Forecasting egg prices for the Los Angeles market

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FORECASTING EGG PRICES
FOR THE LOS ANGELES MARKET

by

David John Post

A Thesis Submitted to the Faculty of the

DEPARTMENT OF AGRICULTURAL ECONOMICS

In Partial Fulfillment of the Requirements
For the Degree of

MASTER OF SCIENCE

In the Graduate College

THE UNIVERSITY OF ARIZONA

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STATEMENT BY AUTHOR

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ACKNOWLEDGMENTS

Many individuals have influenced and directed my graduate work at The University of Arizona. Recognition of all these individuals by name is impractical. Therefore, the author expresses a sincere thank you to everyone who made his graduate work possible.

The author wishes to express his sincere thanks and appreciation to Dr. Robert C. Angus for his guidance, recommendations, and constructive criticism throughout this thesis.

A word of thanks is extended to Dr. Franklin D. Rollins, Extension Poultry Specialist, for providing data and suggestions for this study. Appreciation is also extended to Dr. Jimmye S. Hillman, Head of the Department of Agricultural Economics, and to Dr. Bobby L. Reid, Head of the Department of Poultry Science, for financial support of this thesis.

Acknowledgment is also extended to the Statistics Department of the Agricultural Experiment Station at The University of Arizona for key punching and special thanks to Miss Marilee Shields for programming the various models used in the study.

A special kind of appreciation is expressed to the author's wife, Nancy, for typing the thesis and for her sacrifices, encouragement, and understanding throughout all phases of his graduate work.

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ABSTRACT

The egg industry of the United States has experienced fluctuating egg prices over the past years. Fluctuation in production followed by price variations and revenue changes has created a problem of "boom or bust" in the industry.

The objective of this thesis is to quantify the relationships in the poultry egg industry with special emphasis on forecasting prices of eggs in Los Angeles. If successful, the forecast model would provide producers with a tool to plan production so as to maximize net return or minimize losses.

Method of analysis was stepwise multiple regression using ordinary least squares analysis. Secondary data were used and each of the models was lagged three-quarters and based on 25 observations, from the first quarter of 1964 to the first quarter of 1970.

A single equation model was developed which was a better predictor of price than the more complex multi-equation models analyzed. The correlation coefficient (r) between actual and predicted prices for the single equation model was approximately .89 or in terms of the coefficient of determination (R^2), approximately .79. Regional as well as national variables were evaluated to determine if any local factors affected Los Angeles prices.

A refitting of the selected forecast model periodically by updating the sample period is of considerable importance because

predicting too far beyond the sample time period may significantly affect the structural coefficients and yield unreliable and poor forecasts.

CHAPTER I

INTRODUCTION

The egg industry of the United States has been characterized by fluctuating egg prices. High egg prices make production appear profitable, therefore encouraging producers to increase flock size. Larger flocks result in more eggs and finally lower prices. The price situation is aggravated by efficiencies of large-scale production and new technologies. Both result in the ability to produce more with the same expenditure of resources.

Egg prices are the resultant of interaction of producers and consumers in the market system. In order to estimate prices, consumer behavior must be examined. Total U.S. egg consumption has been increasing as a result of an increase in population. This has provided an outlet for increased production. However, per capita consumption of shell and processed eggs steadily declined from 376 in 1954, to 317 in 1963, and has remained at that approximate level (Table 1). Consumers may be induced to purchase additional eggs at lower prices. Since the demand for eggs is inelastic,[1] the relative increase in consumption will be less than the proportionate decrease in price. This implies that gross revenues are larger when total egg production is low and

1. Martin J. Gerra, The Demand, Supply, and Price Structure for Eggs, U.S. Department of Agriculture, Technical Bulletin No. 1204, November, 1959, pp. 81-84.

Table 1. United States Per Capita Consumption of Shell Eggs, Processed Eggs, and Total Eggs, 1963-70

Year	Shell Eggs	Processed Eggs	Total Eggs
1963	290	27	317
1964	287	37	318
1965	285	29	314
1966	283	30	313
1967	289	34	323
1968	288	32	320
1969	285	31	316
1970	282	31	313

Source: Poultry and Egg Situation, Economic Research Service, U.S. Department of Agriculture.

smaller when total egg production is high. Fluctuation in production followed by price variations can cause net profits to gyrate. Year-to-year variations in producer prices for eggs have exceeded seasonal variations. For example, the monthly average farm price received by producers in Arizona during November and December 1969, and January 1970, reached the 47 to 50 cent per dozen level. Prices for the same months during 1970-71, ranged from 29 to 32 cents per dozen as a result of production response to the high prices the previous year. This problem or pattern of "boom or bust" is nationwide in scope.

Producers have formed large regional cooperatives to deal with production problems. The United Egg Producers (U.E.P.) is an amalgamation of the regional organizations. U.E.P. made recommendations to its members to reduce flock size and production in 1970. The program was called "Action" and had the objective of avoiding the low prices expected following the high prices of 1969-70. The impact of the program was partially offset by the development of a vaccine to control Marek's disease. The vaccine greatly reduced fowl mortality during the latter period of the growing stage and as well as in the early stages of the production with the result that egg production exceeded the levels of the U.E.P. program.

The U.E.P. response to this was to initiate Action Phase II, a follow-up program. The following recommendations were made -- first, to increase fowl slaughter to four million birds per week for 15 weeks starting February 8, 1971; second, to reduce the number of chicks hatched for commercial egg production; third, to have the U.E.P. and regional members remove 50,000 cases of eggs per week for a five-week period starting February 8, 1971. These eggs were to be processed and held for sale at a later date. And fourth, to increase membership in U.E.P. to a level where 70% of the fowl population would belong by 1971.[2]

The point in describing the actions of U.E.P. is to indicate that the organization is manipulating variables in the market system to adjust price. Success in this program depends upon the actions of all producers as well as the magnitude of the production adjustments recommended.

Purpose and Objectives

The purpose of this study is the quantification of relationships in the poultry industry with special emphasis on forecasting prices of eggs in Los Angeles. The forecast model, if successful, would provide producers with a tool to plan production so as to maximize net returns or minimize losses. The major problem associated with this system is that the price forecast model must have high predictive power.

The objectives were to develop a model that was as simple as possible but yet able to predict price with a high degree of accuracy. Regional and national variables were used in formulating the models. Single and multi-equation models were analyzed in deriving a model with high predictive qualities. Each of the models was evaluated to determine how well each predicted actual price changes. Residuals were

2. "Phase II," Action Now, United Egg Producers, 1971, p. 5.

plotted against time and predicted prices to determine if any trends or abnormalities existed.

Secondary data were used to forecast the Los Angeles price delivered-to-retailers as well as to analyze the relationships in the poultry industry. Inferences can be drawn with respect to wholesale and farm prices because they follow the same pattern as retail prices except at a lower level. All models examined were derived from the stepwise multiple regression technique whereby variables are inserted into the model in order of their highest partial F value.

CHAPTER II

CHARACTERISTICS OF THE EGG INDUSTRY AND PRICE PREDICTION MODELS

The purpose of this chapter is fourfold. First, an examination of the Los Angeles egg market is presented. A comparison of the egg industry at present, 1971, and two years ago, and the reasons for changes are then discussed. Third, a description of the nature and structure of price prediction models is examined. And finally, a review of literature is presented.

Los Angeles Egg Market

The Los Angeles egg market includes all of Southern California and is influenced by Southwestern Egg Producers (SWEP), a producer-controlled, egg bargaining cooperative. A major function of SWEP is establishing dealer-paying prices to producers. SWEP has attempted to remove surplus table eggs from market channels and bring production in line with available quantities demanded through a production or marketing base system. Southern California has developed into a surplus area and is a long distance from large deficit areas. Thus, it becomes critical to keep production aligned with quantities demanded. SWEP however, has not been able to control production. Some producers expanded. The result has been gyrations in production and prices received by producers.

Egg prices in the Los Angeles egg market are obtained by the Federal-State Market News Service and published daily. Prices reported for the Los Angeles market are (1) price-to-retailers, f.o.b. distributor's plant, loose-in-cases; (2) price-to-retailers, delivered-in-cartons; and (3) price-to-consumers in large retail stores in cartons.[1] Quotations on the high side of the price-to-retailers, f.o.b. distributor's plant, loose-in-cases quotation for Grade A eggs have been used as a base price by Southern California egg dealers to pay producers. However, the trend in California is to carton eggs "on ranch." Increasing amounts of eggs are sold to retailers on the basis of price-to-retailers, delivered-in-cartons rather than price-to-retailers f.o.b., loose-in-cases. Because of the trend in egg marketing, prices forecasted in this thesis are Los Angeles price-to-retailers, delivered-in-cartons.

A second reason for forecasting the Los Angeles price is that the Arizona price of eggs is highly correlated with Los Angeles prices, not New York prices. Arizona is a deficit area and prices received by Arizona ranchers are usually about one and one-half cents higher than the price received for a dozen eggs by producers in Los Angeles.[2]

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1. Jerome B. Siebert, Review and Analysis of California Egg Prices, University of California Agricultural Experiment Station, Giannini Foundation of Agricultural Economics, February, 1969, pp. 12-13.

2. David L. Schlechty, "Cost-Size Relationships for South Central Arizona Poultry Ranches," Unpublished Master's Thesis, The University of Arizona, Department of Agricultural Economics, 1965, p. 79.

Southern California fulfills deficits in Arizona. Therefore, Arizona is more concerned with market conditions in Southern California than with conditions in New York.

Egg Industry: Past and Present

The Los Angeles egg market and the egg industry as a whole have been experiencing overproduction. California in 1970 had a market egg surplus of 1.3 billion eggs.[3] More eggs are being produced than are demanded by consumers resulting in low prices to producers. Asking prices by SWEP for Grade A large had reached as high as $ .54 a dozen in January of 1970, compared to November of 1971 when the SWEP asking price was as low as $ .19 a dozen, far below the cost of production.[4] The quoted price of $ .19 a dozen for Grade A large is actually on the high side because egg producers sell not only large eggs but medium and small eggs as well. Therefore, prices received by producers are blend prices and are lower than the asking price for Grade A large.

Basic reasons for such a drastic change in the price are the general nature of the demand for eggs at the retail level. The demand for eggs is highly inelastic. That is, a 10 per cent change in the retail price is associated with approximately a change of one to four

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3. Milo H. Swanson, The California Egg Industry: Its Scope and Relationship to the National Situation, University of California Agricultural Extension Service, October, 1971, p. 11

4. Appendix A, p. 77.

per cent in the opposite direction in the consumption of eggs.[5] Production had dropped slightly from 1968 levels in 1969. Per capita consumption had also dropped, 320 in 1968 to 316 in 1969; however, the increase in population offset this decrease resulting in higher prices to farmers. High prices encouraged farmers to expand production. There were three per cent more layers on farms in January 1, 1970 than a year earlier -- one per cent fewer hens but six per cent more pullets of laying age. In addition, there were five per cent more pullets three months old or older, not yet laying. At the same time, there was a decrease in the slaughter of mature hens. Through the first four months of 1970 production was up more than one per cent from a year earlier.[6]

Quantity of eggs produced can change in short time periods. Entry into the egg industry is relatively easy. Investment costs are not as great as in many other agricultural enterprises. A producer can be in full operation six to eight months after the initial investment. Ranchers can adjust production by flock size. When price is favorable a producer can increase the flock size by buying birds, by reducing cull rates, and by force molting. However, when price is not favorable a rancher can cut back flock size, postpone replacements, force molting, and wait until prices are favorable. On the other hand,

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5. Martin J. Gerra and Wayne Dexter, Egg Prices and the Factors That Influence Them, U.S. Department of Agriculture Marketing Service, Marketing Bulletin 5, April, 1960, p. 6.

6. U.S. Department of Agriculture, Economic Research Service, Poultry and Egg Situation, April, 1970, p. 4.

in the tree-fruit production it may take eight years before one can be in full operation. The relative risk of this type of operation, and the relative high cost of investment, discourage people from entering. The relative ease of entry and investment presents the egg industry with wide swings in price and production.

Nature and Structure of Prediction Models

Forecast models in general can be classified into two broad groups. First, a conditioned forecast implies the derivation of predicted values on the basis of some assumed or expected levels of predetermined variables. In other words, forecasts are valid only if the predetermined variables have attained the assumed or stipulated values. Unconditional forecasts are concerned with the predictions of dependent variables without any specific assumptions about levels of the predetermined factors. The method of unconditional forecast implies predicting independent variables that influence the dependent variable in the hypothesized model. Errors are more likely in unconditional forecasting because the error in predicting the independent variables adds to the overall inaccuracy in forecasting the dependent variable. The present analysis deals with prediction models aimed at making unconditional forecasts of Los Angeles egg prices three-quarters of one year into the future.

Prediction models vary considerably in their structure. These models can be categorized into two groups: mechanical extrapolation and analytical models.[7] The category of mechanical extrapolation is comprised of pure trend functions using time as the only explanatory variable. These "naive" models extrapolate estimates of the future levels on the basis of its past values. An example of a pure trend function would be the long-run projections in population. Masters and Jones' short-run model, referred to later in this chapter, would be an example of a "naive" model because it essentially implies that future changes in the price variable would be the same as past changes or it would be a constant proportion of the change in the past.

The basic advantage of trend functions and naive models is that they involve operations that are simple, fast, and economical. When the variable behaves in a regular and predictable fashion, these models may predict equally or even more accurately relative than those estimated by an analytical model consisting of a host of explanatory variables. However, pure trend functions and naive models appear to be of limited use in view of two major arguments, namely, the failure to explain the structure and the interaction of variables within, and the inability to predict important changes that become "erratic" to such models when relationships are not normal in terms of the past.[8]

Unlike the pure trend and naive models, the analytical prediction models aim at incorporating the causal factors that influence the variable or set of variables to be predicted and some precise

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7. S.K. Roy, "Econometric Models for Predicting Shortrun Egg Prices," Ph.D. Dissertation, Department of Agricultural Economics and Rural Sociology, Pennsylvania State University, 1969, p. 22.

8. Ibid., p. 23.

mathematical relations are established between the causal factors and the dependent variable. There are several formulations available for the construction of predictive analytical models. These involve simple, single-equation models, multi-equation recursive models, or simultaneous equation systems. The appropriateness of a particular formulation depends on the actual nature of the specific problem and on the limitations of data, time, and facilities available to solving the problem. The present study utilizes simple equation models as well as multi-equation recursive models using the direct least squares method.

Review of Literature

Recent studies analyzing and forecasting egg prices in the United States include those by Roy, Masters and Jones, and Siebert.[9] Multiple regression analysis was the technique used. Emphasis was placed on price forecasting with some consideration of the structural relationships. Egg price predictions were for either the week, month, or quarter. Roy forecasted the New York price, Masters and Jones the Georgia price, and Siebert the California price.

The criterion for useable forecasts is that its time span must equal or exceed the egg producing firms' reaction time. Reaction time

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9. S.K. Roy, "Econometric Models for Predicting Shortrun Egg Prices," Ph.D. Dissertation, Department of Agricultural Economics and Rural Sociology, Pennsylvania State University, 1969; Gene C. Masters and Harold B. Jones Jr., Predicting Shortrun Egg Price Changes in Georgia, University of Georgia College of Agriculture Experiment Stations, Research Bulletin 80, June, 1970; Jerome B. Siebert, Review and Analysis of California Egg Prices, University of California Agricultural Experiment Station, Giannini Foundation of Agricultural Economics, February, 1969.

is the length of time it takes an egg producer to adjust his production to an anticipated change in the shell egg price. Thus, the present study is concerned with predicting the price three-quarters into the future which exceeds the firms' reaction time. A review of the research proved helpful in terms of methodology, predictive implications, and selection of variables related to price changes and levels.

The most intensive study in recent years, by Roy, formulated weekly, monthly and quarterly econometric models for predicting the price of eggs. In each case, equations were derived by three different algorithms: ordinary least squares estimation, distributed lag, and autoregression techniques. One of Roy's objectives was to evaluate differences in predictions using various types of estimating procedures. The weekly model was composed of a single equation, whereas the monthly and quarterly models were each composed of four equations. In all of his models the wholesale price for large, white, extra-fancy, heavy grade eggs in New York City was the dependent variable.

Roy forecasted the New York wholesale price because it was of crucial importance in determining price levels throughout the U.S. The New York base price was by far the most widely used quotation. Retail as well as farm prices were virtually determined on the basis of the current wholesale price of eggs. Price margins appeared more or less fixed at specific locations. Therefore, he assumed that no other price series could represent the actual prices in the egg industry better than the New York wholesale price.

Roy's weekly econometric model predicted prices more accurately than his monthly or quarterly models. This result was expected because economic variables change slowly. Thus, a particular variable usually does not change as much in a week as a month or quarter. Therefore, it is less hazardous to predict for the next week than for the following month or quarter. A disadvantage inherent however in formulating a weekly model according to Roy is the relative scarcity of complete weekly data of relevant variables. Lack of data prohibits the inclusion of certain important variables and therefore, may seriously endanger the predictive accuracy of the model.

The weekly model had the wholesale price a function of the price of eggs lagged one or more time periods, the number of shell eggs in cold storage as of Monday morning, the number of eggs moving through commercial channels during the preceding week, and the difference between the price on last Friday and the average price during the remainder of the preceding week. A dummy variable was added to adjust for the week following Christmas and Easter. Roy had visualized price as a function of production, eggs used for hatching, those broken for commercial uses, storage of shell eggs which are the determinants of the quantity of shell eggs available to consumers. The advantage of including these variables is that the impact or effect of each individual factor could have been analytically examined. Unfortunately, weekly data on production, hatching, etc., were not available to Roy.

Roy modified the weekly model and based it on the assumption that commercial movements of eggs, excluding the amount delivered to breakers, would be to some extent representative of production and other related variables. It was hypothesized that the current week's price was a function of commercial movement of eggs during the same week and other factors. Shell eggs are highly perishable at the farm and move to the market rapidly. Thus, shell eggs reach the market irrespective of the prevailing demand conditions. Hence, excess or deficit quantity of eggs supplied relative to the quantity demanded would influence the level of price. Price elasticity of demand for shell eggs is highly inelastic. Gerra estimated it at minus four tenths. Therefore, a one per cent change in the retail price of eggs would change egg consumption approximately four tenths per cent in the opposite direction. Lack of data led Roy to hypothesize that commercial movement of eggs during the preceding week would be highly correlated with the commercial movement of eggs during the current week. This was verified by regression analysis. The inclusion of the price of eggs during the preceding week as an explanatory variable accounted for most of the variations in the commercial movement of eggs left unexplained by commercial movement of eggs lagged one time period.

Roy stated that:

> The amount of shell eggs in cold storage as of Monday morning was hypothesized as another relevant variable. Since production and other supply determining variables are fairly stable from one week to the next, a large volume of cold storage holdings would imply a relatively reduced current net supply of shell eggs in the consumer market. Therefore,

> assuming all other variables held constant, cold storage holdings and price would be expected to be directly related to each other.[10]

Independent variables in Roy's weekly model explained 91 to 95 per cent of the price variation depending on the combination of variables. There were no significant differences between the predictive power of ordinary least squares estimation and the more complicated and sophisticated models which used distributed lag and autoregression. This prompted the use of ordinary least squares in our analysis. Roy's monthly and quarterly models further substantiated the use of the simpler least squares approach to forecasting.

More data were available by months than by weeks. Therefore, Roy formulated multi-equation models for predicting the monthly and quarterly price of eggs. Both models are similar in their underlying assumptions and structures. Each model is composed of four equations as compared to one equation in the weekly model. The New York wholesale price was a function of the production of shell eggs, the number of eggs broken commercially, the number of eggs used for hatching, the number of shell eggs in cold storage, and the price of eggs lagged one or more time periods. It was hypothesized that production and price were inversely related, an increase in production raised the quantity offered for sale in the market at a given time and depressed the price levels. The quantity of eggs used for hatching would be expected to directly affect the price. An increase in

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10. Roy, op. cit., p. 56.

hatching would reduce the supply of shell eggs for consumption and hence would raise the shell egg price. The quantity of eggs broken commercially would be expected to affect price in the same manner.

The three variables discussed above -- production, hatching, and eggs broken commercially -- belonged to the current time period. Roy formulated equations to predict each one of these variables. Production was a function of the number of layers on farms the first day of the month, the number of chicks placed for laying flock replacements, egg production lagged one period, and the daily average number of eggs per 100 layers. The number of eggs used for hatching was a function of the number of eggs used for hatching in the preceding period and month-to-month variation in the number of eggs used for hatching a year ago. The number of eggs broken commercially was a function of the price of eggs during the current period, the non-shell eggs in cold storage, and the number of eggs broken commercially during the preceding period.

The method of acquiring a price forecast involved solving the production and hatching equations independently, whereas the price and eggs broken commercially equations were solved simultaneously. The procedure was used with both monthly and quarterly models. Major differences between the two models were time span and dummy variable for seasonal price variations in the quarterly model.

Roy's egg forecasting models were general models in the sense they explained the relationships of the U.S. egg market in the aggregate. His selection of variables indicated concern for the whole market and not for any particular region. Roy's overall methodology appeared to be applicable to the Los Angeles egg market examined in this thesis, and therefore, will be followed closely.

Siebert, Masters and Jones, on the other hand, were concerned with specific areas of the U.S. in forecasting the price of eggs. Masters and Jones attempted to explain and predict short-run fluctuations in farm egg prices in Georgia. They formulated the weekly forecasting models in terms of linear equations based on the stepwise multiple regression techniques. Average prices of large A eggs in the current week were dependent on prices of large eggs on Friday of the previous week, historical average prices for the current week based on the preceding six-year period, weekend inventory position of packers and handlers in the U.S. for the previous or current week, and average daily surplus or shortage conditions of packers and handlers in the Southeast for the previous or current week.

Comparison of the variables, price in the previous week, and the historical average price led Masters and Jones to state that under short-run competitive conditions prices of eggs can be readily projected by simple trend extrapolation. The use of prices in prior time periods plus change factors that reflect trend and seasonality was one of the more basic models that can be developed. Trend extrapolations of this type take account of seasonal patterns and occasional holiday demands as well as short-run factors. Prices in previous time periods are an important indicator of current prices since many of the same forces may remain in effect. They conclude that projecting weekly prices on the basis of this model should result in a relatively high correlation in the short-run. However, this method does not provide anything more than a mechanical relationship between prices, and there is little basis for expecting that price changes will occur exactly as they have in past periods. The model misses all important changes due to other factors not examined.

Masters and Jones used two other variables -- the inventory position of packers and handlers in the U.S. and the surplus or shortage condition of packers and handlers in the U.S. -- because of their contribution to the aggregate coefficient of determination (R^2) in the regression analysis. Changes in inventories or in reported supplies available for sale have considerable influence on short-term market trends. However, changing levels of inventories will affect price only in relation to changes in demand. Masters and Jones state that there may be a large increase in inventories at certain periods, such as immediately prior to Easter, but this may not create any downward pressure on price unless the increase is greater than normal or greater than expected on the basis of past periods. The surplus or shortage condition of dealers and packers can be regarded in much the same way. It is a surplus or shortage relative to demand that counts. A certain quantity of eggs may be carried in a normal inventory but not necessarily considered surplus. However, net surplus or shortage position of packers reflects their willingness to sell or buy at current prices.

Siebert analyzed factors which influence the price of eggs in California. He reviewed the California egg market in general and discussed economic and institutional factors which affect California egg prices. Economic factors hypothesized as influencing prices were the New York price and weekly per capita supplies of eggs in the West as indicated by "Commercial Egg Movement Report" (CEMR), the quantity of eggs produced in California per capita, and monthly military shell-egg purchases for the U.S.

Analysis of the weekly model showed that the egg production areas other than California are influenced, to a great extent, by New York egg prices which are reflections of trading at the New York Mercantile Exchange. Hence, New York prices can be described as prices of egg supplies in direct competition with California supplies. The reason for this relationship is that the other major surplus egg production areas in the U.S. base their prices on the New York market. California prices are influenced by out-of-state markets with surplus production. Thus, egg prices in California are related to New York egg prices. Another variable in the weekly model, per capita supplies of eggs in the West was used because weekly data for the quantity of eggs produced in California were not available. The Market News Service published weekly data for the U.S. and the West which gave an indication of production during the week. California accounts for about 75 per cent of the total Western egg production. Therefore, it was assumed that the CEMR to be greatly indicative of fluctuations in California data.

Production data for California were available for use on a monthly basis. Siebert in his monthly model predicted that the quantity of eggs produced in California would have some effect on California price besides the effect of New York price. Theoretically, the greater the amount of eggs produced in California as surplus to its own needs, the lower the price in relation to other U.S. prices. This was verified in the results. The other variable in the model, military shell-egg purchases, was assumed to have a positive correlation with the California price. The more shell eggs purchased by military agencies, the less available to the California egg market and the higher the price.

Siebert noted that the primary institutional factor affecting the price of eggs in California is the Southwestern Egg Producers (SWEP). SWEP represents an attempt to modify the effect of the pricing system represented by perfect spatial markets through the segregation of sales of Southern California production into a high-priced, local pool and a low-priced, surplus-removal pool. According to Siebert, this practice must have three conditions present for it to work to increase incomes: (1) the industry must be able to segregate the total market into sub-markets; (2) the industry must have the ability to prevent commodities in a lower-priced market from affecting the higher-priced market; and (3) demands in each market must be such that higher prices can be charged in one market while lower prices are charged in another and total income increased. SWEP was able to segregate its total market into sub-markets and receive different prices from each.

Because of a lack of production control however, costs of surplus removal more than offset any advantages gained through their two-pool price discrimination scheme.

CHAPTER III

ANALYSIS OF THE FOUR-EQUATION MODEL

Development of price forecast models depends on the series of data available. The series most available for the Southwest is the Los Angeles market. Since Los Angeles and New York prices are highly correlated, as illustrated by Equation A below, the variables that affect New York price affect the Los Angeles price in the same way. Therefore, many of the variables used in Roy's models can be and are used in models forecasting Los Angeles prices.

Equation A:

$$P_t = .521195 + .710343\ N_t$$

$R^2 = .80$

SEE = 0.028480

$F_{(1,\ 22)} = 88.706$

where

N_t = New York wholesale price large A, 75% quality, in common logarithms

P_t = Los Angeles price delivered-to-retailers in cartons, in common logarithms

The analysis presented in this chapter and the next examines different models and variables with the objective of deriving price forecasting models that can be used by producers in Southern California and Arizona. The predictive abilities of each model will be evaluated in terms of least squares statistics as well as by plotting forecasted and reported prices.

The first model analyzed paralleled Roy's quarterly model. However, the model was placed on a three-quarter lag basis. Roy's model was as follows:

$$P_t = a + b_1D_1 + b_2D_2 + b_3D_3 + b_4Y_t + b_5H_t + b_6(B_t - B_{t-1}) + b_7(S_t - S_{t-1}) + b_8P_{t-1}$$

$$B_t = a + b_1D_1 + b_2D_2 + b_3D_3 + b_4 + F_t + b_5(P_t - P_{t-4}) + b_6B_{t-1}$$

$$H_t = a + b_1D_1 + b_2D_2 + b_3D_3 + b_4(P_{t-1} - P_{t-5}) + b_6H_{t-1} + b_7(H_{t-4} - H_{t-5})$$

$$Y_t = a + b_1D_1 + b_2D_2 + b_3D_3 + b_4L_t + b_5R_{t-1} + b_6E_{t-1} + b_7Y_{t-1}$$

where

P_{t-i} = average price in cents per dozen of eggs during the (t-i) quarter;

Y_{t-i} = total U.S. production of eggs in millions during the (t-i) quarter;

H_{t-i} = total amount of eggs used for hatching in thousand cases, in the (t-i) quarter;

B_{t-i} = total quantity of eggs broken commercially in thousand cases, during the (t-i) quarter;

S_{t-i} = shell eggs in cold storage, in thousand cases, on the first day of the (t-i) quarter;

F_t = non-shell eggs in cold storage, in million pounds, on the first day of the (t-i) quarter;

R_{t-i} = chicks placed for laying flock replacements, in millions, during the (t-i) quarter;

E_{t-i} = eggs per 100 layers during the (t-i) quarter;

L_t = number of layers, in millions, on farm on the first day of the t quarter;

D_1 = 1 for the first quarter (January through March), 0 otherwise;

D_2 = 1 for second quarter (April through June), 0 otherwise;

D_3 = 1 for third quarter (July through September), 0 otherwise;

i = 0, 1, 2, 3, ...

Structure

The three-quarter lag model is also composed of four equations using ordinary least squares estimation. The four functions are

$$P_t = a + b_1D_1 + b_2D_2 + b_3D_3 + b_4Y_t + b_5H_t + b_6(B_t - B_{t-3}) + b_7P_{t-3}$$

$$B_t = a + b_1D_1 + b_2D_2 + b_3D_3 + b_4F_{t-3} + b_5(P_t - P_{t-4})$$

$$Y'_t = a + b_1D_1 + b_2D_2 + b_3D_3 + b_4Y'_{t-3} + b_5E'_{t-3} + b_6R'_{t-3} + b_7L_{t-3}$$

$$H_t = a + b_1D_1 + b_2D_2 + b_3D_3 + b_4H_{t-3} + b_5(H_{t-4} - H_{t-5})$$

The first of the four equations is the prediction equation for average quarterly egg prices. The Los Angeles egg prices are hypothesized as being a function of the current egg production (Y_t), of the number of eggs used for hatching (H_t) during the current quarter, of the number of eggs broken commercially (B_t) during the current period, and of the price of eggs during the previous period. The dummy variables D_1, D_2, and D_3 are expected to take into account some seasonal variation in price. It was hypothesized that production affects price inversely. Other factors remaining the same, an increase in production during the current quarter tends to increase the supply of eggs on the market and as a result depress the price level. The number of eggs used for hatching on the other hand is expected to directly affect the price. If the quantity of eggs hatched increases during the current period, this reduces the supply of shell eggs for consumption and hence, raises the shell egg price. The quantity of eggs broken for processing was hypothesized to affect price directly. All other variables remaining constant, a high level of eggs broken for commercial uses would reduce the supply of shell eggs on the market and therefore, raise the shell egg price. It was also hypothesized that the average price during the current quarter is affected by the quarterly price lagged three-quarters. Prices that are at a relatively low level during the preceding quarter will tend to carry over to the current average price and maintain similar trends.

The price prediction equation has three exogenous variables, H_t, Y_t, and B_t, belonging to the current time period. In order to predict prices, prediction equations had to be formulated for these variables.

The second equation has the amount of eggs broken commercially during the current quarter a function of the cold storage holdings of non-shell eggs lagged three-quarters and the current price of shell eggs relative to a year ago. If the quantity of non-shell eggs in storage is low three-quarters previous, more eggs are expected to be broken during the current quarter. Therefore, variations in the carry-over of non-shell eggs in storage from the previous period may be expected to inversely affect the volume of eggs broken commercially. In the price prediction equation, P_t was expressed as a function of B_t. In the second equation B_t is dependent on P_t. Therefore, B_t and P_t are mutually dependent and their equations are solved simultaneously. The inclusion of P_t as an explanatory variable is based on the hypothesis that the current price of shell eggs may affect the movement of eggs to the breaking plants in the opposite direction. Hence, if the shell egg price is relatively high, a decrease in the number of eggs would move to egg breakers and therefore, an increase in the number of eggs would move through the shell egg market. Dummy variables are also included to adjust for seasonal variations.

The third prediction equation that is formulated is total egg production (Y_t). It is hypothesized that production is a function of the number of layers on farms the first day of the quarter lagged three-quarters (L_{t-3}), of the number of chicks placed for laying flock replacement lagged three-quarters (R_{t-3}), of the number of eggs per 100 layers three-quarters previous (E_{t-3}), and of the total egg production lagged three-quarters (Y_{t-3}). Dummy variables are also included to account for seasonal variations in production. It is hypothesized that R_{t-3} would affect production in the positive direction. Pullets generally reach productivity in about five months. Since R_{t-3} is lagged three-quarters or nine months, these pullets would be laying for approximately four months before the model would take them into account. Therefore, an increase in the number of chicks for replacement purposes three-quarters previous would increase production during the current period provided the removal of old hens is relatively stable. It is also assumed that the average productivity of layers during the current quarter is not significantly different from the past.[1] Therefore, E_{t-3} represents the prevailing trend in the average productivity of layers. It is also hypothesized that Y_t is influenced by the level of production three-quarters previous.

The fourth equation of the quarterly model includes the quantity of eggs used for hatching (H_t) during the current quarter. It is dependent on hatching lagged three-quarters (H_{t-3}) and hatching in the same quarter a year ago relative to the preceding quarter (H_{t-4} - H_{t-5}). It was hypothesized that H_t during the current quarter was a function of the level of hatching in the immediate past, H_{t-3}. It was also assumed that hatching during the same quarter a year ago relative to that of the preceding quarter would explain any quarter-to-quarter variation in the number of eggs used for hatching. The dummy variables D_1, D_2, and D_3 are also included for explanation of any seasonal variations in the hatching of eggs.

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1. Appendix B, p. 88.

Results

The results using ordinary least squares estimation indicate only the variables that have significantly affected their respective dependent variable. In the following estimates, all variables are in common logarithmic units unless associated with the prime sign ('). When the prime is used the units are expressed in actual units. The estimates of the equations were based on 25 observations beginning with the first quarter of 1964. The numbers in parenthesis below the regression coefficient are associated t ratios which indicate the statistical significance of the variable.

Equation I:

$$P_t = \underset{}{11.4057} - \underset{(5.23030)}{.095853}\, D_1' - \underset{(9.03681)}{.186766}\, D_2' - \underset{(3.54976)}{.069470}\, D_3' -$$

$$\underset{(8.19214)}{3.76767}\, Y_t + \underset{(10.9069)}{1.80213}\, H_t + \underset{(2.53571)}{.146860}\, (B_t - B_{t-3})$$

$R^2 = .91$

$F_{(6,\ 18)} = 30.27$

SEE = 0.023257

Equation II:

$$B_t = 3.49890 + \underset{(2.47271)}{.080405}\, D_1' + \underset{(7.79525)}{.263833}\, D_2' + \underset{(3.38811)}{.11437}\, D_3' -$$

$$\underset{(3.12313)}{.461349}\, (P_t - P_{t-4})$$

$R^2 = .80$

$F_{(4,\ 20)} = 19.67$

SEE = 0.058447

Equation III:

$$Y_t = \underset{}{92{,}859.4} + \underset{(6.27604)}{1700.34}\, D_2 + \underset{(4.64967)}{1.72909}\, Y'_{t-3} - \underset{(4.21482)}{6.77116}\, E'_{t-3} + \underset{(3.94824)}{38.395}\, R'_{t-3} - \underset{(2.03186)}{28{,}627.2}\, L_{t-3}$$

$R^2 = .83$

$F_{(5,\ 19)} = 18.99$

SEE = 303.133

Equation IV:

$$H_t = .490428 + \underset{(4.23699)}{.104283}\, D_1 + \underset{(6.55412)}{.145466}\, D_2 + \underset{(4.74771)}{.844841}\, H_{t-3} - \underset{(2.48297)}{.469951}\, (H_{t-4} - H_{t-5})$$

$R^2 = .78$

$F_{(4,\ 20)} = 17.38$

SEE = 0.028948

The first equation, P_t, has all variables significant at one per cent probability level except P_{t-3} which did not attain an acceptable level of significance and was dropped. An increase in Y_t by one per cent may be expected to lower the quarterly price by 3.77 per cent. If H_t or B_t is raised by one per cent, price would increase 1.8 or .15 per cent, respectively, provided the other variables are held constant. Thus, the hypotheses regarding the effect of these variables on the price are supported by the price equation. The estimated constant term is the intercept for the fourth quarter. The intercept for the first, second and third quarters may be derived by algebraic addition of the individual regression coefficients for D_1, D_2, and D_3, respectively, to the constant term of Equation I. The negative signs of the dummy variables imply a downward shift in the first three-quarters relative to the fourth quarter. The high significance of these dummy variables reflects seasonal variation in price which was not fully explained by the other exogenous variables. As long as these seasonal trends continue beyond the sample time period will the inclusion of the dummy variables improve the predicted accuracy of the model.

An examination of Equation II revealed that all variables were significant at one per cent probability level except F_{t-3}, which was significant at the 20 per cent level. It was therefore excluded from the equation. All three dummy variables are again significant which establishes the hypothesis that the other exogenous variables are not able to fully explain the seasonal variations in B_t. The positive coefficients of D_1, D_2, and D_3 may imply that B_t is larger during the first three-quarters than during the fourth quarter. The negative coefficient on $(P_t - P_{t-4})$ implies that a one per cent increase in P_t will result in a .46 per cent decrease in B_t holding all other variables constant. This further substantiates the hypothesis stated earlier.

The production-equation, Y_t, had variables D_2, Y'_{t-3}, E'_{t-3}, and R'_{t-3} significant to one per cent probability levels while L_{t-3} was significant at the 10 per cent level. The dummy variables D_1 and D_3 were excluded because of their insignificance. Variable D_2 was the only dummy variable that could significantly explain any seasonal variation in production that was not explained by the other exogenous

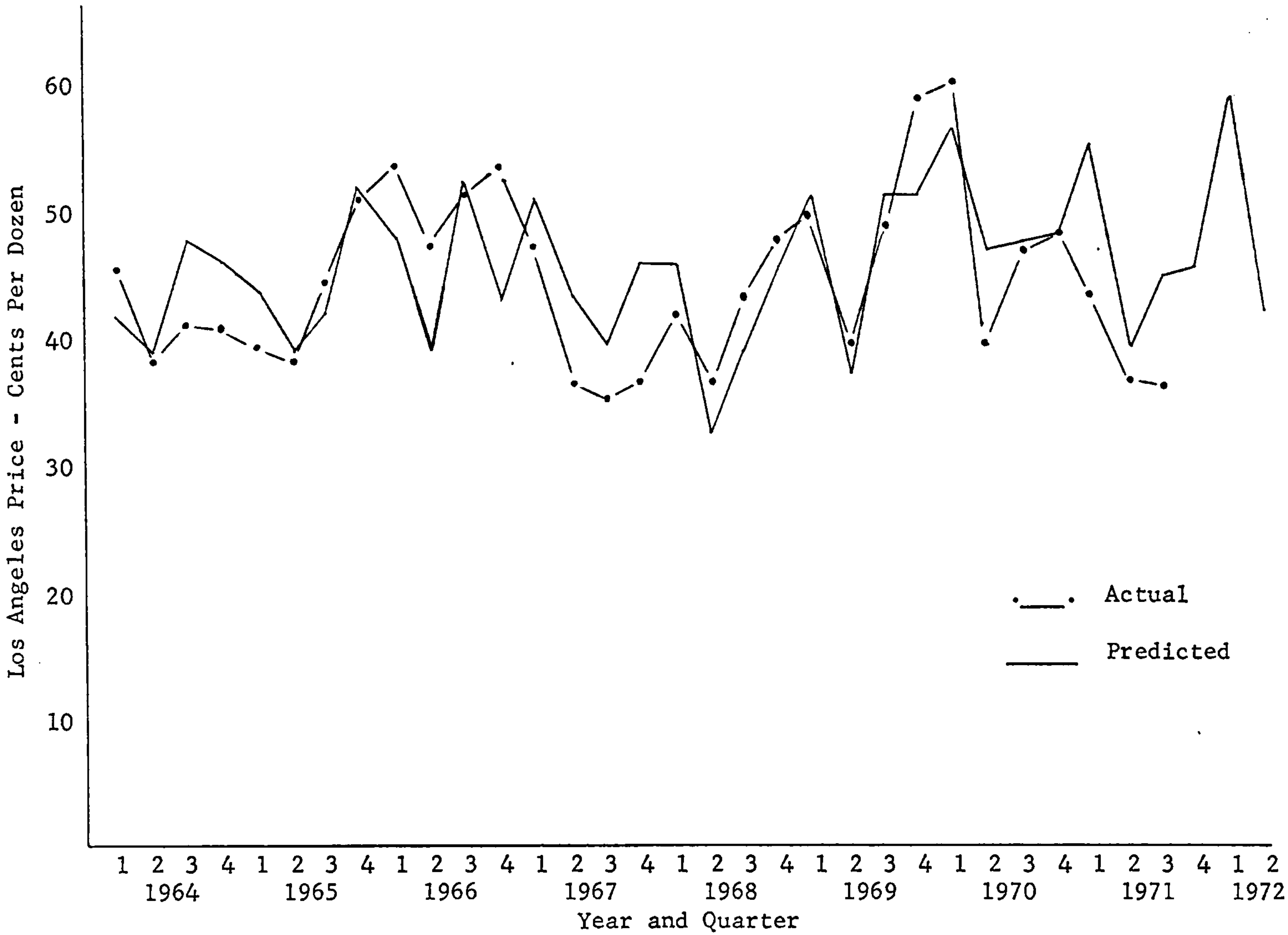

Figure 1. Graph of Actual and Predicted Prices for Four-Equation Model, by Quarters

Table 2. Actual and Predicted Prices Plus Residuals for Four-Equation Model, by Quarters

Year	Actual	Predicted	Residual
	(Cents/Dozen)		
1964			
1	45.5	41.7	+3.8
2	38.1	38.7	-0.6
3	41.2	47.7	-6.5
4	40.8	46.2	-5.4
1965			
1	39.7	43.8	-4.1
2	38.3	38.8	-0.5
3	44.3	42.3	+2.0
4	50.7	52.0	-1.3
1966			
1	53.7	48.1	+5.6
2	47.0	39.4	+7.6
3	51.7	52.1	-0.4
4	53.5	43.3	+10.2
1967			
1	47.0	51.2	-4.2
2	36.3	43.4	-7.1
3	35.3	39.5	-4.2
4	36.7	45.8	-9.1

Table 2.--Continued

Year	Actual	Predicted	Residual
1968			
1	41.7	45.8	-4.1
2	36.5	32.6	+3.9
3	43.3	39.1	+4.2
4	47.7	45.4	+2.3
1969			
1	49.7	51.0	-1.3
2	39.3	37.3	+2.0
3	48.7	51.1	-2.4
4	58.7	51.1	+7.6
1970			
1	60.3	56.7	+3.6
2	39.5	46.5	-7.0
3	46.8	47.4	-0.6
4	47.9	47.9	0.0
1971			
1	43.2	55.2	-12.0
2	36.5	39.6	-3.1
3	36.3	44.9	-8.6
4		45.6	
1972			
1		59.1	
2		42.1	

variables. The positive coefficient of D_2 implies production to be larger during the second period as compared to the first, third, or fourth period. Y'_{t-3} and R'_{t-3} appear to support the hypotheses regarding the effect on the dependent variable Y'_t by the positive signs on the estimated coefficients of these variables. E'_{t-3} and L_{t-3} appear to contradict our hypotheses with having negative signs on the parameters. A negative coefficient for E'_{t-3} is possible if the average productivity per layer decreases but production increases because of a larger number of layers in the flock. This could be the result of replacement pullets entering the laying flock. A young pullet's laying rate is generally lower than that of a mature layer. When replacement pullets are added and old layers are not culled, flock size increases and average productivity per bird decreases. Total production however increases because of the larger flock size. Analyzing L_{t-3} implies that an increase in the flock size, holding average productivity constant, would increase production. However, there is a negative coefficient for L_{t-3}. A possible explanation is that L_{t-3} refers to the number of layers three-quarters or nine months ago. When chicks are placed for laying flock replacement, it takes five to six months for them to reach the laying stage. If L_{t-3} was relatively large, this would imply, holding all other variables constant, a low price. The low price would discourage farmers from increasing their flock size through pullet replacements unless otherwise committed to buying new birds. Therefore, flock size would probably stay the same or may even decrease through heavy culling. The effect would not be felt until the pullets reached laying stage, five to six months later. This would be near the beginning of the current quarter. Present flock size would determine current production. However, the flock size three-quarters ago, L_{t-3}, influenced the level of production during the current quarter. In other words, a large number of layers three-quarters ago signified a lower number of layers during the current quarter and a lower production level. Thus, the negative coefficient for L_{t-3}.

The final equation in the three-quarter lag model, H_t, has all of its variables significant to the one per cent probabilities level except D_3 which was then excluded. Variables D_1 and D_2 are helpful in explaining any seasonal variations that cannot be explained by H_{t-3} and $(H_{t-4} - H_{t-5})$. Since D_1 and D_2 have positive coefficients, it implies that H_t is larger during the first and second quarters as compared to the third and fourth quarters. In addition, it can be said that the seasonal variation in the number of eggs used for hatching is insignificant between the third and fourth quarter. The variables H_{t-3} and $(H_{t-4} - H_{t-5})$ are rather naive in nature but they are quite useful for predictive purposes and in this equation have explained a large part of the variations in H_t.

Evaluation of Results

The four-equation model in this chapter was not the most accurate model analyzed. The price prediction equation had the highest coefficient of determination (R^2), .91, lowest standard error of estimate (SEE), 0.023257, and the highest F ratio, 30.27, of the price equations examined but was not the best predictor of price. Actually, the values represent a combination of equations P_t and B_t's power to predict. The reason for this is that the P_t and B_t equations were solved simultaneously and the results did not represent alone the predictive ability of the price equation. A simple correlation between actual and predicted was calculated from first quarter of 1964 to first quarter of 1970. The correlation coefficient was .82 or in terms of R^2, approximately .68.

A comparison of actual and estimated prices between the first quarter of 1964 and third quarter of 1971 revealed that actual prices changed direction 15 times while estimated prices changed 18 times. Of the 18 times, two were for decreases when actual price increased and three were increases when actual price decreased. A plot of residuals against time and estimated price disclosed no trends or abnormalities in forecasting by the four-equation model (Figures 2 and 3).

An examination of actual versus predicted prices outside the sample period denoted estimated prices decreasing in accuracy over time. The model was quite accurate in predicting third and fourth quarter prices of 1970 but not so in 1971. It may be suggested that a regular updating of the sample period would be important because passage of time may significantly affect the regression coefficients in the model. An example would be the development of Marek's vaccine which has significantly reduced the rate of fowl mortality. This has resulted in overestimating price in 1971. Therefore, forecasts extended too far beyond the sample time period may yield unreliable and poor predictions.

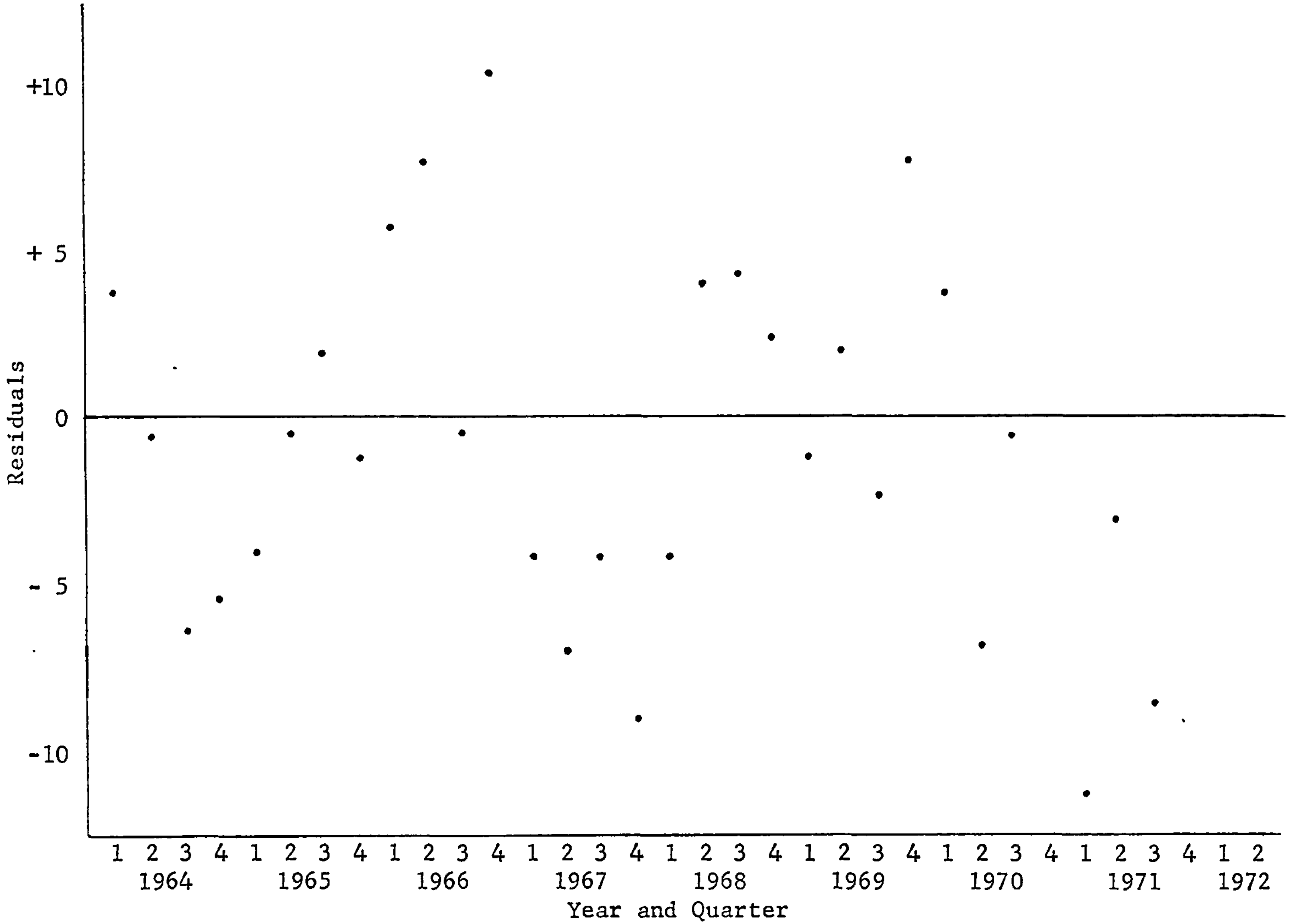

Figure 2. A Plot of Residuals Against Time for Four-Equation Model, by Quarters

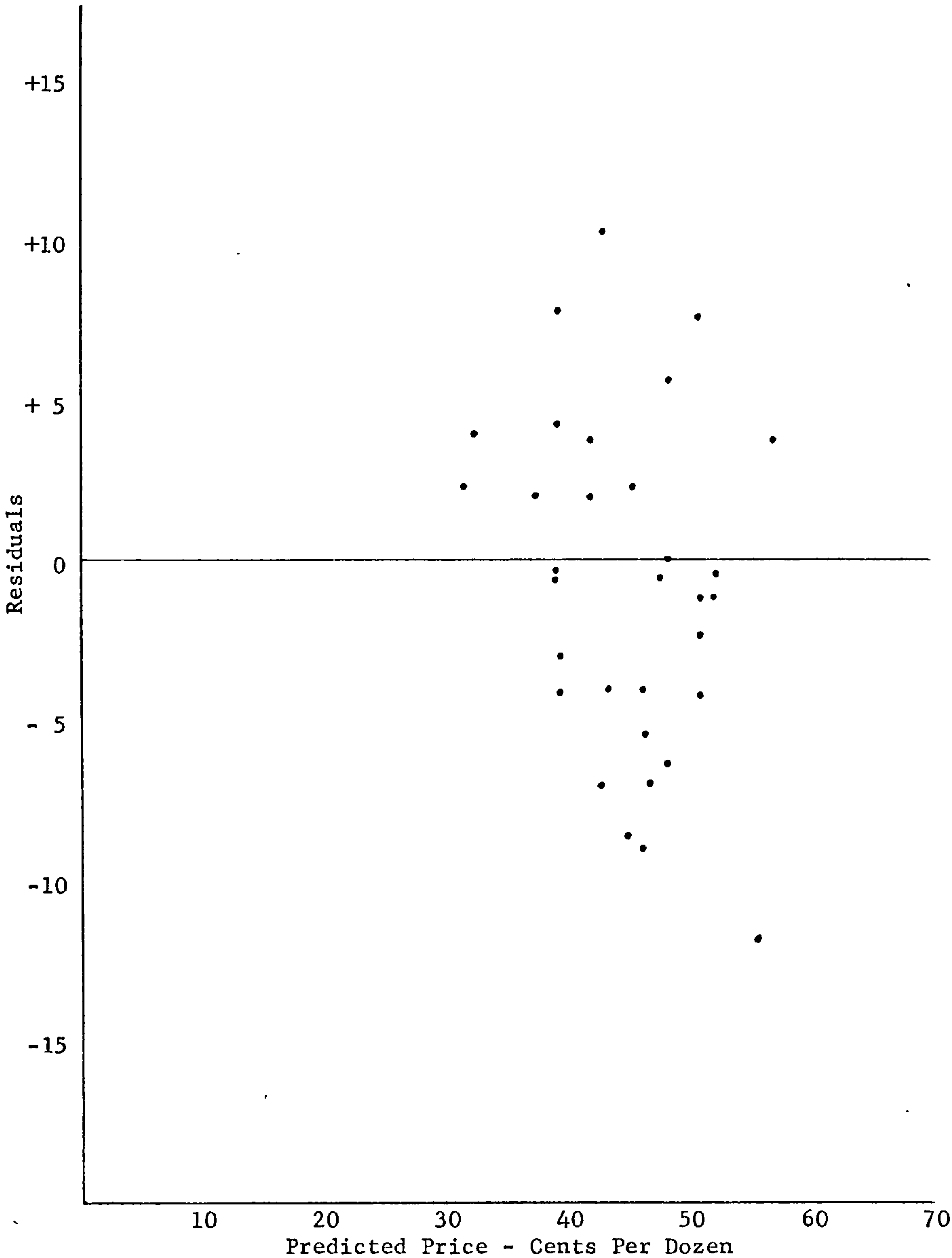

Figure 3. A Plot of Residuals Against Predicted Prices for Four-Equation Model, by Quarters

CHAPTER IV

ANALYSIS OF ALTERNATIVE MODELS

The complexity and inadequate predictive power of the four-equation model in Chapter III directed the analysis to simpler models with the objective of having better forecasting qualities. Each of the models presented is similar in terms of the variables or equations used to the four-equation model. Regional variables are analyzed with the purpose of examining local factors that affect price and of improving the predictive qualities in the price forecast models.

Model I

The first model examined was a single equation model composed of the price equation from Chapter III. All variables in the equation were lagged three-quarters with the objective of having a simple model but accurately forecasting price. The same basic assumptions followed this equation as in the price equation of the four-equation model. The results from the use of stepwise regression and ordinary least squares estimation were as follows:

$$P_t = 4.60544 + \underset{(1.26358)}{0.067018}\, D_1' + \underset{(.597667)}{0.033064}\, D_2' + \underset{(.078239)}{0.005982}\, D_3' -$$

$$\underset{(.514244)}{1.11344}\, Y_{t-3} + \underset{(1.64871)}{1.42613}\, H_{t-3} - \underset{(2.17570)}{0.562958}\, B_{t-3} - \underset{(1.93151)}{0.727636}\, P_{t-3}$$

$R^2 = .60$

SEE = 0.050311

$F_{(7,\ 17)} = 3.665$

. The numbers in parenthesis below the regression coefficient are associated with t ratios which indicate the statistical significance of the variable.

An examination of the estimated equation shows that B_{t-3} and P_{t-3} were significant at the 10 per cent probability level, that H_{t-3} was significant at only the 20 per cent level and that the other variables were insignificant. The signs associated with the coefficients correspond correctly to the hypotheses presented in Chapter III except for P_{t-3}. The negative coefficient for P_{t-3} indicates that a high price for shell eggs three-quarters ago would encourage increases in production. The impact of increased production on price would not be fully realized until the current quarter, lower prices resulting. This is based on the assumption that it takes approximately two- to three-quarters before production can become fully adjusted.

A look at the standard partial regression coefficients for Model I denoted that variable H_{t-3} was most significant in determining price (Table 4) even though it was not the most significant variable in terms of t value. It was followed by variables B_{t-3} and P_{t-3}. Standard partial regression coefficients are the partial regression coefficients when each variable is in standard units. Therefore, a comparison of the coefficients indicates the relative importance of the independent variables involved. The largest absolute value of the standardized regression coefficients denotes the independent variable which is most

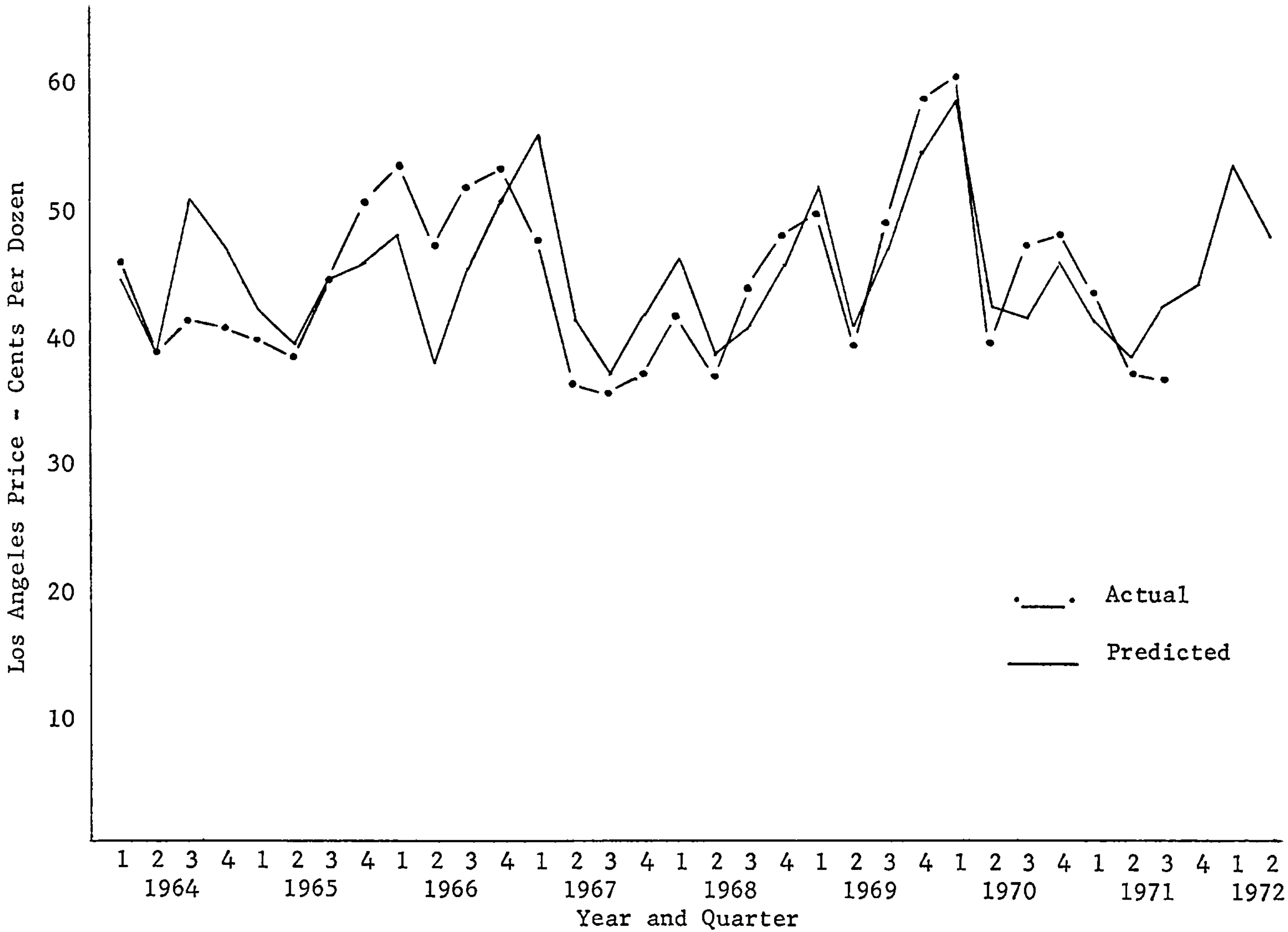

Figure 4. Graph of Actual and Predicted Prices for Model I, by Quarters

Table 3. Actual and Predicted Prices Plus Residuals for Model I, by Quarters

Year	Actual	Predicted	Residual
	(Cents/Dozen)		
<u>1964</u>			
1	45.5	44.2	+1.3
2	38.1	38.0	+0.1
3	41.2	50.7	-9.5
4	40.8	46.5	-5.7
<u>1965</u>			
1	39.7	41.8	-2.1
2	38.3	39.2	- .9
3	44.3	44.3	0.0
4	50.7	45.7	+5.0
<u>1966</u>			
1	53.7	47.8	+5.9
2	47.0	37.8	+9.2
3	51.7	45.2	+6.5
4	53.5	50.8	+2.7
<u>1967</u>			
1	47.0	55.8	-8.8
2	36.3	41.0	-4.7
3	35.3	36.9	-1.6
4	36.7	41.8	-5.1

Table 3.--Continued

Year	Actual	Predicted	Residual
1968			
1	41.7	46.0	-4.3
2	36.5	38.2	-1.7
3	43.3	40.4	+2.9
4	47.7	45.4	+2.3
1969			
1	49.7	51.7	-2.0
2	39.3	40.8	-1.5
3	48.7	46.5	+2.2
4	58.7	54.3	+4.4
1970			
1	60.3	58.5	+1.8
2	39.5	42.1	-2.6
3	46.8	41.4	+5.4
4	47.9	45.6	+2.3
1971			
1	43.2	41.2	+2.0
2	36.5	38.3	-1.8
3	36.3	42.3	-6.0
4		44.0	
1972			
1		53.3	
2		47.5	

Table 4. Standard Partial Regression Coefficients for the Variables of Model I

Variable	Standardized Coefficient
D_1'	.457882
D_2'	.214867
D_3'	.038868
Y_{t-3}	-.319006
H_{t-3}	1.23981
B_{t-3}	-1.15098
P_{t-3}	-.628843

highly associated with variation of the dependent variable. For example, H_{t-3} was twice as important in determining price as P_{t-3}.

Model II

An attempt to increase the predictive power of this equation was considered by using regional variables in the analysis. Regional variables are referred to as variables that may affect the price of eggs in a particular region of the U.S. because of the economic or institutional characteristics that it may possess. The first regional variable analyzed was referred to as C_t. California is the number one egg producer in the U.S. and since it is a surplus producer of eggs, C_t is referred to as the total estimated surplus production in California. This was derived by subtracting the total consumption -- U.S. per capita consumption of eggs times the population in California -- from the total production in California. The variable was lagged three-quarters in the equation and it was hypothesized that the larger the surplus condition for eggs in California, the more depressing effect it would have on price. The other variables in the equation remained the same as in the previous model.

Model II:

$$P_t = -3.18427 - \underset{(2.57949)}{0.085466}\, D_2' - \underset{(2.84632)}{0.086664}\, D_3' + \underset{(3.35164)}{.921311}\, H_{t-3} -$$

$$\underset{(5.17856)}{.563925}\, B_{t-3} - \underset{(1.52808)}{.312260}\, P_{t-3} + \underset{(4.97278)}{.740906}\, C_{t-3}$$

$R^2 = .79$

SEE = 0.035623

$F_{(6,\ 18)} = 11.181$

Addition of C_{t-3}, total estimated surplus in California, significantly increased the predictive qualities of the estimated equation. The variable itself was significant at the one per cent probability level. However, the sign on the coefficient for C_{t-3} did not correspond to the hypothesis given. The hypothesis would be true if the variable was estimated for the current period. However, C_{t-3} was lagged three-quarters. This suggests that a large surplus of eggs three-quarters previous tends to lower prices of eggs during the same period. The relatively low price may influence the farmer or rancher not to increase his flock size significantly until prices become more favorable. The effect of this decision would not be realized until the replacement flock reached laying stage, several months later. Therefore, current production may not be significantly different from the production three-quarters ago, but assuming per capita consumption to be constant, the current consumption would increase because of the increase in population during this time. This would imply a decrease in the surplus number of eggs which would indicate a rise in the price of eggs during the current quarter. This could explain the positive relationship between C_{t-3} and P_t. Other variables in the model have correct signs associated with the coefficients and are significant at the one per cent probability level except for P_{t-3}. It was significant at the 20 per cent level. Variables Y_{t-3} and D_1 were excluded from the equation because of their insignificance.

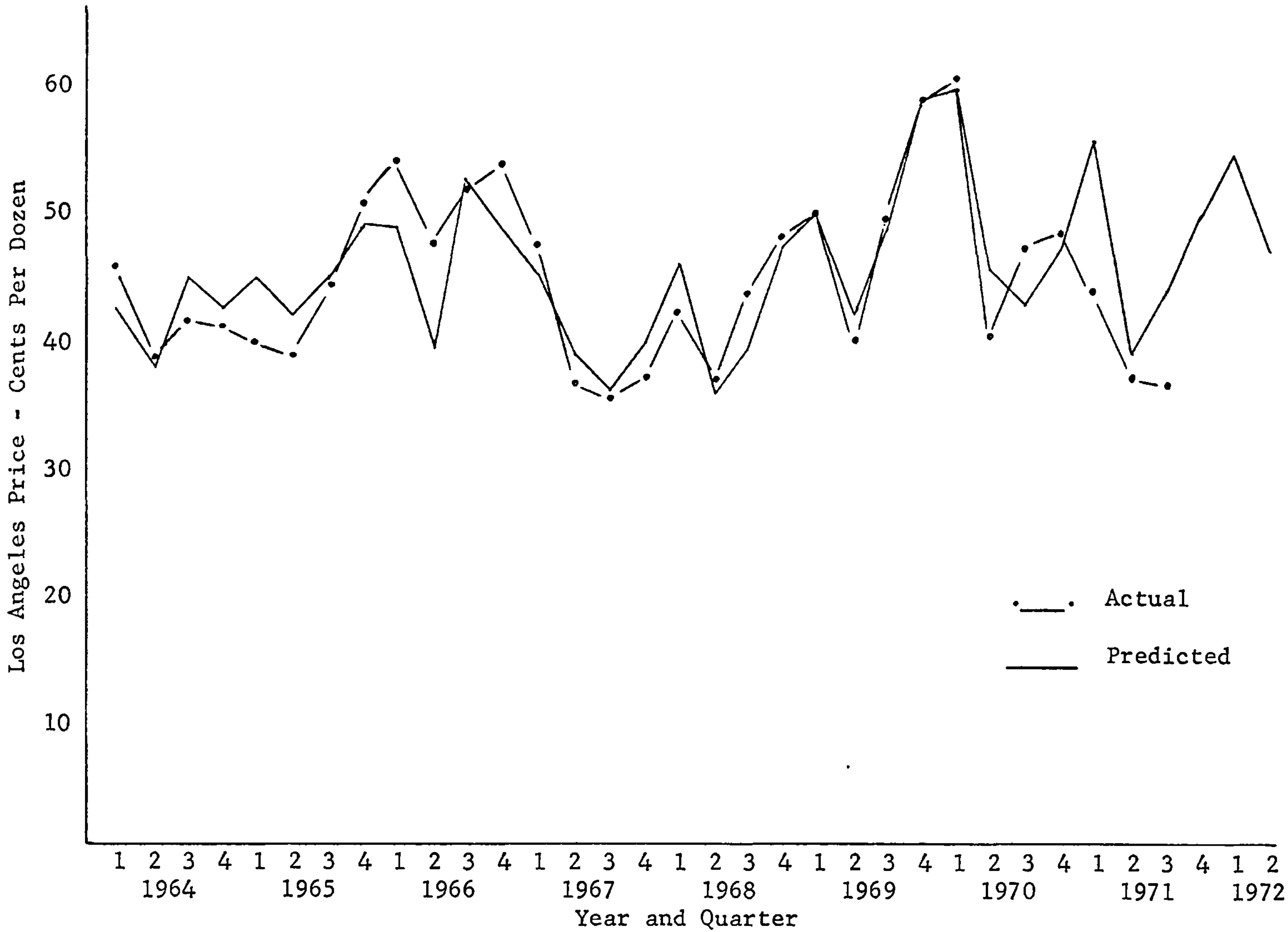

Figure 5. Graph of Actual and Predicted Prices for Model II, by Quarters

Table 5. Actual and Predicted Prices Plus Residuals for Model II, by Quarters

Year	Actual	Predicted	Residual
	(Cents/Dozen)		
1964			
1	45.5	42.3	+3.2
2	38.1	37.5	+0.6
3	41.2	44.7	-3.5
4	40.8	42.3	-1.5
1965			
1	39.7	44.6	-4.9
2	38.3	41.7	-3.4
3	44.3	44.7	-0.4
4	50.7	48.5	+2.2
1966			
1	53.7	48.3	+5.4
2	47.0	39.8	+7.2
3	51.7	52.4	-0.7
4	53.5	48.3	+5.2
1967			
1	47.0	44.8	+2.2
2	36.3	38.6	-2.3
3	35.3	35.8	-0.5
4	36.7	39.6	-2.9

Table 5.--Continued

Year	Actual	Predicted	Residual
1968			
1	41.7	45.6	-3.9
2	36.5	35.8	+0.7
3	43.3	38.8	+4.5
4	47.7	46.8	+0.9
1969			
1	49.7	49.7	0.0
2	39.3	41.7	-2.4
3	48.7	48.4	+0.3
4	58.7	58.6	+0.1
1970			
1	60.3	59.6	+0.7
2	39.5	45.0	-5.5
3	46.8	42.6	+4.2
4	47.9	46.9	+1.0
1971			
1	43.2	55.3	-12.1
2	36.5	38.6	-2.1
3	36.3	43.5	-7.2
4		49.4	
1972			
1		53.9	
2		46.4	

An examination of the standard partial regression coefficients (Table 6) of Model II indicated that variable B_{t-3} was the most important determinant of price followed by variables H_{t-3} and C_{t-3}.

Another regional variable considered to further improve the predictive power of the single equation model was the substitution of California egg production (K_t) for U.S. egg production (Y_t) lagging K_t three-quarters. California is divided into two egg markets, Northern and Southern California, and lack of available data prevented the use of only Southern California production figures in the analysis. Since the Southern California market is larger of the two markets, it was assumed that any variations in Southern California production would be represented in the total production figures. California production therefore, was assumed to have the same effect on the Los Angeles price as Y_t, that is, an increase in production would raise the available supply and, hence, depress the price level. The results from the regression illustrated that K_{t-3} does affect price inversely but was quite insignificant in the model.[1] It proved to be as insignificant as the Y_{t-3} variable in the original price equation.

Other variables analyzed in the price-equation model and proved to be insignificant in determining the Los Angeles shell egg price were (1) total U.S. cold storage holdings of frozen eggs; (2) total surplus production of eggs in the U.S.; (3) total surplus production of shell eggs in the U.S.; and (4) military purchase of

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1. Appendix A, p. 78.

Table 6. Standard Partial Regression Coefficients for the Variables of Model II

Variable	Standardized Coefficient
D_2'	-.555416
D_3'	-.563199
H_{t-3}	.800936
B_{t-3}	-1.15295
P_{t-3}	-.269866
C_{t-3}	.764230

shell eggs in the Los Angeles market. All four of the variables were lagged three-quarters in the model.

Model III

An attempt to derive a better predictor of price involved expanding the price-equation model to three equations. The reason for the expansion of the price-equation model was to improve the predictive power of the model but still be somewhat simpler than the four-equation model of Chapter III. The three-equation model is composed of a price equation, a production equation, and a hatching equation.

The three general equations are

$$P_t = a + b_1D_1 + b_2D_2 + b_3D_3 + b_4Y_t + b_5H_t + b_6B_{t-3} + b_7W_{t-3} + b_8U_{t-3}$$

$$Y'_t = a + b_1D_1 + b_2D_2 + b_3D_3 + b_4Y'_{t-3} + b_5E'_{t-3} + b_6R'_{t-3} + b_7L_{t-3} + b_8P_{t-3}$$

$$H_t = a + b_1D_1 + b_2D_2 + b_3D_3 + b_4H_{t-3} + b_5(H_{t-4} - H_{t-5}) + b_6P_{t-3} + b_7U_{t-3}$$

where

W_{t-i} = U.S. cold storage holdings of frozen eggs at the close of the month, thousands of pounds, (t-i) quarters, in common logarithms

U_{t-i} = Total production minus total shell egg consumption in the U.S. in million, (t-i) quarters, in common logarithms

The remaining variables are the same as in the four-equation model in the previous chapter.

The first function P_t has Y_t, H_t, and B_{t-3} having the same assumptions as the price prediction equation in the previous chapter. The dummy variables D_1, D_2, and D_3 are expected to take into account any seasonal variations in price left unexplained by the exogenous variables. In regard to the other two variables, W_{t-3} and U_{t-3}, it is hypothesized for W_{t-3}, cold storage holdings of frozen eggs, that the more number of eggs put into cold storage frozen, the less number of eggs available in the shell egg form to the consumer and hence, a higher shell egg price assuming all other factors constant. With respect to variable U_{t-3}, total U.S. egg production minus total U.S. shell egg consumption, it is assumed that the greater production is overconsumption, more eggs will exist in surplus and therefore, a lower shell egg price. The variable U_{t-3} is derived by multiplying per capita consumption of eggs in the U.S. in quarters times population in the U.S. in quarters and subtracting this figure from the total production in the U.S. Both variables in the model are lagged three-quarters.

The second relationship has production of eggs in the current period a function of the same variables presented in the four-equation model plus the addition of Los Angeles price lagged three-quarters. As presented in the analysis of Chapter III, the price of eggs was a function of egg production during the current period. However, egg production during the current period was not a function of the shell egg price in the current period. Therefore, it was assumed that the production of eggs is a function of the price of eggs during some previous time period. It is further hypothesized that if price of shell eggs is relatively high during the period, it will encourage farmers and ranchers to increase their flock size and hence, increase production of eggs in the future.

The third function had the number of eggs used for hatching (H_t) a function of two additional variables over the hatching equation of the previous chapter. Besides being a function of H_{t-3}, ($H_{t-4} - H_{t-5}$), and the dummy variables, H_t was also described as a function of the Los Angeles price of eggs delivered in cartons to retailers lagged three-quarters (P_{t-3}) and of U.S. total production minus U.S. total shell egg consumption lagged three-quarters (U_{t-3}). It was hypothesized that an inverse relationship exists between P_{t-3} and H_t. All other factors held constant, when the price of eggs is relatively high, a higher percentage of eggs would go to the shell egg market to benefit from high prices and a lower percentage would be designated for hatching. With respect to U_{t-3}, it was hypothesized that the more surplus eggs in the shell egg market, the more tendency of eggs being diverted to the hatching market because of the low price expected on the shell egg market. Hence, a positive relationship would exist assuming of course, other variables remained the same.

Each equation is estimated with stepwise multiple regression and ordinary least squares estimation. The estimations were based on 25 observations beginning with the first quarter of 1964 and ending with the first quarter of 1970. The numbers in parenthesis below the regression coefficients are associated t ratios which indicate the statistical significance of the variables. The prime sign (') beside some variables designates that they are in actual units while all other variables are expressed in logarithmic units.

Model III:

$$P_t = 14.4507 - \underset{(-1.72149)}{0.094314}\, D_1' - \underset{(2.00892)}{0.126490}\, D_2' - \underset{(2.30461)}{0.075674}\, D_3' -$$

$$\underset{(3.26894)}{5.58836}\, Y_t + \underset{(3.33040)}{2.18909}\, H_t - \underset{(3.01234)}{1.04335}\, B_{t-3} + \underset{(1.68687)}{0.130110}\, W_{t-3} +$$

$$\underset{(1.91945)}{0.991936}\, U_{t-3}$$

$R^2 = .75$

SEE = 0.0407306

$F_{(8,\ 16)} = 6.14$

$$Y_t' = 14{,}358.7 + \underset{(2.24533)}{808.562}\, D_1' + \underset{(6.08876)}{1963.77}\, D_2' + \underset{(6.49339)}{1.12083}\, Y_{t-3}' -$$

$$\underset{(2.26907)}{4.70006}\, E_{t-3}' + \underset{(1.94652)}{22.1078}\, R_{t-3}' + \underset{(3.01033)}{4348.28}\, P_{t-3}$$

$R^2 = .89$

SEE = 257.102

$F_{(6,\ 18)} = 23.40$

$$H_t = 0.490428 + \underset{(4.23699)}{0.104183}\, D_1' + \underset{(6.55412)}{0.145466}\, D_2' + \underset{(4.74771)}{0.844841}\, H_{t-3} -$$

$$\underset{(2.48297)}{0.469951}\, (H_{t-4} - H_{t-5})$$

$R^2 = .78$

SEE = 0.028948

$F_{(4,\ 20)} = 17.38$

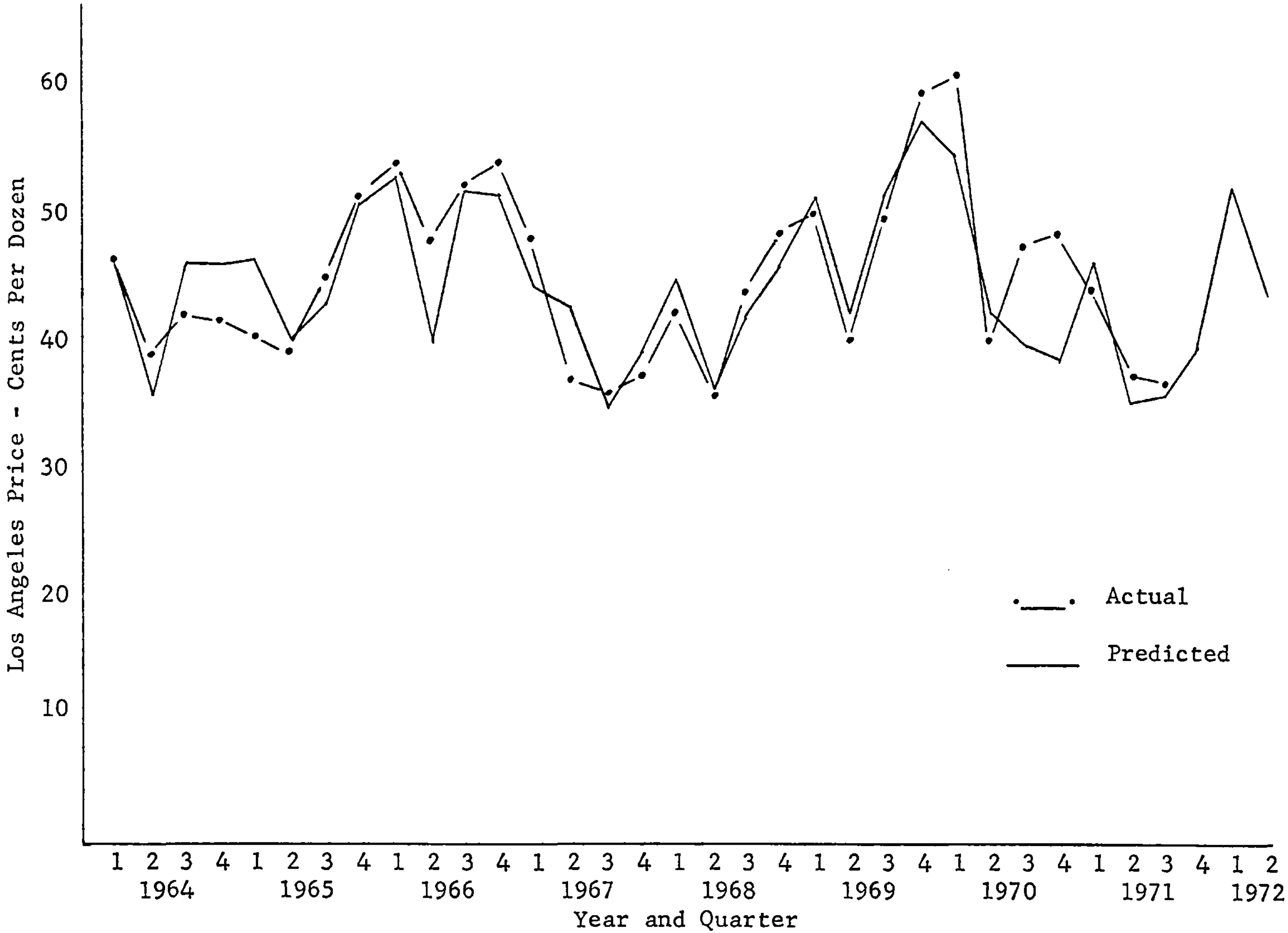

Figure 6. Graph of Actual and Predicted Prices for Model III, by Quarters

Table 7. Actual and Predicted Prices Plus Residuals for Model III, by Quarters

Year	Actual (Cents/Dozen)	Predicted	Residual
1964			
1	45.5	45.4	+0.1
2	38.1	35.2	+2.9
3	41.2	45.1	-3.9
4	40.8	45.1	-4.3
1965			
1	39.7	45.6	-5.9
2	38.3	39.8	-1.5
3	44.3	42.5	+1.8
4	50.7	50.1	+0.6
1966			
1	53.7	52.4	+1.3
2	47.0	39.4	+7.6
3	51.7	51.3	+0.4
4	53.5	51.0	+2.5
1967			
1	47.0	43.7	+3.3
2	36.3	42.0	-5.7
3	35.3	34.1	+1.2
4	36.7	38.6	-1.9

Table 7.--Continued

Year	Actual	Predicted	Residual
1968			
1	41.7	44.1	-2.4
2	36.5	36.9	-0.4
3	43.3	41.2	+2.1
4	47.7	45.2	+2.5
1969			
1	49.7	50.5	-0.8
2	39.3	41.9	-2.6
3	48.7	50.9	-2.2
4	58.7	56.5	+2.2
1970			
1	60.3	53.9	+6.4
2	39.5	41.7	-2.2
3	46.8	38.7	+8.1
4	47.9	37.6	+11.6
1971			
1	43.2	45.6	-2.4
2	36.5	34.3	+2.2
3	36.3	35.2	+1.1
4		39.0	
1972			
1		51.4	
2		43.1	

An examination of the price equation revealed that all of the hypothesized variables were present. The variables Y_t, H_t, and B_{t-3} were significant at the one per cent probability level, while D_1, D_2, D_3, and U_{t-3} were significant at the 10 per cent probability level. Variable W_{t-3} was significant at 20 per cent probability level. The constant term in the estimated price equation represented the intercept related to the fourth quarter. The intercepts for the quarter D_1, D_2, and D_3 can be derived by the algebraic addition of the respective parameters to the constant term in the above function. The negative signs associated with the dummy variables imply a downward shift in the price during the first three-quarters as compared to the fourth. The dummy variables have taken into account any seasonal variations in the price that could not be fully explained by other exogenous variables.

The number of eggs used for hatching (H_t) affected price in the same direction, while current production (Y_t) and number of eggs broken for processing (B_{t-3}) influenced current price in the reverse direction. The regression coefficient related to W_{t-3} was positive as hypothesized while the coefficient associated with U_{t-3} was positive instead of the expected negative estimate. It contradicts the hypothesis that an increase in egg surplus would have a depressing effect on price (P_t). This hypothesis would be true if the variable was estimated for the current period. However, U_{t-3} was lagged three-quarters, the same as C_{t-3}. Therefore, U_{t-3} would tend to affect price in the same way as C_{t-3} in the price-equation model. This would explain the positive relationship between U_{t-3} and P_t.

The hypothesis regarding the four exogenous variables, Y'_{t-3}, E'_{t-3}, R'_{t-3}, and P_{t-3}, on the dependent variable, Y'_t, total production, appeared to be supported by the estimated signs of the variables. The coefficient related with R'_{t-3} was significant at about the 10 per cent probability level while the coefficient associated with E'_{t-3} was significant at five per cent probability level. The coefficients of Y'_{t-3} and P_{t-3} were significant at the one per cent probability level. The dummy variable for the third quarter, D_3, and L_t have been excluded because of their insignificance. The insignificance of dummy variable D_3 indicates no seasonal variation in production during the third and fourth quarter. However, variables D_1 and D_2 were both significant at five per cent probability level, and appeared to be helpful in explaining the seasonal variations in production during the first two quarters.

The final equation in the three-equation model was the hatching equation. The result was the same as the hatching equation in the four-equation model of Chapter III. It had all of its variables significant at the one per cent probability level. Variables D_3 and P_{t-3} were excluded because of their insignificance. Variable U_{t-3} was the first variable to enter the equation with the use of stepwise regression. When the other variables entered the equation, it became less significant because of the interrelationships that existed between the variables. It therefore, had to be dropped from the equation. The variables H_{t-3} and $(H_{t-4} - H_{t-5})$ are rather naive in nature, but are quite useful for predictive purposes and in this equation have explained a significant part of the variation in H_t.

The standard partial regression coefficients for the price equation of Model III (Table 8) pointed out that the variable B_{t-3} was again most important. It was followed by variables U_{t-3} and H_t.

Evaluation of Results

The price prediction models in this chapter were all three-quarter lagged. Two of the models were composed of one equation while the third model was three equations. In terms of coefficient of determination (R^2), standard error of estimate (SEE), and F ratio, the second model with $R^2 = .79$, SEE = 0.035623, and F = 11.81 proved to be the best predictor of price followed by the third and then the first model. A comparison of actual prices and estimated prices between the first quarter of 1964 and third quarter of 1971 disclosed that actual price changed directions 15 times while estimated price for Model II changed 18 times. Models I and III each changed direction 16 times during the period. Of the 18 times Model II changed directions, two were for decreases when actual price increased and three were increases when actual price decreased. Model I twice showed increases when actual price decreased and once showed a decrease when actual price increased. Finally, the third model increased twice when actual price decreased and decreased twice when actual price increased.

A plot of residuals against time and forecasted price was done for each model. The purpose was to examine any trends or abnormalities in each model that may exist in predicting price. The three models

Table 8. Standard Partial Regression Coefficients for the Variables of the Price Equation in Model III

Variable	Standardized Coefficient
D_1'	-.644363
D_2'	-.822017
D_3'	-.491785
Y_t	-1.33748
H_t	1.62766
B_{t-3}	-2.13315
W_{t-3}	.290992
U_{t-3}	1.73340

evaluated disclosed no significant long-term trends or abnormalities in forecasting price (Figures 7, 8, 9, 10, 11, and 12).

The standard partial regression coefficients for each of the models disclosed that variable B_t, number of eggs broken commercially, was the most significant variable in determining price of the variables analyzed. In two of the models it was most significant and in the third, it was second. Other variables that were significant in determining price were H_t, number of eggs used for hatching; U_t, total estimated surplus production in the U.S.; and C_t, total estimated surplus production in California. As mentioned in the previous chapter, a regular updating of the sample period may be helpful in improving the predictive qualities of selected models.

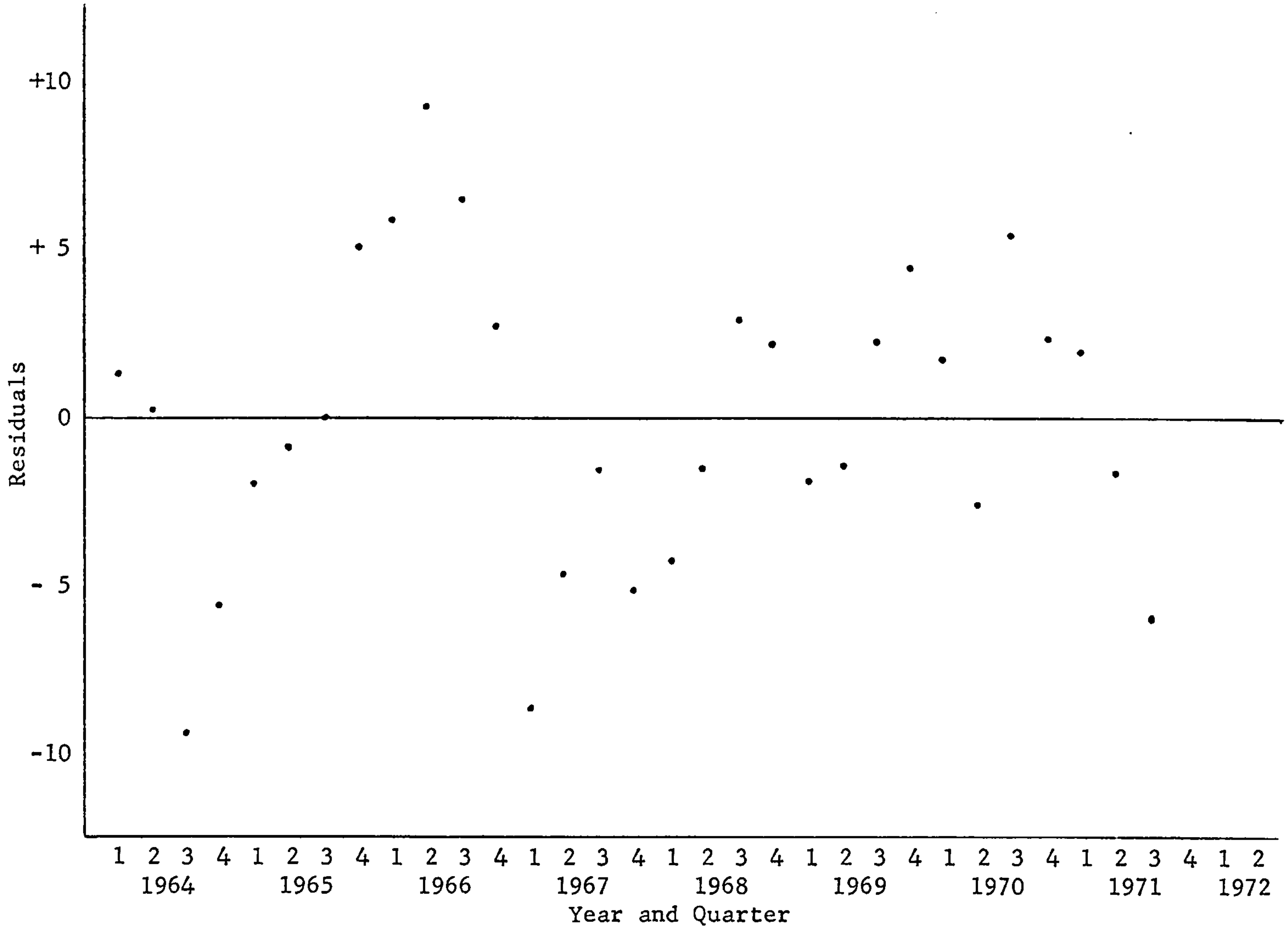

Figure 7. A Plot of Residuals Against Time for Model I, by Quarters

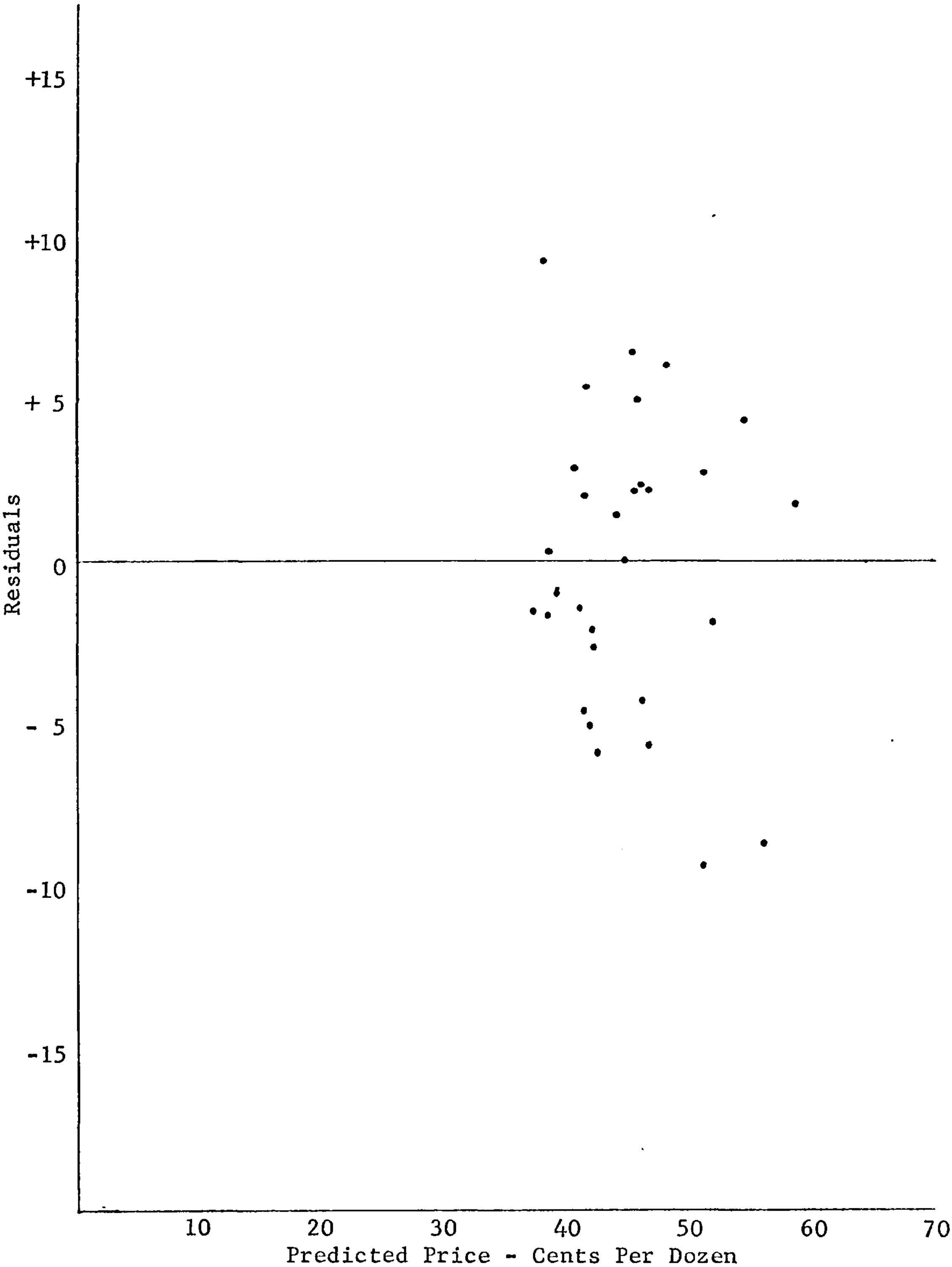

Figure 8. A Plot of Residuals Against Predicted Prices for Model I, by Quarters

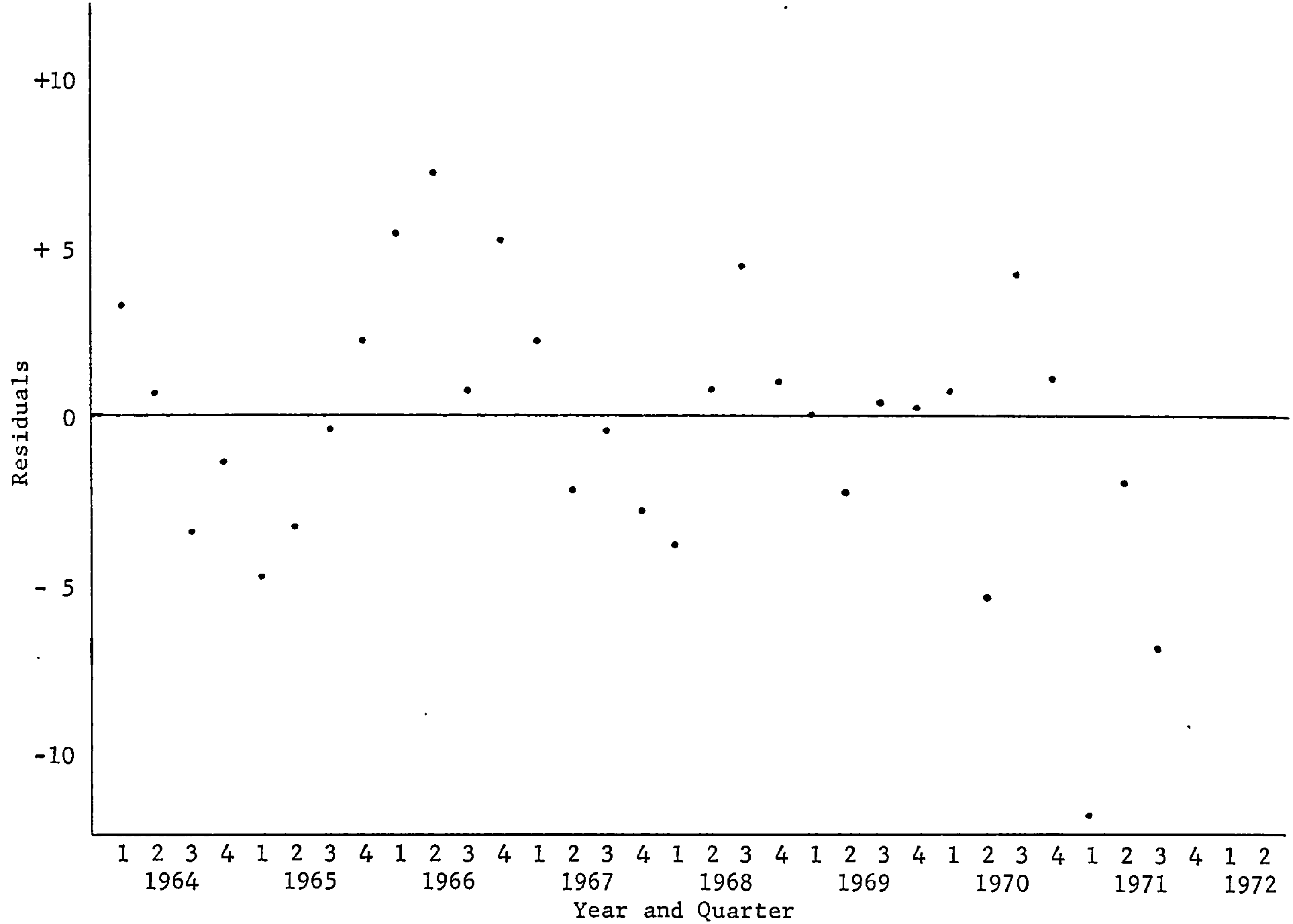

Figure 9. A Plot of Residuals Against Time for Model II, by Quarters

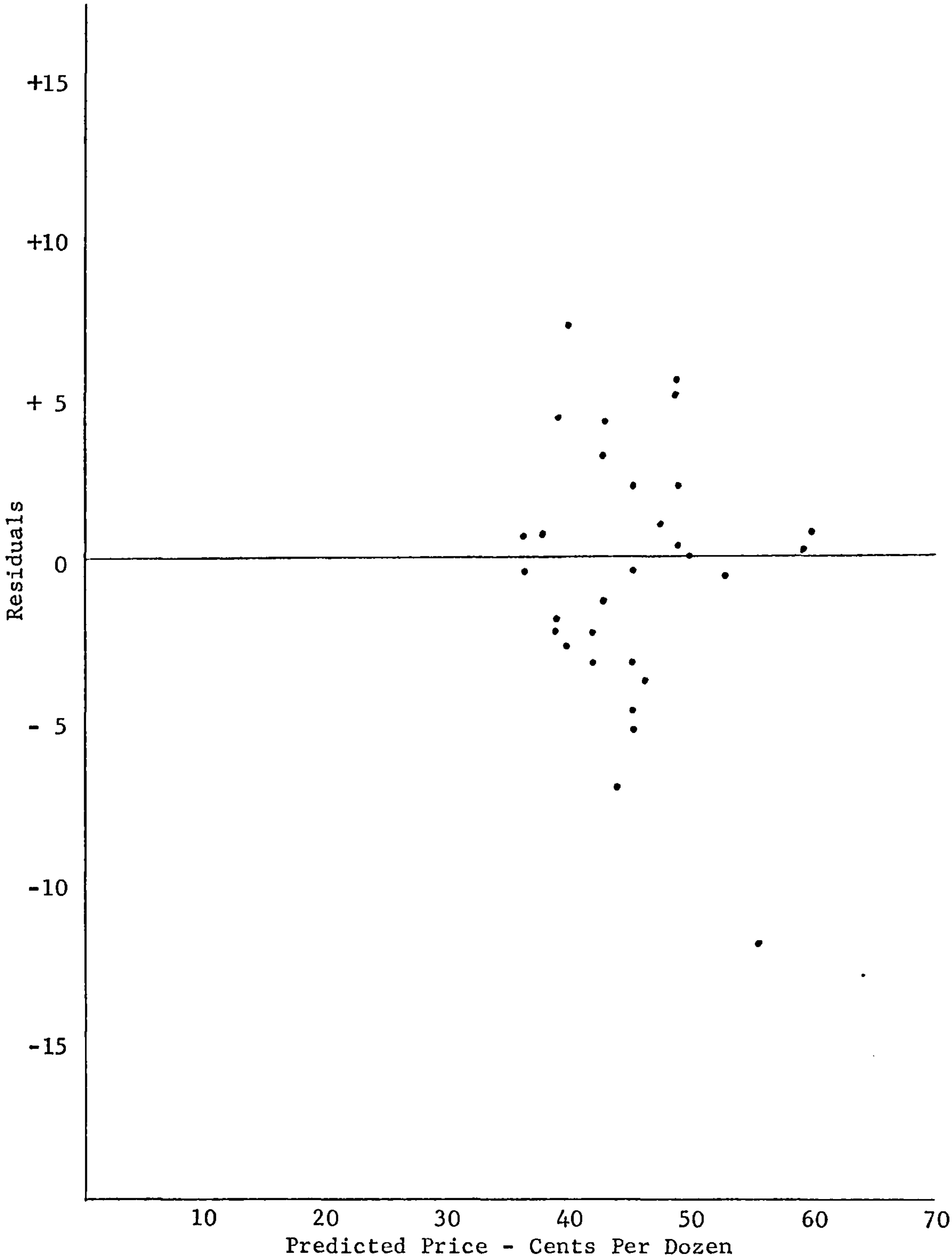

Figure 10. A Plot of Residuals Against Predicted Prices for Model II, by Quarters

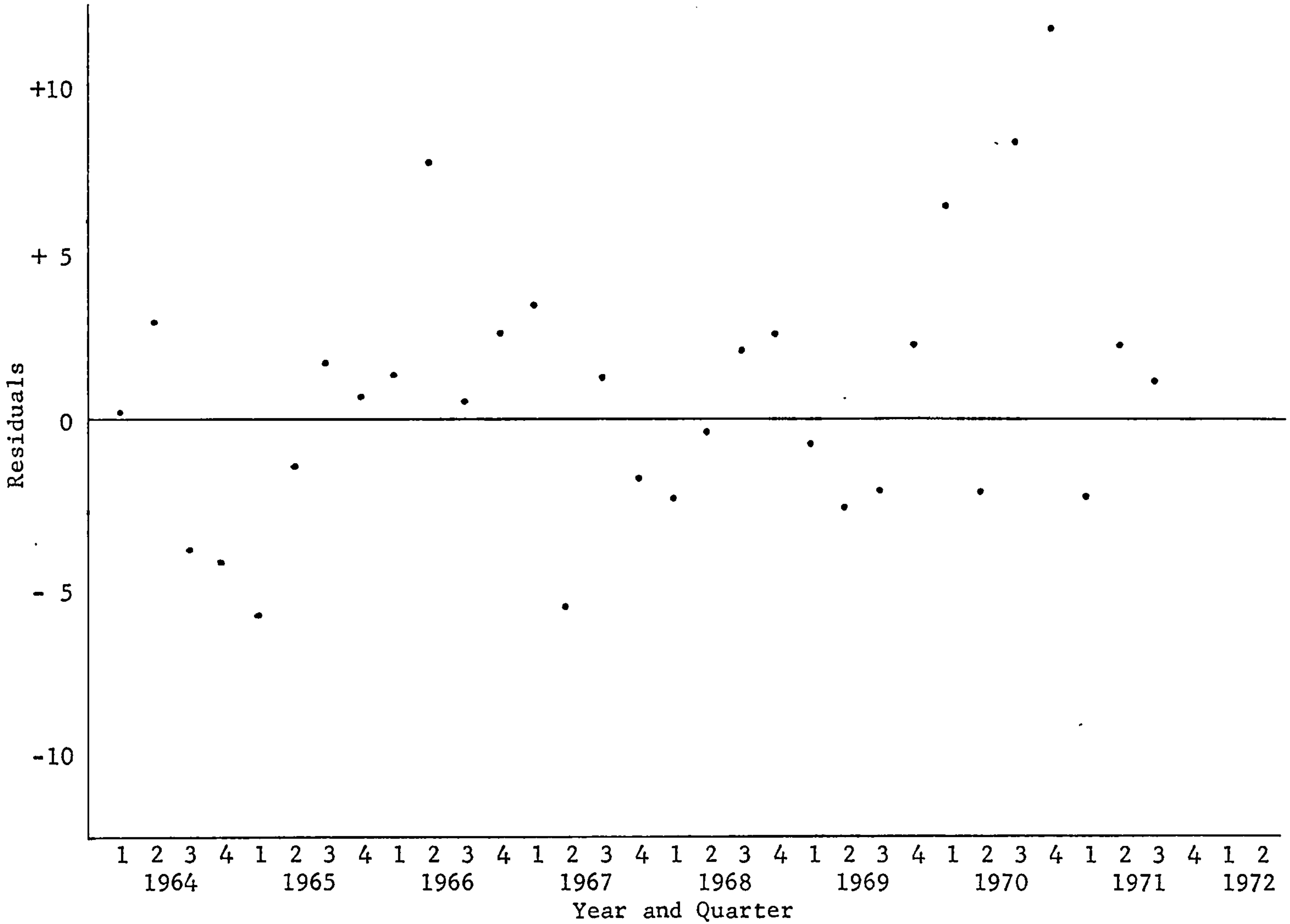

Figure 11. A Plot of Residuals Against Time for Model III, by Quarters

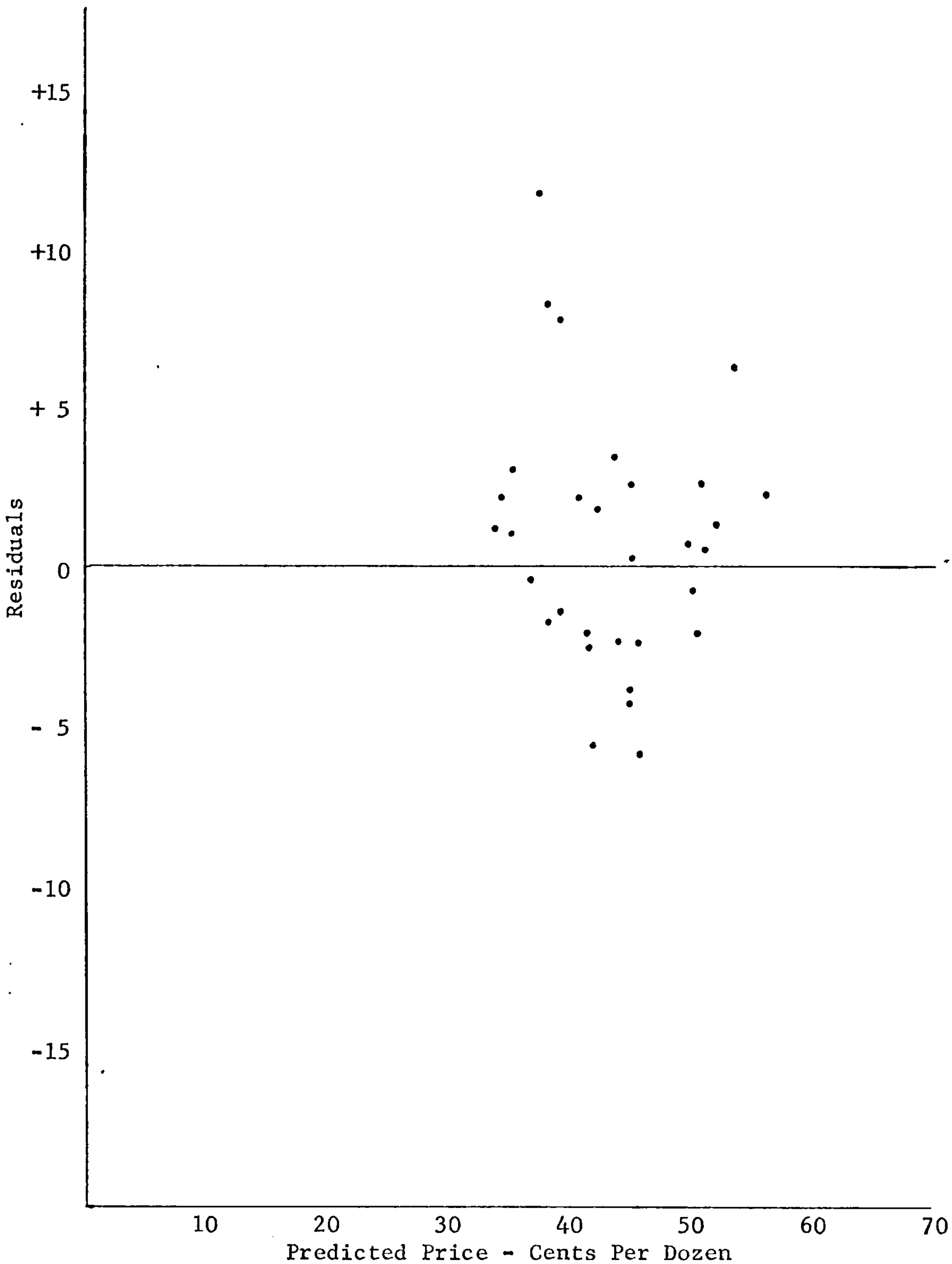

Figure 12. A Plot of Residuals Against Predicted Prices for Model III, by Quarters

CHAPTER V

SUMMARY AND CONCLUSIONS

The commercial egg industry in this country has undergone considerable change in the past several years. Substantial shifts in production and marketing have occurred. The low price situation experienced by producers in 1971 has been aggravated by efficiencies of large-scale production and new technologies. United Egg Producers has attempted to manipulate price by recommending to its members to reduce flock size and production.

The purpose of this study has been to examine the relationships in the poultry industry with the objective of deriving a price forecast model to predict egg prices in Los Angeles. The model would be used by producers in Southern California and Arizona to plan production so as to maximize net returns or minimize losses.

The models analyzed were aimed at making unconditional forecasts and were analytical rather than naive in structure. Each model was lagged three-quarters and forecasted the Los Angeles price delivered-to-retailers in cartons. This price was used because Arizona prices are highly correlated with Los Angeles prices. Since the trend in California egg marketing is to eggs sold to retailers in cartons, the price chosen to be forecasted was the Los Angeles price delivered-to-retailers in cartons. Inferences could be made toward wholesale and farm prices because they would follow the same pattern as the retail price only at lower levels.

The first model examined was a four-equation model similar to Roy's quarterly model. The four-equation model consisted of a price (P_t), a hatching (H_t), a production (Y_t), and an eggs broken commercially (B_t) equation. The dependent variable of each equation was forecasted for the current quarter. The price and the eggs broken commercially equation were solved simultaneously to derive P_t and B_t values. Each of the four equations had dummy variables to explain any variation in the dependent variable left unexplained by the independent variables. It was assumed that the functional relationships or the regression coefficients estimated on the basis of past observations would more or less remain unchanged when predictions were made.

The four-equation model was not the best price prediction model analyzed. Since the P_t and B_t equations were solved simultaneously, the computed coefficient of determination (R^2) for the price equation was not representative of the equation's predictive power. It was found to be somewhat less, approximately .68. This was one of the lowest derived. Variables H_t, D_2, and Y_t however, were significant in determining P_t which offered basis for improving the model in some way.

The objective of deriving an accurate forecast model for predicting Los Angeles prices directed the analysis to simpler models with the purpose of having better predictive powers than the four-equation model. The first two models examined were each composed of only a single equation. All variables in the two models were lagged three-quarters. The same basic assumptions followed these equations as in the price equation of the four-equation model. Regional variables were analyzed with the purpose of examining local factors that affected price and of improving the predictive qualities of the price equation models.

Results from the analysis showed that Model I, $R^2 = .60$, was not as accurate in predicting price as the four-equation model, but Model II, $R^2 = .79$, proved to be significantly more accurate in determining price. One of the variables significant in Model II was a regional variable C_{t-3}, total estimated surplus production of eggs in California. In terms of the standard partial regression coefficients, it was the third most important variable in Model II.

An attempt to increase the predictive power of Model II involved expanding the price-equation model to three equations. Model III was composed of a price equation (P_t), a production equation (Y_t), and a hatching equation (H_t). The dependent variable for each equation was forecasted for the current quarter. As in the four-equation model and the two previous models, dummy variables were used in each equation.

The results indicated that Model III, $R^2 = .75$, was a better forecaster of price than the four-equation model but was not as accurate as Model II in determining price. No regional variables were significant in determining the Los Angeles price for Model III.

Examination of the models disclosed that Model II had the highest R^2, .79, lowest SEE, 0.035623, and the highest F ratio, 11.181. It was generally considered the best price forecast model analyzed.

Evaluation of the predicted prices for each model outside the sample time period disclosed that forecasts made in 1971 were generally higher than the reported prices. The price received by producers during 1971 was usually below the cost of production. However, producers continued to expand rapidly causing further increases in production and lower prices. The development of vaccine for Marek's disease has greatly reduced fowl mortality resulting in more eggs being produced, greatly affecting the forecast model. These and other factors have made the egg industry in 1971 and the first couple months of 1972 to be abnormal and have made price forecasting hazardous.

Predicting prices for any model presented in this thesis too far beyond the sample period may affect the accuracy of the forecast. The regression coefficients may be assumed to be fairly stable within a short span of time but may change over a longer time period due to new developments. With the passage of time, the sample period may be updated by introducing new observations and eliminating an equal number of original observations from the beginning of the sample period. This will retain an equal sample size and maintain an acceptable level of accuracy in predicting the Los Angeles price.

Lack of appropriate data is always a major problem in empirical studies and the present one is no exception. The preceding prediction models were postulated within the existing limitations of data and presumably the completeness of the structure of the models and their predictive accuracy have been affected. Some variables that may have improved the predictive power of the models examined but were not available, were the number of eggs in inventory, the price of eggs used for hatching, and the price of eggs broken commercially. If these variables could become available and the existing variables available sooner, attempts in the future to formulate a short-run price prediction model would achieve a greater degree of success in yielding more accurate forecasts of price.

APPENDIX A

SUPPLEMENTARY MATERIAL

Cost of Production

Schlechty's thesis stated that the cost of producing a dozen eggs in 1963 with flock size greater than 65,000 layers was 28.3 cents in California. Using the index of prices paid by farmers for production from the Agricultural Handbook of 1971, the estimated cost of producing a dozen eggs in 1971, based on the cost of 1963, was found to be approximately 34 cents. The 34 cents per dozen figure was only an estimate and considered quite high. General feeling is that actual cost is somewhere around 30 or 31 cents per dozen.

Model IV

$$P_t = -4.15409 + \underset{(2.11976)}{.065719}\, D_1 - \underset{(-4.82932)}{.118581}\, D_2 - \underset{(-4.92271)}{.148523}\, D_3 +$$

$$\underset{(4.75961)}{2.34314}\, K_{t-3} - \underset{(-4.43687)}{.552413}\, B_{t-3}$$

$R^2 = .73$

SEE = 0.038878

$F_{(5,\ 19)} = 10.487$

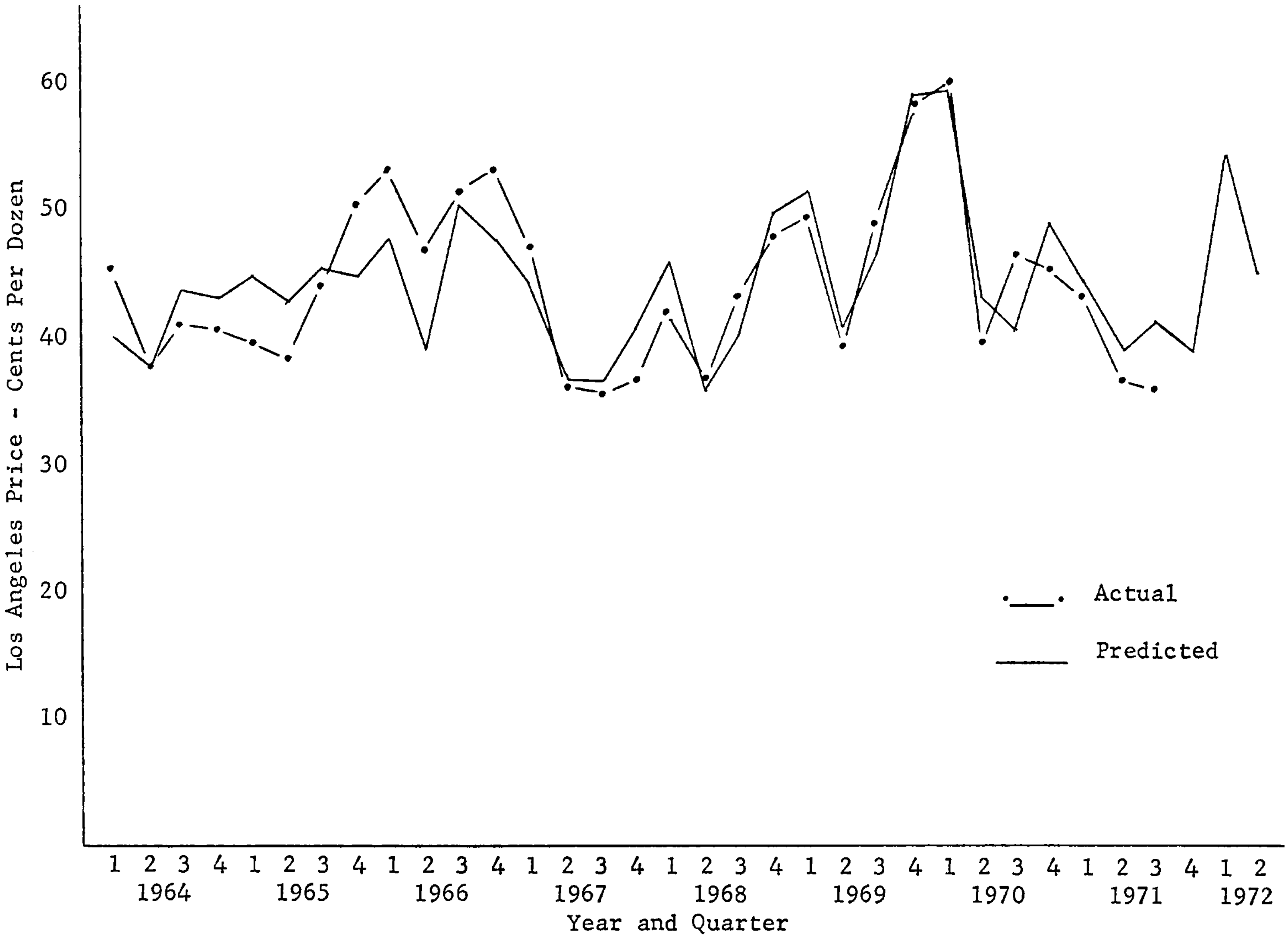

Figure 13. Graph of Actual and Predicted Prices for Model IV, by Quarters

Table 9. Actual and Predicted Prices Plus Residuals for Model IV, by Quarters

Year	Actual	Predicted	Residual
1964			
1	45.5	40.3	+5.2
2	38.1	38.0	+0.1
3	41.2	44.1	-2.9
4	40.8	43.4	-2.6
1965			
1	39.7	45.0	-5.3
2	38.3	43.4	-5.1
3	44.3	45.4	-1.1
4	50.7	45.1	+5.6
1966			
1	53.7	48.1	+5.6
2	47.0	39.7	+7.3
3	51.7	50.7	+1.0
4	53.5	48.0	+5.5
1967			
1	47.0	44.3	+2.7
2	36.3	37.1	-0.8
3	35.3	36.7	-1.4
4	36.7	40.8	-4.1

Table 9.--Continued

Year	Actual	Predicted	Residual
1968			
1	41.7	46.0	-4.3
2	36.5	35.8	+0.7
3	43.3	40.3	+3.0
4	47.7	49.9	-2.2
1969			
1	49.7	51.9	-2.2
2	39.3	41.1	-1.8
3	48.7	46.9	+1.8
4	58.7	59.3	-0.6
1970			
1	60.3	59.5	+0.8
2	39.5	43.2	-3.7
3	46.8	40.6	+6.2
4	45.5	48.9	-3.4
1971			
1	43.2	54.4	-11.2
2	36.5	39.5	-3.0
3	36.3	41.5	-5.2
4		39.3	
1972			
1		54.8	
2		45.2	

APPENDIX B

STATISTICAL TABLES

Table 10. Total Number of Chicks Placed for Laying Flock Replacements (R_t), by Quarters

Year	Quarter			
	1	2	3	4
		(Millions)		
1963	79.365	119.601	46.575	42.198
1964	81.896	115.225	51.530	46.089
1965	72.221	104.513	52.902	48.693
1966	82.026	119.316	62.767	63.063
1967	86.068	107.702	59.717	51.277
1968	71.550	93.592	64.626	64.309
1969	75.323	94.551	67.833	66.127
1970	88.363	92.510	56.890	56.105
1971	69.810	81.870	62.020	

Source: Poultry and Egg Situation, Economic Research Service, U.S. Department of Agriculture.

Table 11. Total Number of Layers on Farm on the First Day of the Quarter (L_t)

Year	Quarter			
	1	2	3	4
		(Millions)		
1963	308	299	285	300
1964	307	298	287	302
1965	313	301	294	304
1966	309	302	293	312
1967	325	317	308	323
1968	329	320	306	313
1969	316	313	307	314
1970	326	319	312	322
1971	335	324	314	322

Source: Poultry and Egg Situation, Economic Research Service, U.S. Department of Agriculture.

Table 12. Total U.S. Production of Eggs (Y_t), by Quarters

Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4
	(Millions)			
1963	15,696	16,704	15,264	15,552
1964	16,272	16,812	15,552	15,840
1965	16,308	17,064	15,984	16,092
1966	16,308	17,028	16,164	16,956
1967	17,424	17,964	17,316	17,460
1968	17,784	17,784	16,884	16,848
1969	16,992	17,712	17,028	17,208
1970	17,244	17,820	17,352	17,820
1971	17,964	18,211	17,676	

Source: Poultry and Egg Situation, Economic Research Service, U.S. Department of Agriculture.

Table 13. Total Number of Eggs Used for Hatching (H_t), by Quarters

Year	Quarter			
	1	2	3	4
		(Thousand Cases)		
1963	3007	2948	2204	2395
1964	2980	2863	2233	2316
1965	2932	3073	2471	2614
1966	3209	3350	2794	2789
1967	3330	3269	2698	2605
1968	3174	3278	2799	2901
1969	3358	3476	3044	3264
1970	3737	3708	2995	3135
1971	3418	3501	3068	

Source: Poultry and Egg Situation, Economic Research Service, U.S. Department of Agriculture.

Table 14. Average Price during the Quarter for Los Angeles Grade AA Large Delivered-to-Retailers in Cartons (P_t)

Year	Quarter			
	1	2	3	4
	(Cents Per Dozen)			
1963	43.4	37.5	41.6	43.8
1964	45.5	38.1	41.2	40.8
1965	39.7	38.3	44.3	50.7
1966	53.7	47.0	51.7	53.5
1967	47.0	36.3	35.3	36.7
1968	41.7	36.5	43.3	47.7
1969	49.7	39.3	48.7	58.7
1970	60.3	39.5	46.8	47.9
1971	43.2	36.5	36.3	

Source: Poultry and Egg Situation, Economic Research Service, U.S. Department of Agriculture.

Table 15. Total Number of Eggs Per 100 Layers (E_t), by Quarters

Year	Quarter			
	1	2	3	4
1963	5186	5727	5287	5098
1964	5401	5756	5348	5174
1965	5411	5744	5396	5235
1966	5344	5729	5415	5306
1967	5457	5761	5522	5353
1968	5490	5694	5473	5338
1969	5401	5717	5504	5382
1970	5351	5623	5413	5394
1971	5468	5705	5588	

Source: Poultry and Egg Situation, Economic Research Service, U.S. Department of Agriculture.

Table 16. Total Number of Eggs Broken Commercially (B_t), by Quarters

Year	Quarter			
	1	2	3	4
	(Thousand Cases)			
1963	2720	5880	3434	2048
1964	3395	5956	3280	2521
1965	4153	5437	3897	2432
1966	2929	5671	3690	3441
1967	4756	6588	5155	3798
1968	4210	5652	4300	2972
1969	2944	5393	4261	3614
1970	4008	5739	4867	4424
1971	4838	5818	4747	

Source: Poultry and Egg Situation, Economic Research Service, U.S. Department of Agriculture.

Table 17. Total Estimated Surplus of Eggs in California (C_t) by Quarters[a]

Year	Quarter			
	1	2	3	4
	(Thousands)			
1963	318,854	540,751	566,899	449,058
1964	362,374	581,316	619,766	532,549
1965	489,194	555,122	602,670	605,040
1966	377,982	506,994	508,354	444,206
1967	383,734	537,644	542,800	494,906
1968	435,794	536,540	587,880	542,500
1969	451,055	635,050	611,240	498,808
1970	401,680	557,199	562,101	538,854
1971	481,576	564,429	606,298	

[a]Total California egg production minus total estimated California egg consumption.

Table 18. Total Egg Production in California (K_t), by Quarters

Year	Quarter			
	1	2	3 (Millions)	4
1963	1697	1892	1931	1889
1964	1815	1959	2024	2003
1965	1930	1975	2027	2084
1966	1834	1925	1944	1961
1967	1907	2022	2062	2087
1968	2021	2057	2101	2108
1969	2009	2158	2142	2071
1970	1982	2106	2133	2175
1971	2100	2175	2219	

Source: Eggs, Chickens and Turkeys, Statistical Reporting Service, Crop Reporting Board, U.S. Department of Agriculture.

Table 19. Total Estimated Population of California, by Quarters

Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4
	(Thousands)			
1963	17,270	17,413	17,556	17,668
1964	17,780	17,892	18,003	18,109
1965	18,215	18,321	18,426	18,487
1966	18,548	18,609	18,669	18,749
1967	18,829	18,909	18,990	19,067
1968	19,145	19,222	19,300	19,375
1969	19,450	19,525	19,600	19,677
1970	19,754	19,831	19,910	19,953
1971	20,030	20,107	20,184	

Source: Statistical Abstract of the United States, U.S. Department of Commerce, Bureau of the Census.

Table 20. U.S. Per Capita Consumption of Eggs, Shell Plus Processed, by Quarters

Year	Quarter			
	1	2	3	4
1963	79.8	77.6	77.7	81.5
1964	81.7	77.0	78.0	81.2
1965	79.1	77.5	77.3	80.0
1966	78.5	76.2	76.9	80.9
1967	80.9	78.5	80.0	83.5
1968	82.8	79.1	78.4	80.8
1969	80.1	78.0	78.1	79.9
1970	80.0	78.1	78.9	82.0
1971	80.8	80.1	79.9	

Source: Poultry and Egg Situation, Economic Research Service, U.S. Department of Agriculture.

Table 21. U.S. Per Capita Consumption of Shell Eggs, by Quarters

Year	Quarter			
	1	2	3	4
1963	73.8	70.6	70.7	74.5
1964	74.0	69.3	70.3	73.5
1965	71.9	70.3	70.1	72.8
1966	71.1	68.8	69.5	73.5
1967	72.3	69.9	71.4	74.9
1968	74.6	70.9	70.2	72.6
1969	72.3	70.2	70.3	72.1
1970	71.1	68.9	69.8	71.8
1971	72.4	71.7	71.5	

Source: Poultry and Egg Situation, Economic Research Service, U.S. Department of Agriculture.

Table 22. Total Estimated Surplus of Eggs in the U.S. (U_t), by Quarters[a]

Year	Quarter			
	1	2	3	4
	(Thousands)			
1963	1,833,629	3,386,934	1,891,160	1,390,071
1964	2,155,094	3,544,861	2,045,964	1,673,757
1965	2,405,704	3,427,628	2,343,101	1,883,551
1966	2,390,175	3,520,565	2,478,963	2,442,763
1967	3,107,805	4,084,446	3,099,260	2,508,237
1968	2,854,078	3,558,482	2,763,130	2,204,072
1969	2,369,108	3,481,688	2,742,899	2,517,491
1970	2,718,128	3,577,697	2,879,940	2,800,646
1971	3,013,255	3,365,372	2,832,457	

[a]Total U.S. egg production minus total estimated U.S. shell egg consumption.

Table 23. Total Estimated Population of the U.S., by Quarters

Year	Quarter			
	1	2 (Thousands)	3	4
1963	187,837	188,627	189,417	190,093
1964	190,769	191,445	192,120	192,738
1965	193,356	193,974	194,592	195,171
1966	195,750	196,329	196,907	197,459
1967	198,011	198,563	199,114	199,623
1968	200,133	200,642	201,152	201,707
1969	202,253	202,711	203,202	203,752
1970	204,302	204,852	205,402	205,952
1971	206,502	207,052	207,602	

Source: Statistical Abstract of the United States, U.S. Department of Commerce, Bureau of the Census.

Table 24. Total U.S. Cold Storage Holdings of Frozen Eggs at the Close of Each Month (W_t), by Quarters

Year	Quarter			
	1	2	3	4
		(Thousand Pounds)		
1963	123,482	243,972	308,500	203,398
1964	129,989	253,745	319,316	211,174
1965	161,977	207,070	292,557	196,613
1966	90,181	130,316	175,095	121,155
1967	120,800	211,200	291,600	283,100
1968	246,500	288,800	320,700	246,500
1969	168,000	163,600	181,400	147,600
1970	123,100	131,300	179,200	172,400
1971	150,000	182,100	236,400	

Source: California Egg and Poultry Summary, Federal-State Market News Service, Consumer and Marketing Service, U.S. Department of Agriculture.

Table 25. Average Price during the Quarter for New York Wholesale Price 75% A Quality (N_t)

Year	Quarter			
	1	2	3	4
		(Cents Per Dozen)		
1964	37.5	32.3	39.1	38.3
1965	31.2	33.4	38.1	45.2
1966	45.0	37.8	45.6	46.2
1967	36.6	28.7	35.0	33.7
1968	33.8	30.1	44.6	46.4
1969	46.3	35.9	46.5	56.8
1970	55.0	34.4	43.1	39.7

Source: Poultry and Egg Situation, Economic Research Service, U.S. Department of Agriculture.

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