.90	37.31	36.87	37.03	37.26
28	34.86	38.45	39.32	38.32	37.69	37.61
29	35.15	36.35	41.80	40.56	39.48	38.72
30	36.34	36.15	42.59	42.20	41.24	40.26
31	38.24	38.25	40.28	41.44	41.56	41.00
32	36.26	36.40	37.10	38.69	39.99	40.44
33	35.21	36.00	38.12	37.61	38.50	39.52
34	37.67	35.55	39.22	38.67	38.15	38.68
35	41.87	34.00	34.70	36.96	37.35	37.29
36	42.53	34.25	37.84	36.27	37.25	37.47
37	39.05	38.00	43.29	40.57	38.61	38.76
38	36.15	38.30	44.75	44.02	41.96	40.15

TABLE II (continued)

Week	Cash	FBR	PBR1	PBR2	PBR3	PBR4
	----------	----------	CENTS PER POUND	----------	----------	----------
39	39.84	35.70	39.33	42.04	42.46	41.30
40	41.74	38.10	39.74	39.54	41.27	41.78
41	38.73	38.60	42.07	40.91	40.38	41.47
42	37.24	42.20	43.28	42.68	41.70	41.11
43	39.56	39.55	40.07	41.68	41.81	41.29
44	41.89	38.90	40.26	40.17	41.20	41.42
45	41.89	41.55	39.31	39.79	39.88	40.73
46	42.09	41.75	46.06	42.69	41.88	41.43
47	41.81	41.50	42.03	44.05	42.46	41.92
48	43.84	38.80	44.52	43.28	44.20	42.98
49	39.14	37.60	34.56	39.54	40.37	41.79
50	36.08	40.00	37.42	35.99	38.83	39.63
51	39.96	45.15	39.59	38.51	37.19	39.02
52	44.53	42.02	41.92	40.76	39.64	38.37
	38.22[b]	39.42[b]	39.73[b]	39.70[b]	39.66[b]	39.66[b]

[a]Cash = nine-city, weighted, wholesale price of broilers in cents per pound

FBR = futures price of iced broilers, 11 weeks forward in cents per pound

PBR1 = estimated price of broilers in cents per pound

PBR2 = estimated price of broilers in cents per pound for a two-week moving average

PBR3 = estimated price of broilers in cents per pound for a three-week moving average

PBR4 = estimated price of broilers in cents per pound for a four-week moving average

[b]Mean

each week's price with any one of the several estimates for that week. It was also used to compare the estimates with one another. The arithmetic for this test consisted of finding the difference of two of the columns' means and dividing this difference by the standard error of the two columns differences. In statistical notation, the test is:

$$t = \frac{\bar{P} - \bar{F}}{\sum_{i=1}^{n} \frac{(P_i - F_i)^2}{n(n-1)}}$$

where P refers to actual price and F refers to the estimates of one of the models (including the futures market).

After this was done for all possible combinations of the prices and estimates, the results were combined in Table III. It can be seen from Table III that the estimates were all significantly different from the actual prices to the 95 percent level. But the estimates are not significantly different from each other even down to the 50 percent level. Thus, the estimates were closely related to each other but significantly different from the actual prices that they were attempting to predict.

Evaluation of the Seasonal Price Pattern Shown by the Coefficients of the Dummy Variables

While the purpose of the construction of the model just presented was prediction, the values of the coefficients of the dummy variables contain some interesting information. This information is presented as though the model were a demand equation not adapted to prediction; thus, the comments in this portion can be taken as only approximately correct.

TABLE III

PAIRED t-TEST RESULTS FROM COMPARING ALL MODELS TO ACTUAL CASH AND EACH OTHER

	Cash	FBR	PBR1	PBR2	PBR3	PBR4
Cash	0.00	2.08*	2.60*	2.92*	3.03*	3.12*
FBR		0.00	.65	.64	.57	.63
PBR1			0.00	.12	.21	.18
PBR2				0.00	.23	.17
PBR3					0.00	.00
PBR4						0.00

*Significant at the 95% level.

As was mentioned, the estimated coefficients of the weekly dummy variables of Table I (pp. 14, 15, and 16) indicate a seasonal price pattern which would have been evident if all other explanatory variables had been held constant. The other explanatory variables do not remain stable, however, so that the observed cash price seasonality is quite different from the one indicated by the coefficients of the dummy variables (Table I).

The values of the dummy variable coefficients are measured from the week which was arbitrarily deleted, week 52. The same seasonality could have been shown with any other week deleted but the estimated coefficients would change since the base point would be changed. To evaluate the seasonality displayed by the dummy variable coefficients, it seemed desirable to hold all other variables constant at the level of some week during which egg sets, the only malleable variable, were at overall average levels 11 weeks before. Egg sets during week four, the last week in January, were at average levels. These fertile eggs are transformed into dressed broilers by week 15, in mid April. Setting the value of the dummy variable coefficient at week 15 equal to the cash price of that week, then results in the seasonality which would have occurred had egg sets been constant at five-year average levels and all other variables held constant at the levels of week four.

The results of this manipulation are shown in Figure 1 along with average weekly cash prices for the period. It is readily apparent that the seasonality of the dummy variable coefficients is much more pronounced than that of actual prices; one of the reasons is that egg sets vary seasonably and by sizeable amounts.

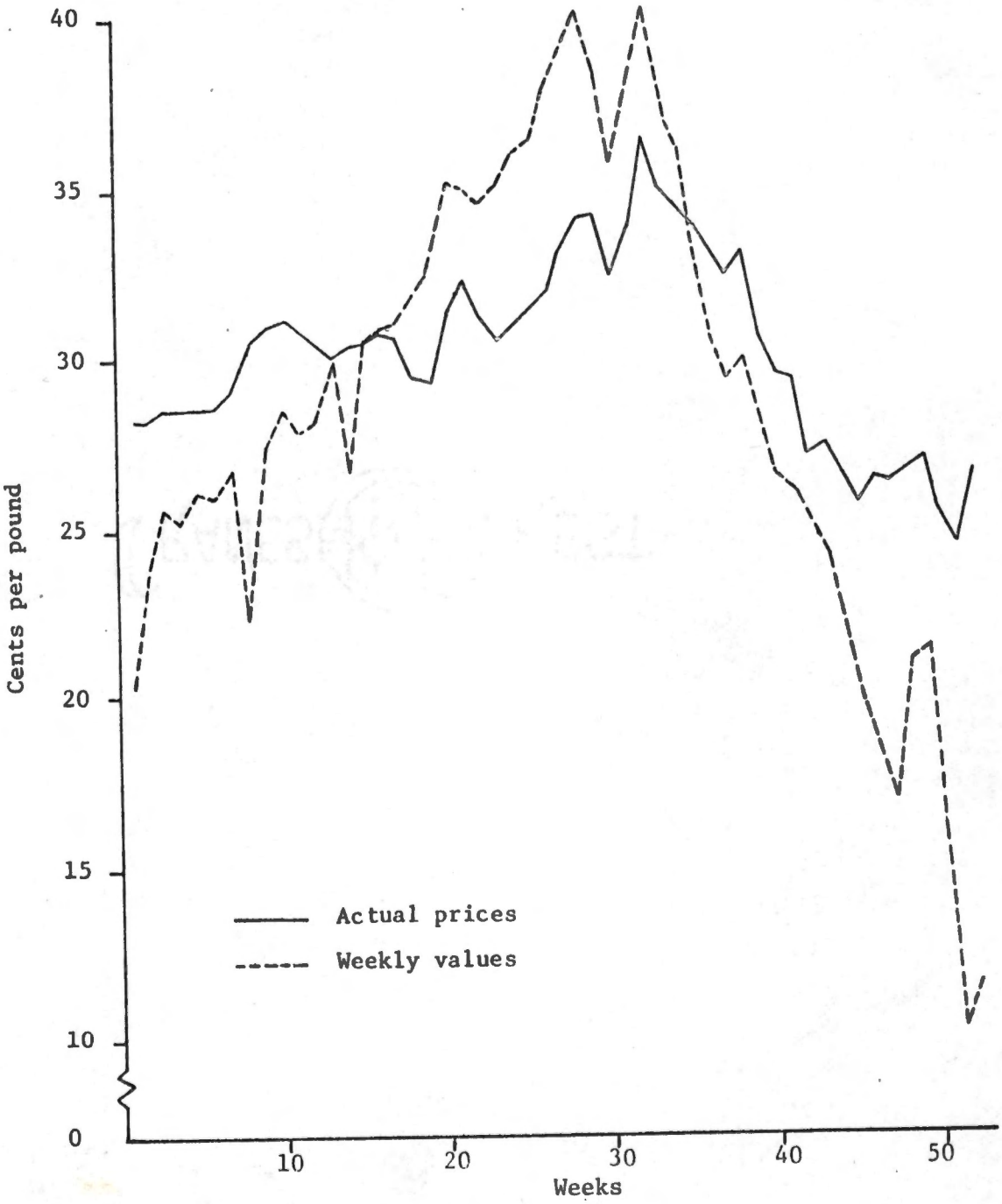


Figure 1. Average 9-city weighted wholesale broiler prices, and weekly values from Table I plus 11.18 cents, January, 1969, through October 16, 1973, U. S.

The seasonality of egg sets is shown in Figure 2. In this figure, the egg sets are plotted 11 weeks after they go into the incubator, so the figures plotted approximate the quantity of broilers supplied for that week. If the weekly variation in egg sets is taken into account, then a third price line could be plotted on Figure 1 representing what prices would have been holding egg sets constant at the fourth week level. Using the estimated coefficient of the egg sets variable, EST, of -1.246 (Table I, pp. 14, 15, and 16) and the deviation of egg sets from the mean value, the price line in Figure 1 for the actual prices can be appropriately adjusted to determine how much of the differences in the two price lines can be attributed to the variation of egg sets shown in Figure 2.

The question arises as to whether varying egg sets profits the producers. Estimations of total revenue using the weekly prices indicated by the actual price line of Figure 1 and varying egg sets compared to total revenue using the "imagined" actual price line and constant egg sets indicates that there is less than 1 percent difference between the two methods. Total production for the year is, of course, identical. Varying egg sets undoubtedly has a cost relative to constant egg sets; whether the less than 1 percent difference in total revenue is sufficient to offset these costs is beyond the scope of this study.

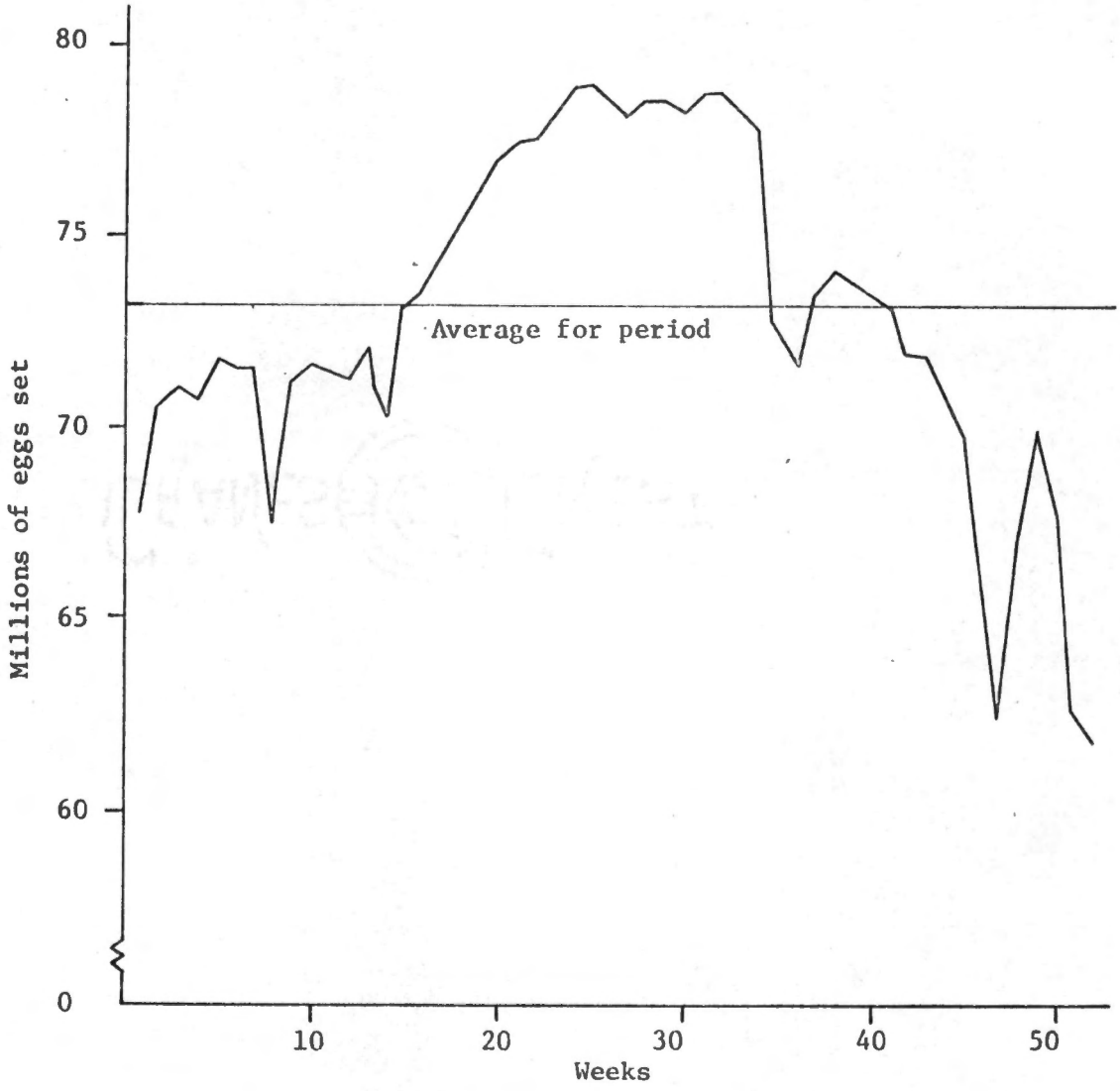


Figure 2. Average egg set plotted 11 weeks ahead, January, 1969, through October 16, 1973, 21 commercial broiler producing states, U. S.

CHAPTER IV

SUMMARY AND CONCLUSION

I. SUMMARY

Broiler production has changed drastically from pre-World War II days to the present. What started out as a sideline to egg production grew into a huge industry composed of large integrators using the mass production techniques of business. No longer are the laying flocks, hatcheries, growers, and processors separate businesses moving the product from state to state. Now the system is almost entirely vertically integrated from the laying flocks to the processed broiler.

This has proven to be a boom for the industry as a whole, but it also has brought along some problems. One problem seems to be the instability in the broiler market. A good price causes integrators to expand production which in turn causes the price to fall. Financial losses are the result. Some integrators must then either sell out to another integrator or simply quit the business. This causes production to fall off which causes the price to rise which starts the cycle all over again.

Another factor that poses problems is that there are economies of scale in the business. This means that a larger number of broilers raised and sold will mean a lower cost per unit of output. The larger firms can thus survive with lower broiler prices better than small firms. This can lead to oligopoly with some element of monopoly power. If there is some way to help out the small firms by allowing them some feasible

alternative to the instability of the market, it could mean that more firms could stay in business which in turn would maintain competition.

One way that producers can be helped is by cutting down their losses caused by overproduction and the resulting decline in the price of the product. To accomplish this, producers need some way to predict prices before the production process is, from a practical point of view, irreversibly started. That is, they need some forecast to help them anticipate what the market is going to do in the 11 weeks from egg set to the finished broiler. The futures market is one device that producers can use to predict what price they can expect for their broilers, but it has never been accepted as a reliable indicator. It has usually varied so much that the profit margin was never stable enough on which to base production. Therefore, what is needed is a prediction model for broiler prices to be used on an 11-week lead basis to help give producers a better idea of the price they can expect to receive when they sell their product.

In order to build this model, it is first helpful to build a demand model which can be transformed by the means necessary to predict the price of broilers. The variables that would make up a demand model are price of the good, quantity of the good demanded, consumers' income, population, price of related goods, and consumers' tastes and preferences. Some variation of these variables will have to be used due to the nature of the 11-week lead needed for the prediction.

The price of the good will be used as the dependent variable since it is the object of the prediction. Quantity demanded cannot be used since it will not be known 11 weeks beforehand; therefore, egg set will

be used as a forecast for quantity since it has a reasonably good relationship with quantity produced 11 weeks later. Consumers' income and population will be combined into a per capita figure as of the time of the prediction. The price of related goods will be represented by a futures market price of hogs since hogs are considered to be a close substitute for broiler meat. A continuous variable for consumers' tastes and preferences is not available so its impact will be quantified by using two sets of dummy variables of the zero-one type. The first set are weekly variables that should show the seasonality of price fluctuations. The second set are holiday variables that quantify the impact of different holidays on the price of broilers. Another variable that could also have some influence on the price of broilers is the cold storage stock of frozen broiler meat. This variable will also be used as current since there are no predictors known for it.

After the 1969 through 1974 data were gathered and compiled, regression analysis was used to calculate the coefficients for each independent variable. The results for the nondummy variables are shown below:

PBR = 82.364 + .2894Y - 275.77 (1/FH) - 1.246EST - .107CST

PBR = price of broilers, 11 weeks ahead

Y = current income

FH = current futures price of hogs for market 11 weeks ahead

EST = current eggs set

CST = current cold storage stock

The weekly dummy variables go from a high coefficient of 29.03 in

week 32 to a low of -1.719 in week 51. The holiday coefficients showed that two of the holidays' sets of before, during, and after weeks had a negative effect on prices while the other sets were inconsistent. They go from a high of 1.731 to a low of -6.564.

After the statistical model was estimated, data for 1974 (the year after data for the model) were used to test the predictive powers of the model. The results were not satisfactory as measured for accuracy against the futures market. In an attempt to improve the prediction powers the most current prediction for 11 weeks in the future was adjusted by the error of the prediction made 11 weeks ago. After this was done, it was determined by comparing the new predictions and the futures market estimates to the actual prices that the futures market estimates were still closer to actual cash more of the time. This was due to some violent fluctuations in the model's predictions, so the two-week, three-week, and four-week moving averages were taken of the new predictions. This helped to smooth out some of the peaks and troughs and enabled the model's predictions to better compete with the futures market estimates.

The test used to compare the estimates with the actual cash prices was the paired "t" test. This test consisted of dividing the difference of two means by the standard error of the differences of the two sets of figures. This was done for all sets of figures including the actual cash prices, the futures market estimates, and the model's predictions with two-week through four-week moving averages.

The results of these tests showed that there was no significant difference between any of the futures estimates or the model's predictions but that all of the estimated prices were significantly different

from the actual prices. This indicated that the model explained the current futures market quite well but was unable to predict the future with any more accuracy than the current iced broiler futures market.

After this was done, another measure taken to compare the estimates with actual prices was to graph the actual average weekly prices along with the weekly values in the model adjusted by 11.18 cents which is the amount that will equate the two sets of numbers at a week when average egg set is the same as actual weekly egg set. Then the average weekly egg set values were graphed 11 weeks ahead to show how the quantity values compared with the price figures.

It could be seen that the producers had done some adjusting of production to account for seasonal price patterns, but they had not dropped production low enough in the latter part of the year to compensate for the low prices that fell in that time period. But it could also be seen by finding the total revenues that the present method of fluctuating egg set brought in less than 1 percent more revenue than setting egg set at its average level and using the adjusted actual price line as the prices received for the broiler meat.

II. CONCLUSION

The main conclusion that can be drawn from this study of broiler prices is that the models used to predict broiler prices 11 weeks in the future were in much closer agreement with current futures market quotations than with prices that evolved in 11 weeks. These results are consistent with the thought that the people who buy and sell contracts on the futures market are looking at some or all of the same variables that were used in the prediction model. The fact that the several statistical models were unable to improve on the price predictions given by the futures market and all yielded results not statistically different from the futures market supports the contention that the futures market reacts rationally to economic stimuli. There is no evidence in this study that the futures market price is other than one based on the best information available at the time. The fact that the futures market was not able to accurately predict broiler prices 11 weeks into the future does not alter this conclusion; rather its inaccuracy indicates only the difficulties of price prediction in a complex market economy. The one central conclusion of this study is that if broiler producers wish to adjust egg sets in the light of expected prices 11 weeks after the eggs are set, there is no known vehicle to arrive at expected broiler price more accurate than the morning paper's report of futures market prices 11 weeks hence.

One limitation that should be pointed out about this study is the short testing period of only one year, 1974. The correct statistical technique would have been to test the model for a greater number of years,

but this was not practical for a study of this limited nature. Also, the model should be updated by the addition of new data as soon as these data are available.

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