



The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.

AN OCTOBER PREDICTION OF THE DETROIT
NOVEMBER PRICE FOR EGGS AT THE WHOLESALE LEVEL

By

Moon K. Lee

The Research Paper to the
Department of Agricultural Economics
MICHIGAN STATE UNIVERSITY

in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE

June, 1971

ACKNOWLEDGMENTS

The research paper owes a formidable debt to professors Lester V. Manderscheid and Henry E. Larzelere, an author cannot even begin to acknowledge. They have guided me from the start and their patient and kind criticism and helpful suggestions have saved me many an error and enhanced the exposition immeasurably.

The author made frequent use of computer facilities at the University, and appreciated their cooperation.

Special thanks from my heart are due to my parents and my wife.

TABLE OF CONTENTS

Chapter I

Introduction

Problems	1
Nature of egg production	2

Chapter II

Background and Previous Studies

History	3
Production	4
Egg-type chicks Hatchery operation	11
Michigan egg industry	12
U. S. Egg price in General	13
U. S. Egg Pricing systems	17
Previous Studies	18

Chapter III

Price predicting equations

Source of data	26
Equation I	27
Equation II	32

Equation III	36
Equation IV	42
Estimating 1970 November Detroit Price	47

Chapter IV

Demand elasticities

Demand elasticity with respect to its own price	49
Economies of scale	52
Demand elasticity with respect to U. S. personal income..	56

Chapter V

SUMMARY	58
---------------	----

CHAPTER I

INTRODUCTION

The primary objective of this study is to formulate a multiple regression equation for predicting the November average price of Grade A, white, large eggs delivered in Detroit, Michigan. To accomplish the objective, several equations will be tried. The equation with the highest predicting power will be chosen to predict November price in 1970 as of October of that year. October was chosen on the basis that October price difference between medium and large size affected the November price considerably. Therefore the factor just could not be dropped. The secondary objective in the study is to examine demand elasticities for eggs. Egg producers and policy makers may have the base in making decisions if egg marketing order is in effective in future.

PROBLEMS:

The problem was to determine the independent variables that would account for the variation in Detroit November price. At first the technical or biological nature of producing eggs was studied. It is essential to know something about the kind of feed, production practice, the length of time period at each stage of growth and others. Secondly, marketing practices, channels, and egg market structure were studied. But due to limited time and efforts, the marketing pictures could not be fully exploited by the author. Further study concerning egg distribution and marketing channels in Midwestern region is badly needed. Another big obstacle in setting up the equations was insufficient data about the

Detroit area. Supply was believed to be on the national basis, but the demand situation in the Detroit metropolitan area could not be fixed, except the trend is that per capita demand has been decreasing since World War II. Therefore supply sides were the main targets to investigate. The question of vertical intergration and contracts between retailers and producers needs researching in Midwest. About 30% of producers were producing eggs on contract basis.

NATURE OF EGG PRODUCTION

It is necessary for us to know the technical aspects of the egg producing process, before we get into the complicated problems of marketing and pricing. The Single-Comb White Leghorn is the most popular breed in U.S., since the Leghorn is more productive and less risky to disease infections. After careful selection of hatching eggs, it takes about three weeks for the eggs in the incubator to hatch. Then the chicks were dried, counted, sorted and sexed in hatcheries. The undesirable chicks should be culled when they transferred from the incubator to the brooder house. Pullets, which are young female hens of less than one year old, are fed in the house until they are ready to lay. Pullets consume a large amount of feed and the rate of growth is higher than hens. So culling of the prospective low-productive pullets is desirable as early as possible. After approximately five months in the brooder house, pullets are old enough to be layers. At this stage pullets should be carefully culled and the laying house should be

thoroughly cleaned and disinfected before used. Most of the poultrymen keep laying hens in production for twelve months. The annual production of a flock producing eggs is usually characterized by a peak in rate of production in the second to third month of lay. But during the remainder of the laying year, the curve shows a steady gradual reduction in the flock and production. Some producers use the method of molting to expand production another year. In California 32% of hens and pullets of laying age had completed molting as of January 1, 1971.¹ Eight percent of layers in California were in the molting period. In the United States about ten percent of all layers are molted as of 1971. The rate of molting is expected to increase in the future, as the technique of molting improves.

CHAPTER II

BACKGROUND AND PREVIOUS STUDIES

HISTORY

Historically, chickens were brought to the United States from Europe by the earliest settlers at Jamestown, at the mouth of the James River, Virginia in 1607. Chickens and eggs were popular during Colonial days. By this time flocks increased in size and produced enough eggs for home supply and to exchange for groceries in the nearby town. The industry expanded to West of the Alleghenies. Further expansion was speeded up by inventing refrigeration, artificial incubation, and the brooding

1. USDA, SRS, Crop Reporting Board, Eggs, Chickens and Turkeys January, 1971.

system. Early this century the discovery of vitamins in feeding chickens brought a revolutionary change in nutrition. Statistics before 1909 are unable to be obtained. But 1910 saw that the U.S. produced 2,475 million dozen eggs which average 306 eggs to each person during the particular year¹. Since 1910, the industry has been changing rapidly in various aspects. After World War II, the production of eggs moved rapidly from a general farming operation to a commercial operation. But the consumption rate per person has been decreasing since 1945.

PRODUCTION

The United States was the world's largest egg producing country in 1969, comprising about one quarter of world production. USSR, ranked second. United States produced about 67 billion eggs in 1969, among these about 85% were consumed as domestic civilian table eggs in shell form². The remaining ten percent was shared by egg breakers, hatcheries, military persons and a negligible portion became exports. Imports can be overlooked due to a negligible amount. Year to year percentage change in U.S. production from 1946 to 1969 ranged from negative 3.7% to positive 5.4%. But the average year-to-year percentage change is 1.42%. Seasonal variation in production during two decades has reduced drastically from plus and minus average 15% in 1949 to plus and minus average 2.7% in 1969 illustrated in Figure 1.

1. USDA, ERS, Food, Consumption, Price, Expenditures
Agricultural Economics Report 138, 1968

2. USDA, Poultry and Egg Situation, No. 262, June 1970 P.20

The percentages are the averages of twelve months, where the monthly average percentage is the index of the annual average. The seasonal variation in egg production has reduced so much that today there is no difference in seasonality between non-agricultural production and egg production. Another point worth being noted is that the egg industry has grown about 13% during the last decade, while non-agricultural industries combined have grown 65%.¹ Consult the Figure 2. In respect to the shifting production area, in 1950 the North Central States and North Atlantic states produced about 80% of the nation's eggs. However, in 1970, South Atlantic, South Central, Western states produced about 58% of the nation's eggs. In particular, the South Atlantic states tripled production as compared to that of two decades ago. Western states almost doubled their egg production since 1950. West North Central states, including Iowa and Minnesota, saw the trend declining almost by half since 1950. The five largest egg producing states, California, Georgia, North Carolina, Arkansas and Pennsylvania, in order, are where about one third of U.S. eggs are produced. The number of layers in U.S. as of January 1, 1971 was 331 million heads. There are 1.6 layers per person. The percentage change from previous years in number of layers during the Korean War was about 3% each year. From 1954 to 1966, no serious fluctuation was recorded and the percentage change from previous years could be averaged about one percent up or down each year. But in 1967, the change jumped up to about four percent increase. 1968 and 1969 saw a slight

1. U.S. Department of Commerce, Office of Business Statistics, 1969 Business Statistics 17th Biannual Edition, 1969, P.10

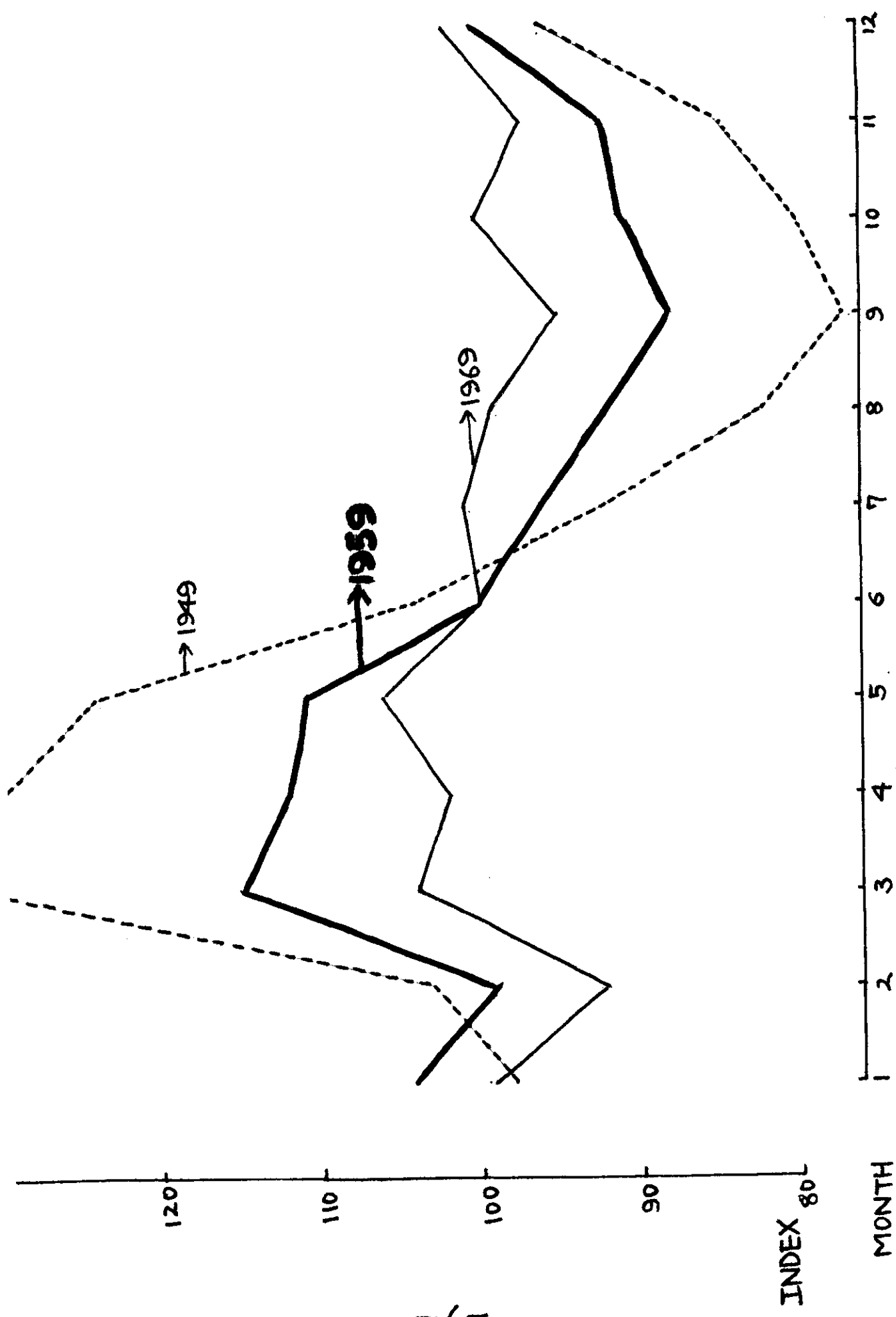


Figure 1; Seasonal egg production, U. S., 1949, 1959, 1969
Source; Various issues of P.E.S.

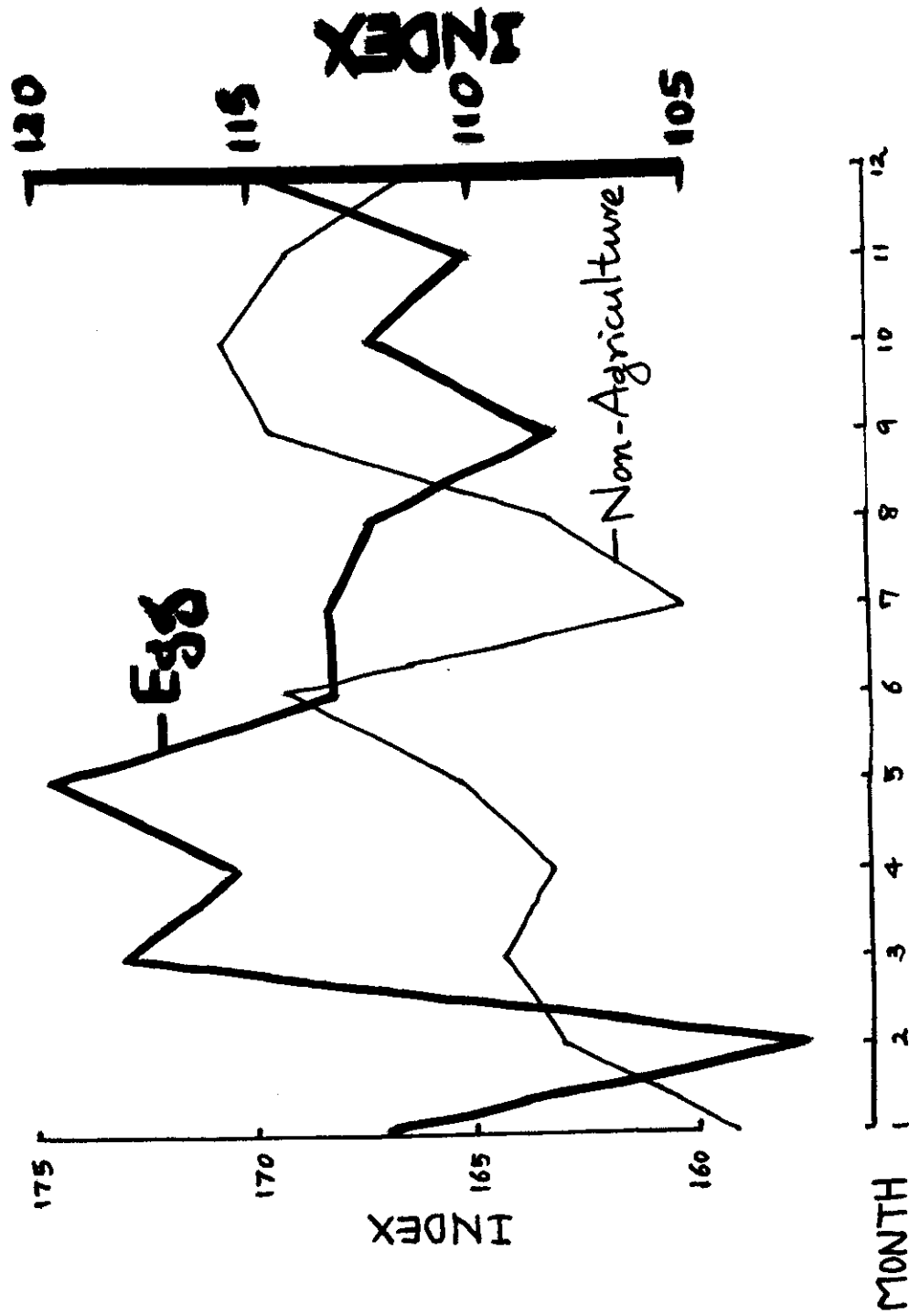


Fig 2; Seasonal production variation, 1968,

Comparison between Egg industry and Non-Agriculture Sector
 1957-59=100
 Source; U.S. Department of Commerce, 1969 Business statistics

decrease in the number of layers, resulting in higher egg price in the U.S. in 1969. This high price was partially due to the unchanged rate of lay per layer in 1969. Therefore about one percent increase in layers would be a normal growth, considering the rate of lay per layer increase. The rate is affected by many factors such as feed, layers health, comfort in laying house and the natural weather situation. This rate depends not only on the biological factors but also on that the poultrymens' expectations of future profits. The ratio between pullets and hens will greatly affect this rate. The more pullets, the higher the rate is. The rate of lay per bird in 1969 was 220 eggs. The annual rate of lay seems to be increasing at a decreasing rate over two decades. Figure 3 seems to indicate that there might be a probable three of four year cycle due to technology and adoption of the technology and age of flock. The above statement is hard to accept due to lack of concrete evidence. As of 1964, still 83% of U.S. farms sold their eggs, but about 80% of U.S. eggs came from 5% of the large flock owners who had flocks of more than 1000 birds. This fact of specialization would have been clearer, if the 1969 Census of Agriculture were on hand.

Table 1: Changes in Distribution of laying
flock size and egg production.
U.S., 1959 and 1964

Flock Size	1959 Percentage of Farm	1964	1959 % of Eggs Sold	1964
1 - 399	86	83	26	10
400 - 1599	10.4	12	22.8	12.6

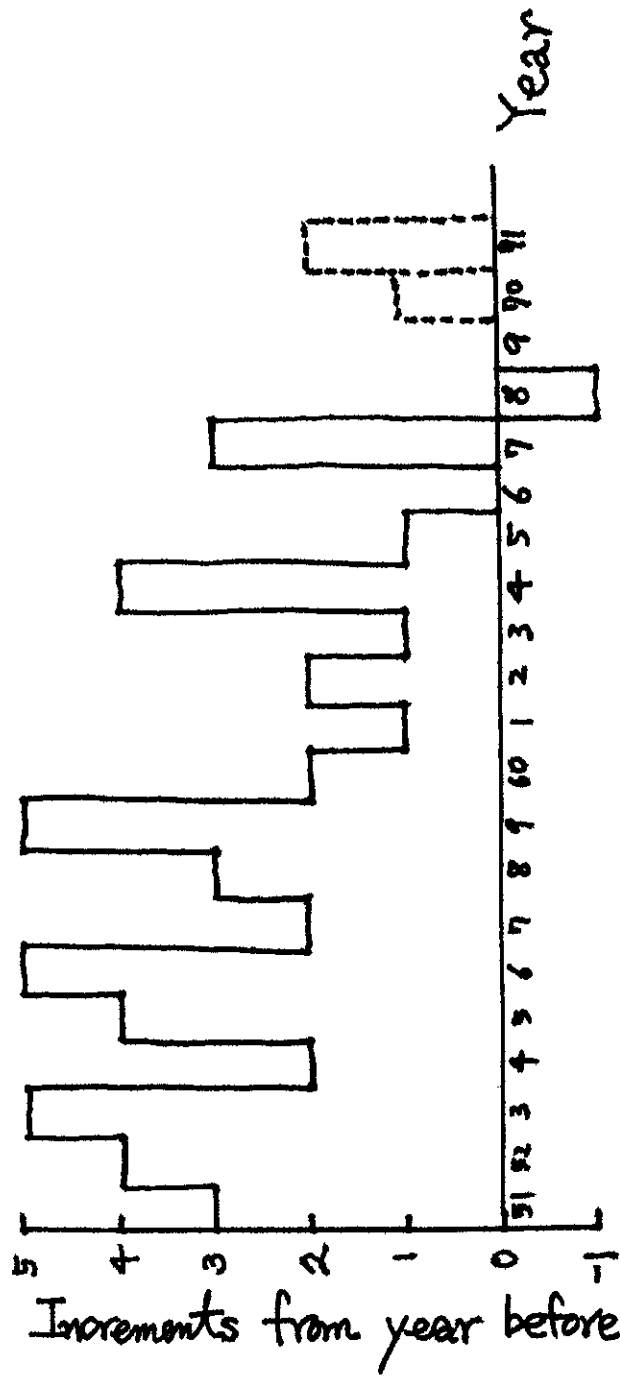


Fig 3; The rate of lay, Increment from year before
 Unit; eggs per layer, 1951-1969

Source; USDA, ERS, Poultry and Egg Situation, Various Issues

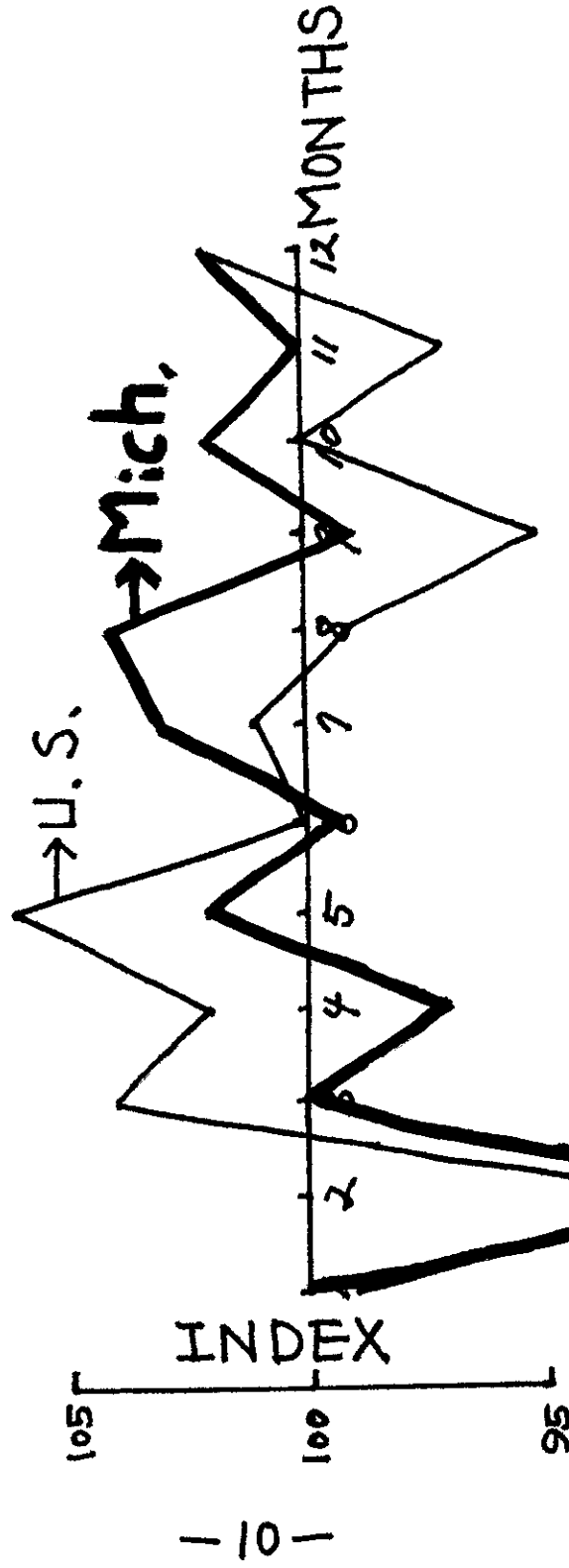


Fig 4; Seasonal Production Variation, U.S., Michigan.

1969

Source; USDA, Poultry statistics and Michigan
Agricultural statistics. 1970

1600 - 3199	1.6	1.7	13	7.4
3200 and over	2	3.3	38.2	70
Total	100%	100%	100%	100%

Source: 1964 Census of Agriculture, P. 191

EGG-TYPE CHICKS HATCHERY OPERATION

Commercial hatcheries produce almost all of the chicks hatched in the U.S. While the size of a hatchery is increasing, the number of hatcheries in U.S. has dropped drastically.

Table 2: Egg-type Chickens hatched by commercial hatcheries by region, Unit, thousands

Region	1960	1970
North Atlantic	81,393	67,907
East North Central	91,213	93,587
West North Central	128,788	89,531
South Central and South Atlantic	98,319	216,163
West	66,053	100,017
TOTAL	479,666	576,205

Source: USDA, SRS, Crop Reporting Board, Egg, Chickens and Turkeys, January 1971, P. 10

Commercial hatcheries moved to the South and West, following the shift of the production area. Hatcheries in California, Georgia, and Florida produced about 30% of egg-type chicks in 1970. As of January, 1961, about 3.5 million hatcheries existed, but in 1969, the number of hatcheries had reduced by more than half of the 1961 figure. Only 1.5 million hatcheries were in business¹, with egg capacity per hatchery about three-

1. USDA, ERS, Poultry and Egg situation, No. 256, April 1969

hundred thousand in average.

MICHIGAN EGG INDUSTRY

For the last two decades, Michigan has produced about half of the eggs consumed in the state. In 1969, Michigan, with about 4.3% of U.S. population, produced about 2.1% of U.S. eggs. Trend in Michigan egg production seems to be decreasing slightly year after year. Michigan pattern of seasonal production variation in 1969 was similar to that of the U.S., but Michigan production varied less than that of U.S. average fluctuation. See figure 4. The annual average fluctuation was 2.1% in Michigan, with 2.7% as the U.S. seasonal fluctuation. One thing worth being noted is that eggs per layers in Michigan is higher than that of national standings.

Table 3: Eggs per layers, U.S.
and Michigan, 1965 - 1969

Year	U.S.	Michigan
1965	218	224
1966	218	226
67	221	228
68	220	227
69	220	228

Source: Michigan Department of Agriculture,
Michigan Agriculture Statistics, January 1970

This higher rate and less seasonal variation may indicate that Michigan has more large commercial egg farms than the national average. Michigan hatcheries produced about 1.8% of the chicks hatched in U.S. in 1969. The trend in Michigan hatchery production has been declining since 1950. In 1950, Michigan produced about 27 million chicks. But as the Michigan egg

industry has been slowly declining the hatchery production reduced to about 10 million chicks produced in 1969¹. But this hatchery production seems to be enough to meet the demand from Michigan egg producers without importing chicks from other states.

U. S. Egg price in general

The trend in egg price over years showed gradual decline. This may be caused by slowly decreasing marginal revenues of producing eggs proved at the end of this report. According to the trend line, the egg price received by farmers seems to be decreasing about 0.37 cents per dozen every year (Figure 5). Turning to the seasonal price variation, in 1967-1969 period the seasonal low in May of 77 jumped up to seasonal high of 126 in December in index terms but in 1962-1964 period, the variation ranged from 83 to 114 in index terms based on the annual average (Figure 6). The general pattern for the last fifteen years was that April, May, June and July had the seasonal lows, and that September, October, November and December had the seasonal highs (Figure 7). Turning to the regional price differences, Detroit November egg prices is very closely related to the New York November prices by the evidence of simple correlation coefficient which was 0.989. The coefficients among Detroit, Chicago and New York were nearly one, which indicated that egg prices had basically national characteristics.

1. Michigan Department of Agriculture, Michigan Agricultural Statistics, January 1970

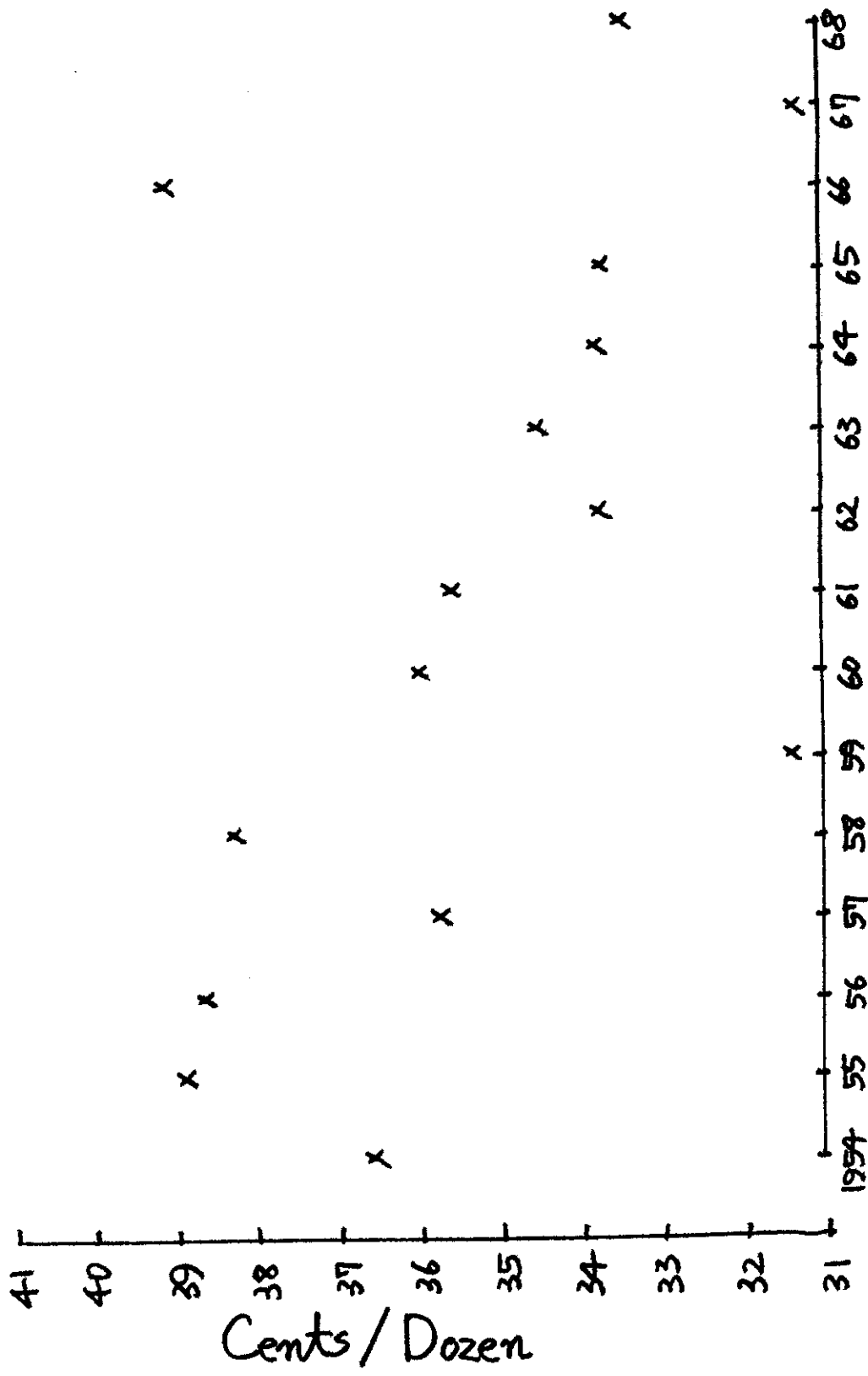
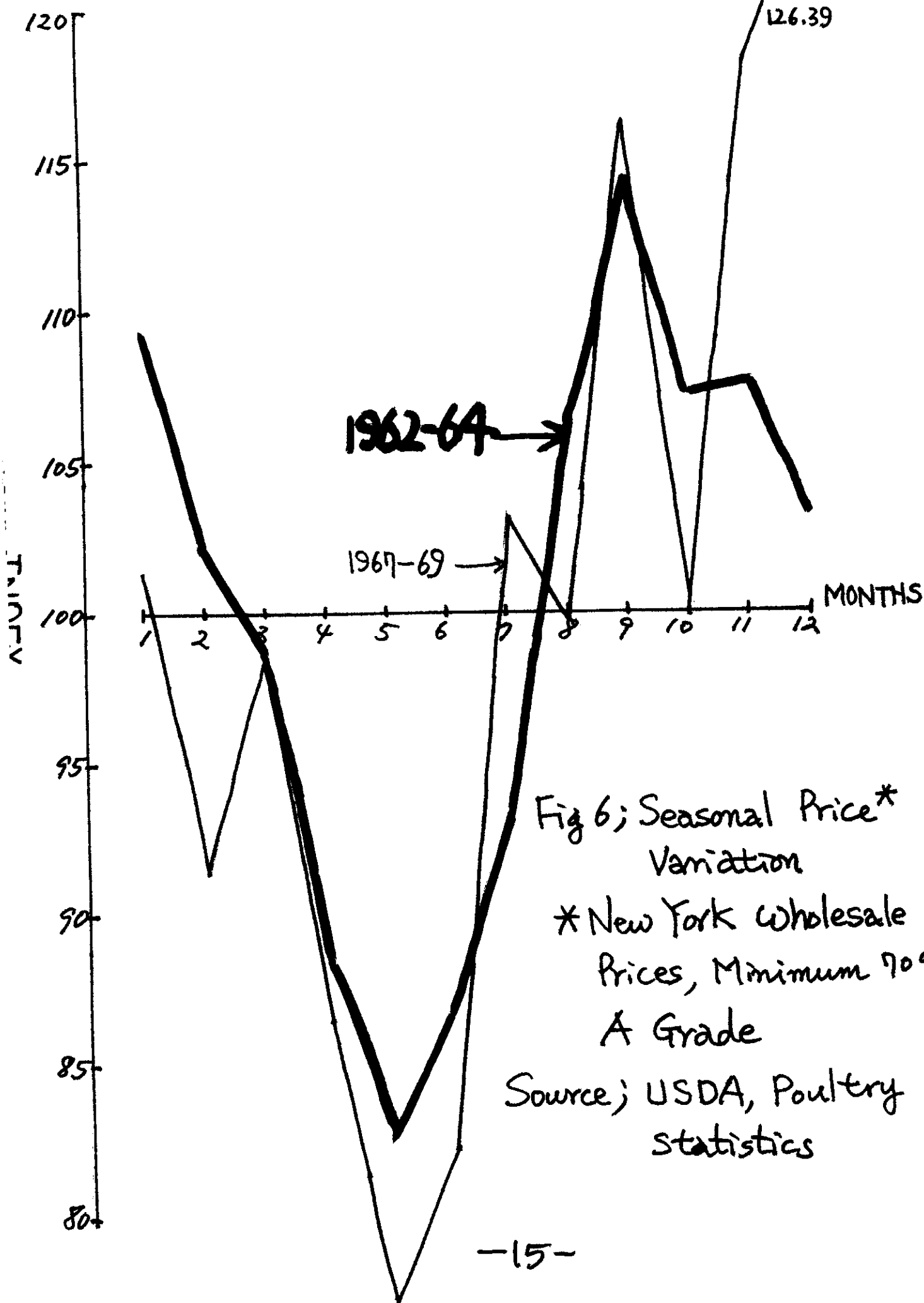


Fig 5; Annual Average Egg Price trend (1954-1968)

Source; USDA, Agricultural Prices



U. S. EGG PRICING SYSTEMS

A big obstacle in predicting egg prices is the highly outmoded and institutionalized egg pricing system. Since 1950, the egg industry has changed very much, in the aspects of production and marketing practice. George B. Rogers and Leonard A. Voss have clearly summarized the changes.

1. The emergence of new surplus-producing areas to challenge the Midwest, formerly the main source of supply for deficit area;
2. the movement of candling and cartoning operation away from major consuming centers and toward country points in producing areas;
3. a substantial improvement in the average quality of egg sold off farms to packing plants and other buyers;
4. a growth in the volume of eggs moving direct from packing plants to retail warehouses, retail stores, and other final sellers or users, and a drastic reduction in the volume of eggs moving through wholesale distributors in terminal markets;
5. the development of a substantial degree of coordination of producing, input supplying, and marketing functions;
6. the emergence of new producer-oriented organizations concerned with overall marketing policies; and
7. the application of advanced technology in breeding, feeding, housing, disease control, and management which has both leveled out the seasonality of egg production and minimized short-run disruptions of the flow of eggs off farms.

But under the present egg pricing system, base price quotations are determined on every business day at several

-
1. USDA, ERS, Marketing Research Reports No. 850,
Pricing Systems for Eggs, May 1969

terminal markets, where only about one quarter of the eggs were marketed in the late 1960's. The quality of eggs in the terminal markets may be quite different from the kinds now moving in large volume through marketing channels, mainly through assemblers and packers. Therefore the price which should be the indicator of general supply and demand can be easily misrepresenting the mainstream of channels. Therefore the fluctuation in quoted price will vary more by reduced buyers and sellers, and by reduced amount of quantity dealt with. Several alternative methods of pricing systems were suggested under the funds appropriated to the Economics Research Service, USDA. The importance of the basic price at the terminal market arises, because price to producers are often determined by discounting from the quoted price, and the retail prices may be determined by markups which reflects costs, local competitive conditions and variable pricing policies. Retail margin in Los Angeles, in 1969 averaged 6.24 cents per dozen. In 1959, it was 7.24 cents in this area for Grade A large eggs. The retail margin is said to be almost fixed as compared to the change in the wholesale price fluctuation. In Detroit it is believed to be about 7 cents per dozen retail margin.

PREVIOUS STUDIES

In 1959, Martin J. Gerra of the Agricultural Marketing Service, investigated relationships in the egg economy. The observation period was 1931-1954, excluding the war years of 1942-1945, in time series data. He developed eleven

structure equations, two demand, two supply, two price level, one storage function, and four identity equations. Gerra determined the statistical coefficients, and various elasticities by two methods of simultaneous approaches and least squares.

The system was set up as follows;

$$Q_E / H = a_1 + b_{12} P_R + c_{11} I/H + c_{12} P_M + c_{13} P_C + c_{14} P_B + c_{15} P_T + c_{16} P_O + u_1 \quad (1)$$

$$Q_F = Q_A L_F \quad (2)$$

$$Q_E = Q_F + A \quad (3)$$

$$L_F = L_J + C_F - M - L_C \quad (4)$$

$$C_F = a_5 + b_{52} \frac{P_F'}{P_D} + u_5 \quad (5)$$

$$L_C = a_6 + b_{62} P_F / P_G + u_6 \quad (6)$$

$$P_F = a_7 + b_{72} P_R \frac{Q_F}{H} + c_{71} W + u_7 \quad (7)$$

$$P_F' = a_8 + b_{82} P_R' + b_{83} \frac{Q_F'}{H} + c_{81} W + u_8 \quad (8)$$

$$P_R' = a_9 + b_{92} \frac{Q_F'}{H} + b_{93} \frac{S'}{H} + c_{91} \frac{1}{H} + c_{92} P_H' + c_{93} P_C' + c_{94} P_B' + c_{95} P_T' + c_{96} P_O' + u_9 \quad (9)$$

$$S'/H = a_{10} + b_{102} \frac{Q_F'}{Q_F} + c_{101} F - u_{10} \quad (10)$$

$$Q_E' = Q_F' - S' \quad (11)$$

All variable in the system of equations were related to the calendar year except those having a prime ('), which designates value of the variables for January - June. The following variables, he assumed, were endogenous for this analysis;

- Q_E ; Civilian domestic disappearance of eggs, billions
- P_R and P'_R ; Retail price of eggs, per dozen, cents
- Q_F ; Farm production of eggs, billions
- L_F ; Average number of layers on farms during the year, millions
- C_F ; Number of pullets raised, millions
- L_C ; Number of layers sold and consumed on farms where produced, millions
- P_F and P'_F ; Farm price of eggs, per dozen, cents
- Q_E^1 ; Farm production of eggs minus the January-June net into storage movement of shell, Frozen, and dried eggs (shell equivalent), excluding Government stocks, billions

The following variables were assumed to be "predetermined" in Gerra's study;

- I ; Consumer disposable income, billion dollars
- P_M and P'_M ; Retail price of meats, poultry and fish, index numbers (1947 - 1949 = 100)
- P_C and P'_C ; Retail price of cheese, index numbers (1947 - 1949 = 100)
- P_B and P'_B ; Retail price of bacon, index, do
- P_T and P'_T ; Retail price of ready-to-eat cereals, index numbers, do
- P_O and P'_O ; Consumers' price index of all items, do

- Q_A ; Average number of eggs produced per layer during the year
- L_J ; Number of hens and pullets of laying age and pullets not yet laying on farms, January 1, millions
- A ; Difference between civilian domestic disappearance of eggs and farm production of eggs, billions
- M ; Mortality of layers plus a balancing residual, millions
- P_G and P_G' ; Average price of poultry ration, Per 100 pounds, dollars
- H ; Population eating out of civilian supplies, July 1, millions
- Q_F' ; Number of eggs produced on farms, billions
- W ; Unit labor cost of marketing food products, index numbers, do
- F ; Gain of loss on future contract, previous year, speculative long position, per dozen, cents

The results obtained by the least-squares method were as follows;

$$\Delta Q_F / H = -3.05 - 0.84 \Delta P_R - 0.03 \Delta I/H - 0.07 \Delta P_M \\ (0.47) \quad (0.05) \quad (0.54) \\ + 0.52 \Delta P_G - 0.61 \Delta P_B - 1.77 \Delta P_T + 5.11 \Delta P_O \quad R^2 = 0.72 \quad (1) \\ (0.82) \quad (0.22) \quad (0.59) \quad (1.66)$$

$$\Delta Q_F = -3.05 + 15.36 \Delta P_F' / P_G', \quad R^2 = 0.72 \quad (2) \\ (2.40)$$

$$\Delta L_C = -8.91 - 9.22 \Delta P_F / P_G, \quad R^2 = 0.55 \quad (3) \\ (2.10)$$

$$\Delta P_F = 0.02 + 0.96 \Delta P_R - 0.05 \Delta Q_F / H - 0.05 W \\ (0.05) \quad (0.03) \quad (0.07) \\ R^2 = 0.99 \quad (4)$$

$$\Delta P_F' = 0.31 + 0.95 \Delta P_R' - 0.04 \Delta Q_E' / H - 0.17 \Delta W' \quad (5)$$

(0.04) (0.03) (0.05)

$$R^2 = 0.99 \quad (6)$$

$$\Delta P_R' = -2.03 - 0.66 \Delta Q_E' / H - 0.41 S' / H + 0.02 \Delta I / H$$

(0.32) (0.29) (0.04)

$$-0.15 \Delta P_M' \quad 0.28 \Delta P_C' \quad -0.10 \Delta P_B' \quad -0.73 \Delta P_T'$$

(0.45) (0.42) (0.20) (0.51)

$$+ 1.54 \Delta P_O', R^2 = 0.64 \quad (7)$$

(1.38)

$$\Delta S' / H = 0.95 + 1.41 \Delta Q_F' / Q_F \quad 1.23 F, R^2 = 0.69 \quad (8)$$

(1.23) (0.23)

The numbers in the parenthesis show standard errors of coefficients. He was not satisfied with the result in the Model I. Therefore the Model of the egg economy was reformulated by dropping P_M , P_C , P_B , P_T and P_G and W from the matrix of predetermined variables. The reasons for dropping is the high degree of intercorrelation among several of the predetermined variables in the demand equations. This technique is to realize the small standard error of the coefficient, since when correlation coefficients between predetermined variables are large, the variance of the coefficients are going to be large. He called this new model Model II. The results of Model II by the least-squares method are as follows;

$$\Delta Q_E / H = -4.69 - 0.73 \Delta P_R + 0.04 \Delta I / H$$

$$(0.44) \quad (0.05)$$

$$+ 1.43 \Delta P_0 ;$$

$$(0.81)$$

$$R^2 = 0.38$$

$$\Delta P_F = 0.24 + 0.98 \Delta P_R - 0.11 \Delta W$$

$$(0.05) \quad (0.06)$$

$$R^2 = 0.97$$

$$\Delta P_F' = 0.36 + 0.95 \Delta P_R' - 0.16 \Delta W$$

$$(0.04) \quad (0.06)$$

$$R^2 = 0.98$$

$$\Delta P_R' = -2.36 - 0.36 \Delta Q_E' / H - 0.40 \Delta S' / H + 0.03 \Delta I / H$$

$$(0.22) \quad (0.26) \quad (0.04)$$

$$+ 0.46 \Delta P_0'$$

$$R^2 = 0.52$$

Concerning the elasticity of demand for eggs, the simultaneous limited information approach seems to yield higher values of elasticities than those by the method of least squares. Furthermore, Model I produced higher elasticities than Model II. Demand elasticities with respect to its own price came out to be negative 0.40 with standard error being 0.18 by the simultaneous method in model II, and this was significant at the ten percent level. Demand elasticity with respect to income was insignificant even at ten percent level, 0.11 with the standard error being 0.10 by the least squares method in a newly formulated Model, which was deflated by the general price and took logarithmic form. Demand elasticity with respect to general price turned out to be 0.33, at the ten percent level of significance, with standard error being 0.19 by the least squares method

in the Model II. He also made some findings about the supply elasticities. Supply elasticity of pullets raised with respect to egg-feed ratio, January-June, was 0.4 with standard deviation of 0.08. The supply elasticity of layers sold with respect to egg-feed ratio, annual average, ranged from -0.4 to -0.7. All the elasticities stated above are inelastic. His study was based on the data of annual average or annual totals and correlated the first differences of the variable rather than actual raw data.

Another recent study by Gene C. Masters and Harold B. Jones, Jr., in 1970 at University of Georgia, was titled "Predicting short run egg price changes in Georgia". They used a single-equation least squares regression to explain weekly changes in the Georgia market. The general model they employed was the following format;

$$P_1 = F(P_0, P_h, I_{0,1}, S_{0,1})$$

Where;

P ; the average price of large eggs in the current week,

P_0 ; the price of large eggs on Friday of the previous week

P_h ; the historical average price for the current week based on the preceding six-year period,

$I_{0,1}$; the weekend inventory position of packers and handlers in the U.S. for the previous or current week,

$S_{0,1}$; the average daily surplus or shortage condition of packers and handlers in the Southeast for the previous current week

They ran three versions out of this general model, the form of the model and workability is as follows;

<u>Form of Model</u>	Estimating 1967 prices		Estimating 1968 prices	
	R^2	S.D.	R^2	S.D.
$f(P_0, P_h)$	.829	1.54	.915	2.16
$f(P_0, P_h, I_0, S_0)$	.846	1.49	.922	2.07
$f(P_0, P_h, I_1, S_1)$	.905	1.17	.922	2.07

Sources: Gene C. Masters and Harold B. Jones, Jr.,
University of Georgia, Research Bulletin 80,
Predicting short run egg price changes in Georgia,
June 1970

In the third model, the Friday's price (P_0) was the most important variable, accounting for 80% percent of the price variation. Packers' long or short position (S_0) was the second most important, by explaining 9% of the total variation. The other two were less than 1%. They did not pay attentions as to demand or supply elasticities for eggs and concluded the study examining some differences in prices between markets.

CHAPTER III

PRICE PREDICTING EQUATIONS

The method of analysis used in this study was least squares regression. The goal is to find the price predicting equation with the least value of the squared residuals between the actual price and the predicted price. The egg industry has changed very much since 1950, and it has recently

been changing very rapidly. Therefore the usefulness of this model may be questionable after a decade or two, because, by that time, very different factors may influence the egg price.

The multiple regression was constructed with the November Detroit wholesale price, Grade A large, as the dependent variable. A linear additive regression was used and the general equation was;

$$Y = a + b_1 X_1 + b_2 X_2 + \dots + U$$

Once the equation was obtained, the coefficients were checked for the proper signs to make sure they were consistent with expectations based on the economic theory and the previous study. The effectiveness of variables was judged by the test of significance. Next, R^2 , the range of residuals, and standard deviation were examined to measure the workability of the model.

SOURCE OF DATA

The period examined was from 1953 to 1969 or from 1954 to 1969, which numbered 16 or 17 sample points, in time series. Two sample period existed, since the first difference method was used from the equation II. Larger sample size could have been obtained, yet too many changes in the egg industry prevented this. Secondary data was used in this study. Most of the data were from the publications of the USDA and the U.S. Department of Commerce. Some missing data had to be estimated. The first difference were calculated by the author from the secondary data. The first difference refers to amount of change from the

previous years, either by percentage or by actual form.

This method of transferring data has the effect that the trend over years can be partially eliminated.¹ Another form being used was percent of trend which was designed to remove the effect of the trend. For an example, see the variable X_{21} in the equation II. The quality of eggs has been improving and grading and packing station has moved from one point to another, and channels of egg marketing changed its shape. So it was very difficult to examine the same quality at the same level.

EQUATION I

The first multiple regression equation tried with four independent variables being put in the equation as raw form.

$$Y = 1.9504 + 0.1854X_{11} + 0.1063X_{12} + 1.054X_{13} + 0.079X_{14}$$

(0.605) (0.1780) (1.9658) (0.149)

Y; Predicted November shell egg actual price, average price paid delivered at Detroit, Michigan. U.S. and consumer Grade A, white, large, loose basis. Unit: Cents per Dozen

X_{11} ; February in the present year shell egg actual price, Detroit, U.S. and Consumer Grade A, white large, loose basis. Unit: Cents per Dozen

X_{12} ; Actual Consumption per year per capita, Unit: Eggs

X_{13} ; Actual Egg-Feed ratio, U.S., May, Unit: Ratio

X_{14} ; Actual cold storage holdings, October, Midwestern, Unit: 1000 pounds

$$R^2 = 0.2341$$

$$\bar{R} = 0.000$$

$$S_{y.x} = 8.0041$$

1. William A. Spurr and Charles P. Bonini, Statistical Analysis for Business Decisions, Richard D. Irwin, Inc., 1967, P. 651

The dependent variable, Detroit November price averaged 45.41 cents from 1953 to 1969, with a low of 31 cents in 1967 and a high of 58.21 cent in 1969. The numbers in the parenthesis show the standard errors of the coefficients.

Variable X_{11}

February Detroit price was selected as the first independent variable because of the following reasons. When the February egg price is high, the egg producers would make a decision in April, assuming the time lag of two months, to order more baby chicks, raising large flocks of replacement pullets. After five months or so, the pullets would have come into the laying age in September, and would be producing small pullet eggs. In November, the size of eggs becomes big enough to be large eggs, the type which we are examining. So the author felt that the February price would be a good indicator for November egg production. The simple correlation coefficient and partial correlation coefficient between November price and February price were 0.426 and 0.088 respectively. R^2 had increased only 0.05 by this February price, and the regression coefficient was 0.185 cents, in otherwords, one cent increase in February price will result in 0.185 cents increase in November price, while others would be unchanged. This variable was insignificant even at one half a change of error. All the statistics above show that something was wrong in the process of expectation. The author had expected negative ~~wign~~ with the higher production in November, the November price would decrease, rather than increasing,

The time lag of two months from the February egg price to April, when producers decided to raise the increased number of replacement pullets, may be the whipping boy, since the egg industry has been operating on the basis of specialization and vertical integration to some extent. So the decision making process is becoming complicated and highly institutionalized. Another explanation is simply that the producers do not think the February price is a go-ahead signal for increasing orders for replacement pullets. The reason for low t-value may be due to high simple correlation between February price and consumption and egg-feed ratio, which was 0.5 in both cases. All this evidence seems to show that the nine month interval is not the appropriate one to predict the egg price.

Variable X_{12}

Per capita consumption was selected as a independent variable to indicate the level of demand forces. Actually this variable was based on U.S. annual farm production, including frozen eggs, divided by the U.S. population. In turn, this supply was adjusted by the population. This data was further trimmed by the fact that the consumption rate in urban area is 5% lower than U.S. average rate. This variable has an obvious trend that the rate has been decreasing, except for a couple of years when the prices were at very low level. The reason might be assumed that increasing the number of the U.S. population which have a very light diet in the morning, as automation takes over hard labor. Another reason for the

decreasing demand for eggs can be referred to is the trend that U.S. consumers prefer the processed or ready-to-cook form of foods to the unprocessed types. The increasing number of women employed in Detroit may not spend as much time as before in preparing meals in the morning. The author tried to examine the reason for decreasing demand for eggs. But insufficient data blocked my efforts.

Variable X_{13}

Egg-feed ratio was included as the indicator of adjustment of flock size and, in turn, egg production. The ratio is the amount of feed that could be purchased by the price of eggs at farm level. The value is the number of pounds of feed equal in value to one dozen eggs. The higher the ratio, the more advantageous it is to the egg producers. Feed and labor were the major costs in producing eggs. Feeds consist of yellow corn, oats, wheat, and barley as the cereal grain which make up the main parts of poultry ration. To furnish necessary protein, minerals, vitamins, meat scraps, tankage, fishmeal, soybean oil meal, and other supplements should be provided. Therefore the feed price is influenced by supply of feed available, demand situation from other industries sharing the same feed, and price of the livestock. Constant culling will take place when the ratio is low, and the number of pullets raised for replacement flocks will increase when producers face situation where the pullets can be fed at lower cost. In conclusion, the egg-feed ratio was hoped to be the adjuster to production. In particular, the author chose the ratio in May, since culling of undesirable chicks occurred after a month

in the brooder house. The statistical results are as follows. Simple and partial correlation coefficients between egg-feed in May and November egg prices are 0.36 and 0.15, respectively. Expectation of the sign was negative, for the higher the ratio, the more production, the lower the price. The sign turned out to be positive 1.05, without significance for the t-test of no effectiveness of this variable. The logic behind this variable was not accomplished due to producers' desire to keep chicks once they were hatched. The big mistake might result from the fact that May was not the proper month. I will try other months later in this report.

Variable X_{14}

Cold storage for frozen eggs, at the end of October, in the Midwest was considered for many reasons. The variable was expected to have some influence demanding for shell eggs. Frozen eggs had been purchased mainly by bakers and pie-makers. They may use lower graded shell eggs produced by egg-breakers. The November egg prices will go up, when frozen eggs stock runs out in October, caused by the strong demand from bakeries. On the contrary, November price will go down, when abundant stocks of frozen eggs exists. Egg breakers seem to operate on expectation. When they expect the price in the Fall to go up, they buy large amount of shell eggs in Spring. Therefore this frozen egg stock variable has some source of unreliability due to producers' future prediction. The regression coefficient was -0.08 with 0.6 of significance. The result seemed to be disappointing and this variable had not satisfied the expectation.

SUMMARY OF EQUATION I

The result of Equation I was a multiple coefficient of determination 0.23, the standard error of estimate was about plus and minus 8 cents with two third of the confidence. Test of significant for each variable, indicated none of the variable are effective. Even the F statistics showed all the variables in a bundle was not effective, since F was 0.91 with degree of freedom of regression being 4, degree of freedom of error being 12. Too much remained unexplained and remained to be solved. The first trial was, in a word, a failure.

EQUATION II

In the previous equation, actual data was used. The author discovered that some variables had obvious trends caused by production practices, improved skills and other reasons. Therefore, I hoped that by employing the method of first difference by either actual or percentage, and the method of eliminating trends might increase R^2 and decrease the error of deviation. The Equation II was;

$$\hat{Y} = 42.144 + 0.136X_{21} - 0.330X_{22} + 3.086X_{23} - 0.060X_{24} \\ (0.269) \quad (1.095) \quad (1.148) \quad (0.123) \\ -0.278X_{25} + 1.217X_{26} \\ (0.245) \quad (0.957)$$

\hat{Y} = Predicted Detroit November egg price, raw data, Unit; cents per dozen

X_{21} = Number of egg-type female chickens hatched, per capita, April, U.S., Percentage deviation from trend.
Unit: Percent

X_{22} = Number of layers, November, U.S., Percentage change from one year earlier, Unit: percent

X_{23} = Consumption per year per capita, relative first difference adjusted 95% of national data, Unit: Percent

X_{24} = Egg-feed ratio, average of November of the previous year and May in the present year. Relative first difference.
Unit: Percent

X_{25} = Price difference between Medium and Large size in October, New York. Percentage deviation from expected trend disregarding signs, Unit: Percent

X_{26} = Consumer Price Index, actual difference from previous year. Index base: 1957 - 1959 = 100
Unit: Index

$$R^2 = 0.612$$

$$R = 0.594$$

$$S_{y.x} = 6.031$$

Variable X_{21}

The number of egg-type chickens hatched in April in the U.S. was expected to affect the number of layers in September and October. This variable may indirectly affect the number of layers by influencing the rate of culling in October to make room for new pullets coming in. Midwestern chicks would have been used, but the author could not, because chicks are free to move any place nowadays by improved highway system. The regression coefficient was positive 0.135 with type I error being 0.627. The form of the variable was not actual chickens produced but percentage deviation from expected trend of the year, in other words, only the cyclical and irregular part in the variable was considered in correlation. The reason is worthy of explanation. Seasonal variation has decreased, hatcheries currently operate four or five times a year as compared to once in the Spring two decades ago. Therefore, the obvious trend was decreasing from 20 million in April 1954 to 60 million in April 1969 there were about. On the per capita basis in April, 0.63 baby chicks per person in 1954, but the ratio had dropped to 0.14 in 1969, which was partially due to production practice.

Variable X_{22}

The number of layers in November was introduced to indicate some base for production, with the expected sign being negative. When the number of layers increases one percent from the previous year, the egg price decreases 0.33 cents with other variables constant. But the test of significance shows that the effectiveness of this variable is zero, no effect. Therefore the regression coefficient was hard to believe.

Variable X_{23}

This consumption variable was saved from the first equation, but the form of data has been changed from raw data to relative change of first difference. The regression coefficient was about -3 with a highly significant level. I can conclude that one percent increase in consumption is related to three cents drop in Detroit price. This consumption variable may be interpreted either as production or as demand.

Variable X_{24}

Egg-feed ratio has been saved for another trial. May egg-feed ratio in the first equation did not appear to be effective. This time, in order to consider the crop harvesting situation of the previous year, November ratio in the previous year was selected. This ratio was modified by the present May ratio to account for the willingness to raise pullets this year. Therefore, the data were the average of May in the present year and November of the previous year. The regression coefficient was -0.06 , a coefficient I found was difficult to accept due to high type I error. Reason might be that this ratio was highly correlated with the April hatchery

production and the November number of layers.

Variable X_{25}

Price difference between medium and large size eggs was selected to consider some biological nature of producing eggs. The eggs laied by new pullets, during the first few months, are small in size. Therefore abundance of small eggs in the market might indicate an increasing shipment of large eggs in the market a couple of months later. Wide deviation of the medium egg price from the large size may indicate a decrease in the price of large size eggs after one month, as the pullets grow. The regression coefficient was -0.278 and significance level was 28% on a one tail test. Due to the high error level of this statement, the author was not convinced this variable was an effective one. But I will test this same variable in different combinations with other variables.

Variable X_{26}

Consumer price index was selected to acquire insight concerning the national economy. Actually, in a broad sense, the egg price was affected by the situation within the egg industry and by the situation of the national economy; such as inflation, income, general price, field crop prices, and others. In order to combine these effects, consumer price index was chosen to hopefully be representative. The regression was 1.21 cents with a significance level of 0.23. Egg price was thought to rise, as other price went up.

SUMMARY OF EQUATION II

The result of the second Equation improved in comparison to the first one. R^2 was 0.61 and the adjusted multiple correlation coefficient was 0.59. Standard error of estimate was plus and minus six cents with two out of three times being correct. F-statistics was 2.36 which had significance level of 12% at the one tail. Only the consumption variable had passed the t-test within 5% level. On this result, the author realized that about three cents in Detroit price is associated with one percent change in consumption rate.

EQUATION III

Efforts to increase R^2 and to decrease standard error continue. R^2 deletes and the level of significance of each variable and simple correlation coefficients between independent variables were examined. The variable with a relatively low R^2 delete and with a relatively low significance level, and those with low correlation value with other independent variables were saved to be tried again. Of course these latter variables should have importance in the aspects of production and marketing in the egg industry. The remainder were dropped from consideration. Another change in the form of equation II was the dependent variable being treated in the form of actual first difference rather than raw data. The equation obtained was;

$$\hat{Y} = -4.6328 + 0.9834X_{31} - 2.8432X_{32} - 1.299X_{33}$$

(1.008) (1.5529) (1.0062)

$$\begin{matrix} -2.2916X_{31} & -0.2607X_{35} & + 2.1106X_{36} \\ (0.843) & (0.1003) & (0.9606) \end{matrix}$$

$$R^2 = 0.87$$

$$R = 0.89$$

$$S_{y.x} = 5.029$$

\hat{Y} = Estimated November Detroit price, actual first difference, Unit: Cents per dozen

X_{31} = Number of U.S. layers, January 1, relative first difference, Unit: Percent

X_{32} = Consumption per year per capita, relative first difference, adjusted 95% of national data, Unit: Percent

X_{33} = Rate of lay per bird, per year, actual first difference, Unit: eggs

X_{34} = Egg-feed ratio, actual first difference, average of November of the previous year and May in the present year. Unit: ratio

X_{35} = Price difference between medium and large size, October, New York, Percentage deviation from expected trend with signs, Unit: Percent

X_{36} = Consumer price index, actual first difference from the previous year, index base: 1957-59 = 100

Variable X_{31}

U.S. layers at the beginning of the year was selected to consider base of production. Producers usually keep flocks for one year period. The size of the January flocks would affect production in November. The regression coefficient was 0.93 with one third probability of type I error. This meant that one percent increase in number of layer in January from the previous year induced about one cent increase in wholesale price. With a common knowledge, when the number of layers increases, the price would go down. But the interval of ten months between January layers and the November price seemed to be too long, and new pullets and

culling effects would be suspected to exist during ten months. According to the t-test, it failed to pass and R^2 delete was only one percent. No strong relationship between January layers and November price was shown.

Variable X32

The consumption rate regression coefficient was negative 2.3 in Equation III. This coefficient was negative 3.03 in Equation II. So far, the coefficient did not deviate very much. The level of significance was 10% at this time, as compared to 2.5% in Equation II.

Variable X33

The rate of lay was actually the ratio of U.S. egg production over the number of layers on hand during that year. This rate is affected by many factors. Improved facilities and breeds will push the rate higher. But another important factor is the ratio of pullets over layers. The more pullets, the higher rate of lay. Therefore this X33 variable was selected to consider all of these combined effects. The rate was 170 eggs per bird per year in 1949, and it had increased to 220 eggs after two decades. The slope of the curve over years seems to be decreasing. In other words, the rate has been increasing with a decreasing rate. The regression coefficient was a negative 1.3 with significance level of 0.23. It is hard to believe that this variable is effective.

Variable X_{34}

The actual egg-feed ratio change in the ratio from the year before was used, instead of the relative first difference. The regression coefficient was negative 2.3. This indicated that if the ratio increases by one, favorable to producers, the Detroit wholesale price will go down by 2.3 cents because of increased production. This conclusion is reliable since the type I error is less than 0.05.

Variable X_{35}

The price spread between medium and large size in October experienced good results at this third trial. With significant level being less than 5%, the regression coefficient was a negative 0.26. When spread deviates one percent from the normal spread obtained by trend line, the Detroit price goes down by 0.26 cents. The price difference between these two sizes was 16 cents in 1954, but as the seasonal production variation reduces, the differences was reduced to 3.67 cents in 1969 see Fig 8. This trend was due to production practices. The author felt that this trend should be eliminated, leaving only the cyclical and irregular aspects. But the reliability of the trend line could be suspect. For an example in computing the relative deviation, in October, 1967, the price spread between sizes was 6.48 cents in New York. But the trend line predicted a 5.31 cent price spread. By percentage term, the irregular portion was 22.03% of the trend. This 22.03% was used as the independent variable.

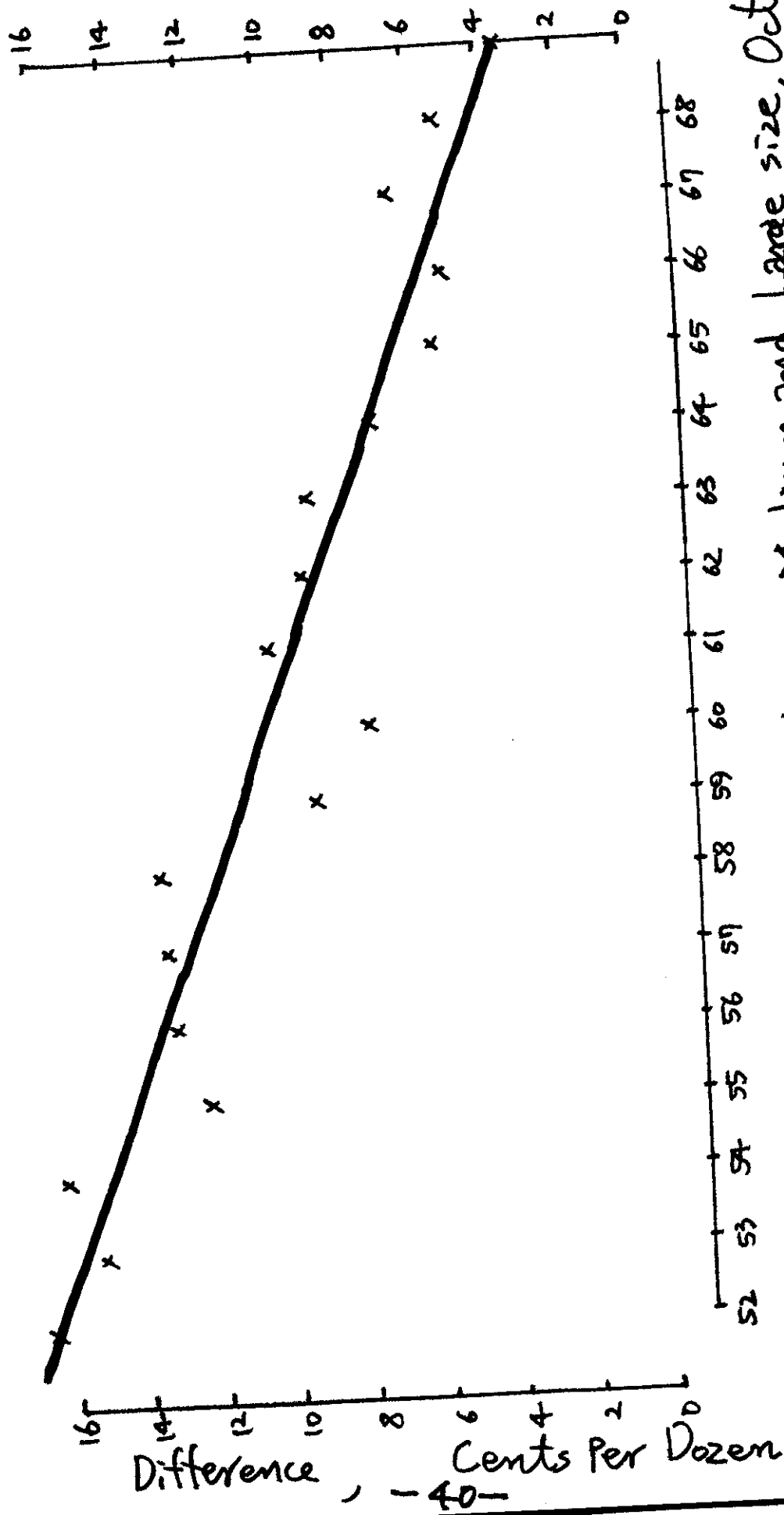


Fig 8; Price Spread between Medium and Large size, October
by Year
Source, USDA, Poultry Statistics

Variable X_{36}

The consumer price index was proved to be effective in determining the November price this time since the type I error was about 5%. The regression coefficient was 2.11. Therefore, we can say that when consumer price index increases by the index of one index point from the year before, the egg price will increase by about 2.11 cents. However, this coefficient is larger than can be justified on economic grounds. Therefore, the consumer price index variable must be reflecting other variables such as income which are correlated with it.

DURBIN - WATSON TEST

One of the important statistical assumption was that there was no auto-correlation between disturbances. This assumption is suspect in any time series study. Equation III had the Durbin-Watson statistics of 2.22, with the number of observations being 16, and independent variables equal to six. This statistic fall in the inconclusive region of 2.00 to 3.58. Thus, the question of whether or not violation exist remains unanswered.

SUMMARY OF EQUATION III

Equation III produced a greatly improved result. R^2 was 0.37 and the adjusted multiple correlation coefficient was 0.39. In terms of F-statistics, the null hypothesis of no effectiveness of all variables combined was rejected at the very low level of type one error of 0.001. But that standard error was

still 5.029, with the hope of being decreased, in other words, plus or minus of about five cents would be the confidence interval with the reliability of two out of three times. In the examination of each individual variable, four out of six variables considered had passed at 10% level test. Those four are consumption rate per capita, egg-feed ratio, price difference between sizes, and consumer price index. These four are to be saved for the next trial, hoping to reduce the standard error of estimate. The unexplained residuals in natural numbers is presented in Table 4.

Table 4 - A comparison of actual and predicted Detroit November egg price for Equation III, 1954-1969, Unit; Cent per Dozen

Year	Actual Detroit November Price	Predicted Price	Residuals (Y - Y)
1954	48.18	43.33	4.85
55	52.35	52.71	-0.36
56	42.84	38.96	3.88
57	52.55	46.89	5.65
58	43.88	48.49	-4.60
59	34.74	42.32	-7.58
60	56.38	54.34	2.04
61	40.03	43.53	-3.50
62	43.50	39.32	4.18
63	40.40	45.01	-4.61
64	36.11	33.67	2.44
65	43.36	41.63	1.73
66	46.55	49.90	-3.35
67	31.76	32.98	-1.21
68	43.42	44.01	-0.59
69	58.21	57.17	1.03

EQUATION IV

As the last attempt to reduce the standard error of estimate, the variable of the January number of U.S. layers was dropped. Instead, to strengthen the production side, hatchery

production was tried. Seven independent variables were used to predict the November Detroit wholesale price. The fourth and last Equation was ;

$$\hat{Y} = -3.945 + 0.6722X_{41} - 0.247X_{42} - 1.744X_{43}$$

(0.465) (0.124) (0.807)

$$-1.853X_{44} - 1.85X_{45} - 0.244X_{46} + 1.766X_{47}$$

(0.886) (1.045) (0.092) (0.837)

$$R^2 = 0.918$$

$$\bar{R} = 0.920$$

$$S_{y.x} = 4.355$$

\hat{Y} = Predicted Detroit November egg price,
Actual first difference, Unit: Cents per dozen

X_{41} = Number of layers, U.S., May and June, Relative
first difference, Unit: Percent

X_{42} = Hatchery production, April, U.S., actual first
difference, Unit: Million eggs

X_{43} = Consumption per year per capita, relative
first difference, adjusted 95% of national
data, Unit: Percent

X_{44} = Rate of lay per bird, per year, actual first
difference, Unit: Eggs

X_{45} = Egg-feed ratio, actual first difference, average
of November of the previous year and May in
the present year. Unit: Ratio

X_{46} = Price difference between medium and large size,
October, New York, Percentage deviation from
expected trend with signs, Unit: Percent

X_{47} = Consumer price index, actual first difference
from the previous year, index base; 1957 - 59 = 100
Unit: Index

Variable X_{41}

The variable of January number of layers in U.S. was dropped,
instead layers in May and June in U.S. was considered. These two

months were closer to November than was January, and were expected to have more influence than the latter. The regression coefficient was positive 0.67, which was the opposite to the expected sign, with 0.18 significance. The interpretation would be that when May and June layers increase by one percent, the November Detroit price would increase 0.67 cents. This outcome leads to feeling that effect of large number of layers in May and June will not last until November. Some other disrupting forces are suspected to exist between May and November number of layers. But the disrupting forces would be such factors. The level of significance went over 10% level as culling or replacement of new pullets or distortion in price determining process. The author tested the layers variable during three different intervals, January, May and June, and November, in three different equation, but all three variables had no significant effect on November price. Therefore the number of layers was thought of as a function of a number of other variables. Another reason for the non-significance might be high correlation to other variables.

Variable X_{42}

April hatchery production variable produced clean-cut result in the fourth equation. With less than one percent of type I error, when the April hatchery production increase by one million from the previous year, the November egg price would go down by one quarter of a cent, due to increased new pullets in September.

Variable X_{43}

The same per capita consumption data was used, but with less than ten percent significance, the result in the fourth equation was a regression coefficient of -1.74 an increase of percent in per capita consumption from the previous year, increase in a price decline of about three cents in Equation II, 2.84 cents in Equation III, and 1.74 cents in Equation IV.

Variable X_{44}

The rate of lay per bird had a regression coefficient of -1.85, with less than ten percent of type I error, the more highly productive pullets in the flocks, the more eggs would be produced, and the price would go down 1.85 cents with an increment of one more egg per bird.

Variable X_{45}

The Egg-feed ratio increment by the ratio of one resulted in price decrease of 1.86 cents. In the third equation, the coefficient was -2.3 with type I error being 0.024. These conclusion coincide with the expectation. In the average, about two cents in November price decreases, when more eggs are produced due to advantageous egg-feed ratio increment of one.

Variable X_{46} and X_{47}

Results in equation IV were similar to those in Equation III.

Variable of Michigan personal income

The income variable is frequently employed to investigate

the demand situation of a product. The author tried the income variable in different format. But the effectiveness of the variable to the November price was rejected at the 10% level, and the result was two cents decreases in price when one dollar increase in personal income per capita.

DURBIN - WATSON TEST for the EQUATION IV

The Durbin-Watson statistic for the Equation IV was 2.26, which fell in the wide range of the inconclusive region of from 2.00 to 3.69. Therefore, the user of the Equation IV should keep in mind the fact that t and F test in the Equation may or may not be reliable, due to the possibly biased variance of each independent variable.

SUMMARY OF THE EQUATION IV

The results from Equation IV were that R^2 was 0.918 and the adjusted multiple correlation coefficient was 0.92. The null hypothesis of no effectiveness of all variables combined was rejected at the level of 0.001, and the standard error of estimate was 4.355 cents. In other words, Equation IV can be employed to predict the November Detroit wholesale price, by the data in the equation, as close to the actual price inserting as a plus and minus 4.355 cents, allowing the chance of falling out of the interval to be one out of three times in practical situation. Turning to the individual variables, hatchery production in U.S. in April, per capita consumption rate, rate of lay per bird,

price difference between sizes in October and consumer price index were significant enough to be major influencing factors, respectively, for the Detroit November price. The unexplained residuals are shown in the Table 5.

Table 5 - Comparison between actual and estimated November Detroit prices

Year	Actual	Estimated prices	Residuals
1954	48.18	42.74	5.47
55	52.35	51.86	0.49
56	42.84	40.23	2.61
57	52.55	49.77	2.77
58	43.88	45.55	-1.67
59	34.74	39.79	-5.05
60	56.38	56.49	-0.11
61	40.03	44.15	-4.12
62	43.50	38.59	4.91
63	40.40	44.00	-3.60
64	36.11	34.00	2.11
65	43.36	45.51	-2.51
66	46.55	45.93	0.61
67	31.76	35.15	-3.39
68	43.42	44.13	-0.71
69	58.21	56.40	1.80

ESTIMATING 1970 NOVEMBER DETROIT PRICE

In order to test the workability of the Equation IV,

$$\hat{Y} = -3.94 + 0.6722X_{41} - 0.247X_{42} - 1.744X_{43}$$

$$-1.853X_{44} - 1.85X_{45} - 0.244X_{46} + 1.766X_{47}$$

the author had collected the data up to October in the present year to predict the November price. The number of May and June U.S. April hatchery production, egg-feed ratio, price difference between sizes in October, were able to be obtained easily from USDA

publications. The number of May and June layers had increased from 617.7 million in 1969 to 626.6 million in 1970, which was a 1.28% increase from the last year. Hatchery production in April, 1970 increased by nine million from April, 1969. The egg-feed ratio in November, 1969 was 7.3, and that of May, 1970 was 13. Taking the arithmetic average of those two ratios, it was 10.15, the increment of 2 from the year before in ratio terms is shown. Price spread between sizes was considerable in New York in October, 1970, it was 6.8 cents, which was a 112% deviation from the expected spread of 3.2 cents between sizes. See the Fig 8 for the spread trend line at page 40. But it is questionable how much the spread between medium and large sizes would be narrowed in future years. There were no problems in collecting the data for the four variables stated above. But the remaining three variable caused difficulty in estimating the average of 1970, as of October of that year. The per capita consumption rate was estimated to decrease about 1.5% by trend in 1970 only, the rate of lay was estimated to be about 222 eggs in 1970 by considering a probable 3 or 4 year cycle illustrated on page 9. The average consumer price index of 1970 was thought to be 135.7 using the May, June and July averages. These three variables should be estimated quite accurately by the best known information and data. The actual Detroit wholesale November price was found in the "Dairy and Poultry Market News", the daily egg report published by Consumer and Marketing Service, USDA, and ranged from 37.35 cents to 41.72 cents per dozen in the November average,

delivered, at loose basis. 39.78 cents was averaged to be the mean of the actual price. By using the Equation IV, the following values of X_i s were inserted into Equation IV:

$$X_{41} = 1.28\%$$

$$X_{42} = 9$$

$$X_{43} = -1.5\%$$

$$X_{44} = 2 \text{ eggs}$$

$$X_{45} = 2 \text{ (ratio)}$$

$$X_{46} = 112\%$$

$$X_{47} = 8 \text{ (Index)}$$

The estimate of the November, 1970 price in October was calculated to be the first actual difference of 22.30 cents from the previous year's price of 58.21 cents. By subtracting the first difference from 58.21, the estimated price was 35.91, that is an 3.87 cents less than the actual price of 39.78.

CHAPTER IV

DEMAND ELASTICITIES

DEMAND ELASTICITY WITH RESPECT TO ITS OWN PRICE

Demand elasticity with respect to its own Detroit price was examined by the single least squares method in order to check some implications to egg producers, consumers and policy-makers. The author could have used the price predicting model in the previous chapter to obtain the elasticities,

but the price data in the previous chapter were the monthly price, which was not suitable for the purpose of investigating the effect on annual demand change due to annual price variation. Another reason for setting the new model is to make the model consistent with the elasticity models employed by various researchers. The separate new model was set up as follows;

$$\hat{D} = -2.67 - 0.1151X_{51} + 0.4763X_{52} + 0.1392X_{53}$$

$$(0.0249) \quad (0.071) \quad (0.2399)$$

\hat{D} = Estimated consumption rate per year per capita, % first difference, adjusted 95% of national data, Unit: Percent

X_{51} = Annual average Detroit wholesale prices, Grade A, white, large, loose basis, % first difference, Unit: Percent

X_{52} = Consumer Price Index, % first difference, Index base 1957 - 1959 = 100, Unit: Percent

X_{53} = Michigan Personal Income per capita, % first difference, Unit: Percent

$$R^2 = 0.64$$

$$\bar{R} = 0.74$$

$$S_{y.x} = 1.18$$

All units in the equation were in percentage terms, so the regression coefficient of the variable X_{51} , -0.115 was the value of demand elasticity with respect to its own wholesale price, during the period of 1954 to 1969. One standard error of the elasticity was 0.025, and t-test for the no effectiveness of the price variable was rejected at the significant level less than 5%. Therefore when egg price goes down 10%, then per capita consumption will be up by about 1%. This is very inelastic in demand situation for eggs. This very inelastic situation is expected to continue

as long as consumers don't have good substitutes for the shell eggs as now and per capita consumption for shell eggs decreases. Table 6 shows all the previous studies from 1915 to 1954 by various researchers.

Table 6 - Elasticities of Demand with respect to its own price, by type of analysis, for specified periods.

Study	Period Included	Method	Elasticity	S.E.
Fisher				0.69
Model I	1915 - 40	Simultaneous	-1.23*	0.08
Model II	1915 - 40	Least Squares	-0.32	0.06
Fox	1922 - 40	Least Squares	-0.34	0.08
	1922 - 40	Least Squares	-0.43	0.13
	1921 - 50	Least Squares	-0.32	
Judge				
Nordin, Judge				
and Wahby	1921 - 41	Least Squares	-0.55**	0.18
Gerra	1931 - 54	Simultaneous	-0.40*	0.06
	1931 - 54	Least Squares	-0.10	

** Significant at less than 5% level
 * Significant at less than 10% level

Source: Martin J. Gerra, The Demand, Supply, and Price structure for Eggs, USDA, Technical Bulletin No. 1204, November 1959

Careful examination of the Table 6 reveals that elasticities produced by simultaneous method have higher values than the values by the least squares method. Comparing the elasticities computed by the method of least squares, the elasticities of demand with respect to its own price is becoming less and less elastic over the decades, since in 1921 to 1941 period according to Nordin, the elasticity was -0.55, in 1931 - 1954 according to Gerra, it was -0.40. by simultaneous method. One research

bulletin published by University of Maine indicated that the demand elasticity for shell eggs is in the range of -0.23 to -0.30 .¹ The elasticity I examined was -0.12 from 1954 - 1969. My study was significant at the high level of one percent. Therefore I can conclude that the elasticity of demand has been heading for a less elastic situation since 1915. This less and less elastic demand situation for eggs over the years has important implications for egg producers. Producers will face a favorable situation when egg prices go up. But total revenue will decrease as egg prices decrease, due to inelastic demand. Over the year the trend was toward slowly decreasing egg prices, which means a less favorable situation for egg producers. The more inelastic situation over the decades has another meaning for egg producers. Marginal revenue has been getting smaller and smaller over the past two decades on the basis of decreasing egg prices, assuming the egg producers operate on the pure competition basis. The above analysis can hold only if the demand function over year has not shifted down ward.

ECONOMIES OF SCALE

As we observed in a previous chapter, the size of egg farms has increased. We can use the economic theory to say that the egg industry is in the region of economies of scale.

1. University of Maine, Approaches to supply management for the egg industry, A Northeast Regional Extension Publication

Economies of scale is defined to be forces causing the long run average cost curve to decrease for larger outputs and larger scales of plant in a firm per unit of time. References concerning production costs for the industry was scarce. But average cost curve are believed to be shifting downward to the right as the scale of egg plant expanded. This is illustrated at Figure 9. Short run average cost curve seemed to moving from SAC_1 for the last several decades for a typical firm. Decreasing cost can be justified by the efficiency in feed production, reduced marketing cost, and improvement in labor management.

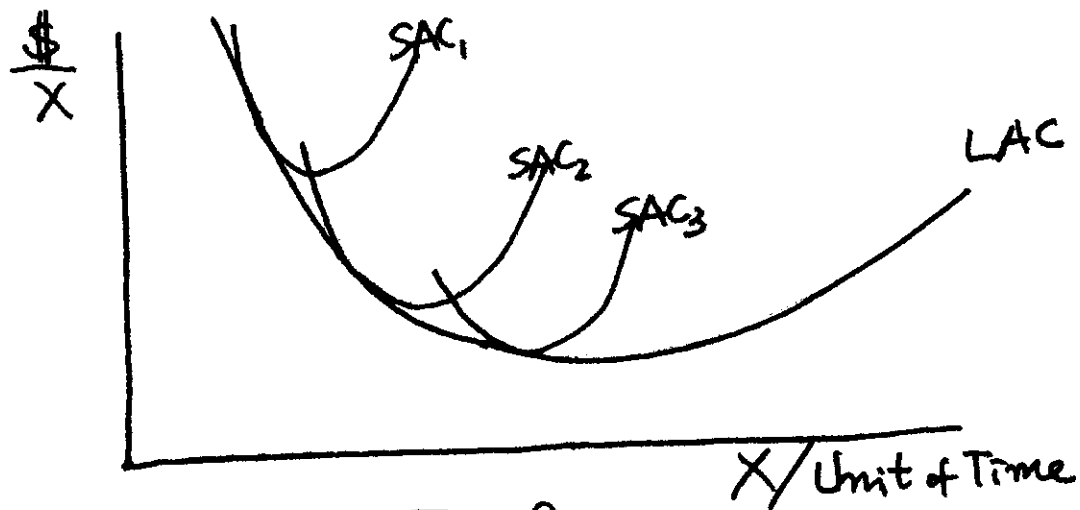


Fig 9

Decreasing cost in producing eggs can be assumed still in another way. Since the egg price, which can be equal to marginal revenue for the firm in pure competition industry, has been going down, the egg industry is not able to make

a profit unless the lowest point in the short run average cost curve is located below the straight marginal revenue line facing a firm. The egg industry has relatively less fixed cost portion than the other crop producing industries, due to large portion of feed and labor cost. Therefore entry to and exit from the industry is relatively easier than in other industries. In a short run a producer stays in business as long as he covers the variable costs. But in future, as the size of a unit gets larger, the technology improves, mechanization speeds up, the average variable cost curve will shift downward, larger gap between average cost and average variable cost will be realized, due to increasing portion of fixed cost in future, the egg industry will have the tendency of losing the flexibility of entry to and exit from the industry. In a long-term analysis, when no fixed cost would exist by definition, inefficient producers with higher cost curve will make a loss, and efficient producers will survive. Therefore by economic theory under the assumption of pure competition, each firm remaining in the industry will produce up to the lowest and the efficient point in the long run average cost curve. Still the egg industry seems to be at region of economies of scale caused by division and specialization of labor, and usefulness of technology. At present time, eggs are not eligible for the Federal Marketing Orders, for which basic legal authority lies in the Agricultural Marketing Act of 1937 and its

subsequent amendments. But the following will probably happen, if an egg marketing order is in effect. Demand elasticity for eggs with respect to its own price at wholesale level has been less and less elastic. This situation would be expected to continue as long as consumers don't have good substitutes for the shell eggs or per capita consumption for eggs continue to decrease. The author had obtained a demand elasticity of -0.115 , which was very inelastic for the last two decades. This implies when the annual egg price goes up by one percent, demand for eggs decrease by only about 0.1% , which indicates that demand for eggs is not sensitive to its price change. In the previous equation, price variable was introduced as an independent variable to measure the elasticity, and R^2 delete of the variable was 0.013 in the regression and partial correlation coefficient between the price and consumption was -0.8 . These figures seem to indicate that price is the most important factor consumers have in mind whether to buy or not. Therefore when egg price rises, consumers buy less amount of eggs for that period. Demand elasticity can be utilized to measure price flexibility when production of eggs change. Martin J. Gerra noted that a price concession of about 2.5% would be required to increase per capita consumption by one percent by using the reciprocal of the elasticity of demand, -0.11^1 , in 1959. Another study published in 1968 showed the concession

1. Martin J. Gerra, The demand, supply, and price structure for eggs, USDA, Tech. Bull. No. 1204, 1959, P. 79

would be in the region of 3 to 4%.¹ But the result the author obtained was about 8.6% of price flexibility calculated on the basis of demand elasticity of -0.12. This, in turn, can be interpreted that if the supply of eggs was curtailed by one percent under the marketing order, the egg price would go up by ten percent from the year before. The elasticity of demand for eggs is suspected to have been less and less elastic, for the following three reasons. At first, consumers don't have any good substitutes for eggs for decades, so demand for eggs is relatively stable regardless of egg price fluctuation. At second about 90% of shell eggs were used mainly as the table eggs, negligible portion of industrial outlets exist. At third, the egg price has been decreasing so less and less portion of income is spent for purchasing eggs. For the reasons stated above the elasticity will be less and less elastic in future.

DEMAND ELASTICITY WITH RESPECT TO U. S. PERSONAL INCOME

The author set up another equation, since he wanted to use U. S. income in place of Michigan income. Percentage change in demand due to the percentage change in U.S. income was calculated by using the model;

$$D = -3.2522 - 0.1075X_{61} + 0.1883X_{62} + 0.3709X_{63} \\ (0.020) \quad (0.2275) \quad (0.1204)$$

D = Estimated consumption rate per year per capita,
% first difference, adjusted 95% of national
data, Unit: Percent

1. University of Maine, Approaches to Supply management for the egg industry, P. 13

X61 = Annual average Detroit wholesale prices,
Grade A, white, large, loose basis,
% first difference, Unit: Percent

X62 = Consumer Price Index, % first difference,
Index base 1957 - 1959 = 100, Unit: Percent

X62 = U.S. Personal Income per capita,
% first difference, Unit: Percent

$$R^2 = 0.73$$

$$\bar{R} = 0.82$$

$$S_{y.x} = 1.01$$

The interpretation would be that when U.S. consumers personal income increases by one percent, the demand for eggs will go up by 0.37%. The significance level was 0.01 for the coefficient of the regression. However correlation between price index and U.S. income was high, which provides a poor basis for calculation. The author suggest to drop price index at next research. The study by Nordin, Judge, and Wahby in the period 1921 to 1941, by the method of least squares, produced 0.41 with statistically significant level of 0.05.¹ Gerra's value of elasticity, in the period of 1931 - 1941 plus 1946 - 1954, showed about 0.11 by the least squares method, with no significance at the 10% level. The author's elasticity would be close to Nordin, Judge, and Wahby's results, at a different period, since the discrepancy was only 0.04 between these two elasticities. Therefore the demand elasticity with respect to income was concluded to be about 0.37 in the period 1954 - 1969

1. Martin J. Gerra, The demand, supply, and price structure for eggs, USDA, Tech. Bull. No. 1204 1959, P. 79

CHAPTER V

SUMMARY

The primary objective of this study was to formulate a multiple regression equation for predicting the November average price of Grade A, white, large eggs delivered in Detroit, Michigan. The problem in this study was to determine the independent variables which influence the Detroit price.

The United States was the world's largest egg producing country in 1969, and no particular evidence was found to suggest that U.S. would rank second in egg production in a years. Turning to utilization, the consumption rate per person in shell form has been decreasing since 1945. But utilization of dried and frozen eggs is becoming larger.

Seasonality in egg production has been reduced very much, but seasonality still exists. Production area has been shifting from North Central to Western and Saurth Atlantic states. The number of layers times the rate of lay per layer makes total U.S. egg production. The number of layers seems to be growing one percent annually on the average and the rate of lay seems to be growing about half of a percent annually on the average. The annual growth of rate of lay per bird is increaseing at a decreasing rate.

As of 1964, still 83% of U.S. farms sold their eggs, but about 80% of U.S. eggs came from 5% of the large flock owners who had flocks of more than 1600 birds. The more specialization and larger

flocks seems to be technically feasible. Michigan egg industry produced about half of eggs consumed in the state. The trend in Michigan egg production is decreasing slightly year after year, But some evidence indicated Michigan egg industry was more efficient than the national average.

The egg prices for the past twenty years indicated about one third of a cent drop every year at the farm level and the seasonal price fluctuation reduced very much, but price in Spring is still low, and Winter high. Turning to the regional price differences simple correlations of 0.99 among Detroit, Chicago, and New York led to a conclusion that egg prices had basically national characteristics. Egg pricing is characterized a highly outmoded and institutionalized egg pricing system.

The method of analysis used in this study was least squares regression. The period examined was from 1953 to 1969, which numbered 16 sample points. Four separate multiple regression equations were tried one by one. The dependent variable was Detroit November shell egg prices, delivered at Detroit, Michigan, gradeA, white, large, loose basis. The first and second equation failed to produce any significant findings. The third equation produced fairly good result. R^2 was 0.87 and the standard error of estimate was about five cents. The major influential variables on the price in Detroit, in the third equation, were consumption rate per capita, average egg-feed ratio of November of the previous year and May in the present year, consumer price index and price difference

between medium and large sizes. On the fourth and last equation, the standard error of estimate was reduced to about four cents. The seven independent variables tried were May and June number of layers, April U.S. hatchery production, Consumption rate per capita, rate of lay per bird, the average egg-feed ratio of November of the previous year and May at the present year, price difference between medium and large size eggs in October and consumer price index. The major and important factors influencing November Detroit egg price were April hatchery production, per capita consumption rate, rate of lay per bird, and price difference between sizes in October and consumer price index. A Durbin-Watson test for the equation IV was inconclusive with respect to auto-correlation among disturbance. In order to test the workability of the equation IV, the November price in 1970 was estimated as of October 1970. The actual egg was 39.79 cents per dozen but the estimated price by the Equation was 35.91 cents, resulting in a discrepancy of 3.87 cents.

Demand elasticity with respect to own price was estimated to be -0.115 , which was very inelastic during 1954 to 1969 period. The elasticity I found was the lowest value over several decades, which leads to a speculation that the demand elasticity was heading for less and less elastic situation. Over years the egg prices had been slowly decreasing, so it reduced total revenue to egg producers, which was less favorable to them under the assumption of unchanged costs of production. The egg industry

now seems to be enjoying the economies of scale and the author feels that larger and larger flocks will be realized in future. As the portion of fixed assets increases in the egg industry, the entry to and exit from the egg industry by a firm was expected to be less flexible than ever.

Demand elasticity can be utilized in another way. If the supply of eggs was curtailed by one percent by some agreement, or by other factors, the egg price would go up by ten percent from the year before. The egg price has become more inelastic due to the following conditions. At first consumers do not have any good substitutes for shell eggs. Second, a negligible portion of industrial outlets exist. Third the egg price and consumption has been decreasing, so less and less portion of income is spent for purchasing eggs.