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QUARTERLY EGG PRODUCTION ESTIMATORS

Robert G. Hoffman*

INTRODUCTION

Egg production is a continuous process determined by the number of layers in the nation's flock and the rate at which they produce. Annual production usually varies little from year to year. However, economic and biological factors with accompanying management considerations cause production to vary seasonally with peaks usually occurring in the second quarter.

Total egg production statistics include eggs produced for human consumption as well as hatching purposes.[1] The impact of changes in total egg production on farm prices is difficult to assess since eggs used for hatching (primarily broilers) and table eggs are influenced by different economic and structural factors. While second quarter 1969 total egg production declined only 0.5 percent from a year earlier, an eight percent increase in broiler hatchings reduced table egg production 1.2 percent. The importance of knowing the nature of supply is important because small changes in egg production result in sharp price moves [1, 2, 3], as indicated recently by the supply-price swings in 1967-68.

Our objective then is to present a series of quarterly supply estimators for: (1) Total egg production, (2) Eggs used for hatching, and (3) Table egg production.

Relationships are designed to project egg supplies 6 to 9 months into the future. The demand side of the egg economy is not integrated into this short-run supply appraisal framework. However, because of the relatively small absolute effect of current prices on current production, projected prices may be estimated from projected production and an assumed elasticity of demand.

METHODOLOGY

Quarterly estimating equations were fitted based on the poultry industry structural relationships shown in Chart 1.

Total production is defined as flock size times the rate of lay. Eggs used for hatching are estimated from total hatchings of egg-type and broiler-type chickens. The difference between total production and hatching egg use is considered table egg production.

List of variables (quarterly basis)[2]

Dependent

HBT. = Broiler hatch—U.S. total (million)

HEP = Egg-type pullet replacement hatch—U.S. total (million)

LRT = Rate of lay—eggs per hen and pullet of laying age per day (percent)

FHP = Hens and pullets of laying age—average (million)

EHB = Eggs used for broiler hatching—total (million)

EHE = Eggs used for egg-type hatching—total (million)

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[1]Published egg production statistics include eggs produced for all purposes. Estimates of hatching egg utilization, relative to egg consumption, are then based on total hatchings.

[2]Poultry industry data used in this analysis are available on request from the Price Research and Methods Section, Economic and Statistical Analysis Division, ERS, USDA.

Independent

PGH = Price received by Georgia producers for hatching eggs–(cents per dozen)

TBT = Broiler chickens tested for pullorum disease–t-(1-3) (million)

PBW = 9 city wholesale RTC broiler price–(cents per pound)

PBI = Feed Ingredient cost (broilers); corn, prices received by farmers (65%); soybean oil meal, Decatur, bulk (35%)–(cents per pound)

TET = Egg-type chickens tested for pullorum disease–t-(1-4) second quarter only (million)

HEP*= Egg-type replacement hatch–same quarter previous year as percent of previous calendar year total (percent)

PEF = Prices received by farmers for eggs–(cents per dozen)

HRT = Pullet replacement hatch–one-half egg-type hatch t-(2-5); and broiler pullets placed domestically for hatchery supply flocks t-(2-4)–(million)

PEI = Feed ingredient cost (Eggs); corn, prices received by farmers (80%); soybean oil meal, Decatur, bulk (20%)–(cents per pound)

TQ = 1959 = 59.00; 59.25; 59.50; 59.75

TR = 1959 = 59.00; 0; 59.50; 59.75

D1, D2, D3 = 1st., 2nd., and 3rd. quarter dummy seasonal shifters (1.0, or 0)

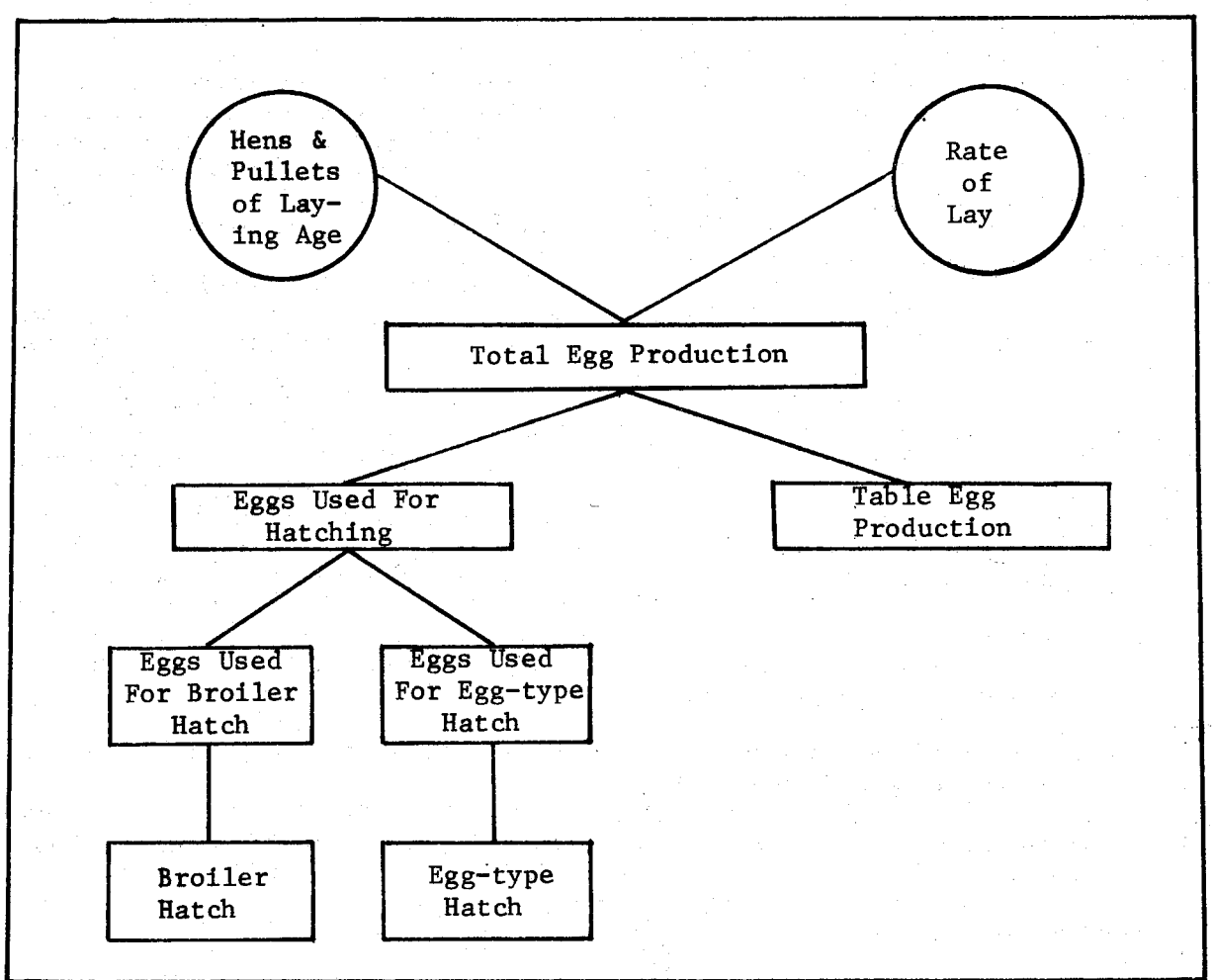

CHART 1: EGG PRODUCTION STRUCTURE

Product/feed ingredient price ratios are used extensively throughout the analysis as economic variables. These ratios vary from the more conventional product/feed price ratios in that the two major feed ingredient items are weighted together to form the combined ingredient price. Two major factors are responsible for this approach: (1) The feed price series published by SRS and used in computing the published poultry ratios has shifted significantly in level in recent years, because of changes in feed price definition. (2) Prices received for corn, and a wholesale price level for soybean meal allows the measurement of changes in these price levels on short term poultry supplies relative to policy considerations. This eliminates the necessity of estimating feed prices. Projected values of the ratios are dependent on projected egg and feed ingredient prices.

Seasonal shift variables are used to account for the seasonal nature of production, and trend variables are used in the layer number (FHP), rate of lay (LRT), and broiler hatch (HBT) equations. The "TR" trend variable in the rate of lay equation has a zero value in second quarter. Since the 1940's, the rate of lay in the spring months (second quarter) has shown virtually no upward trend. Trend and the seasonal shifter variables were combined into one variable (HEP*) for egg-type hatchings.

The data period used to fit the ordinary least squares equations cover the 1959-68 period; an era of rapid expansion in broiler production and sharp decline in the number of egg producing farms, although egg production remained relatively stable.

The general form for each least squares estimator is as follows:

$$X_O = f(X1; X2; X3;...Xn) + e_o$$

Standard errors of regression coefficients are shown in parenthesis.

s.e. = Standard error of estimate

D.W. = Durbin-Watson statistic.

Layer Numbers, Rate of Lay, and Total Production

The equations estimating layer numbers and rate of lay are most important to the system. Total egg production is then determined by multiplying layer numbers, times daily rate of lay, times the days in the particular quarter.

Layer Numbers: (1)

$$FHP = 80.14789 + \underset{(0.03894)}{0.32396HRT} + \underset{(0.42445)}{1.02878\frac{PEF}{PEI}}$$

$$+ \underset{(0.23707)}{1.93543TQ} - \underset{(1.71146)}{1.60620D1} -$$

$$\underset{(2.16340)}{13.50018D2} - \underset{(1.85235)}{16.13841D3}$$

$R^2 = .913$ s.e. = 3.62095

D.W. = 1.99839

Rate of Lay: (2)

$$LRT = 24.86161 - \underset{(0.05214)}{0.10581\frac{PEF}{PEI}} + \underset{(0.04059)}{0.50497TR} +$$

$$\underset{(0.26923)}{3.62872D1} + \underset{(2.71178)}{39.38564D2} + \underset{(0.28198)}{2.02090D3}$$

$R^2 = .970$ s.e. = 0.570

D.W. = 2.01326

Total Egg Production: (3)

ETP = (FHP) x (LRT) x (days in quarter)

The trend and seasonal shift variables are highly significant in nearly all cases. The regression results also show that relatively large changes in replacement hatchings are needed to influence layer numbers, i.e., a 3 percent change in the lagged hatch results in a 1 percent change in layer numbers.

The current quarter's egg/feed ingredient cost ratio has a small but significant effect on both layer numbers and rate of lay. The layer number equation implies that a 20 percent change in the current quarter's egg/feed ingredient cost ratio (about 6.5 cents per dozen) would be necessary to change numbers 1 percent. The variable explains the changes in culling rates of marginal layers in response to current prices. The effect on rate of lay is smaller, and in the opposite direction with a 33 percent change in the ratio resulting in a 1 percent change in the rate of lay. The net effect on total egg production of an increase of the egg/feed ingredient price ratio is an increase in total production—the increase in layer numbers more than offsets the decline in rate of lay.

Broiler Hatchings, and Egg-Type Pullet Hatchings

The second group of equations estimates total broiler, and egg-type pullet hatchings. These equations are used to estimate eggs used for hatching.

Hatch—Broiler: (4)

$$HBT = -1-1615.61905 + \underset{(2.92999)}{9.28379TBT} +$$

$$3.65549\frac{PBW}{PBI}(t-1) + 2.15548PGH(t-1)$$
(3.16102) (0.55336)

$$+ 28.18817TQ + 58.91007D1 +$$
(1.60800) (8.28096)

$$98.46687D2 + 24.48026D3$$
(11.69493) (9.02602)

$R^2 = .971$ s.e. = 17.65215

D.W. = 1.00659

Hatch–Egg-type Pullets: (5)

$$HEP = -6.89286 + 0.84918TET +$$
(0.49264)

$$1.98085HEP^* + 1.32663\frac{PEF}{PEI}(t-1)$$
(0.18065) (0.56992)

$R^2 = .940$ s.e. = 7.78894

D.W. = 1.52863

The broiler hatching equation explains a large share of total variation with lagged testings being highly significant. The coefficient indicates that a 3 percent change in the lagged testings variable would change hatchings 1 percent.

The relatively minor absolute and statistically insignificant effect of the broiler/feed ingredient price ratio on hatchings was unexpected. Further testing appears necessary to refine lag relationships and to reduce the problem of autocorrelation in the residuals. The egg-type pullet hatch equation also has autocorrelation problems. However, the relationship appears to be a reasonably good estimator for this system.

Hatching Egg Use, and Table Egg Supply

Eggs used for hatching are estimated for broiler-type and egg-type from the hatching equations above [(4); (5)]. The combined total is then subtracted from total egg production to derive table egg production.

Hatching Eggs–Broiler: (6)

$$EHB = 70.76121 + 1.17525HBT +$$
(0.03025)

$$3.30457\frac{PBW}{PBI}(t-1) + 16.89518D1 -$$
(1.64989) (5.32696)

$$9.79164D2 - 29.86516D3$$
(6.79948) (5.08934)

$R^2 = .991$ s.e. = 11.13915

D.W. = 2.23335

Hatching Eggs–Egg-type: (7)

$$EHE = -13.53303 + 2.39403HEP +$$
(0.24150)

$$1.81086\frac{PEF}{PEI}(t-1) + 53.83795D1 -$$
(1.39664) (11.29902)

$$52.02522D2 - 0.94855D3$$
(17.57956) (7.71397)

$R^2 = .956$ s.e. = 16.52750

D.W. = 2.62739

Eggs Available for Human Consumption: (8)

$$EAH = ETP - [(EHB) + (EHE)]$$

Product/feed ingredient price ratios have been included in the relationships to explain the variation in utilization of hatching egg production actually set for hatching. For both the broiler and egg-type equations, the lagged ratio appears with a positive sign, although statistically insignificant in the egg-type equation. The results suggest that the proportion of available hatching eggs actually used for hatching varies with profitability.

IMPLICATIONS

The relationships tested and shown permit a rather detailed discussion of the current and projected poultry and egg situation. The general nature of the lagged relationships are shown in Table I.

The supply model considered here assumes that replacement pullets (broiler and egg-type) enter the laying flock at 6 months of age (2 quarters). For any given quarter "t", the laying flock is largely defined by replacement hatchings 2 through 5 quarters earlier. One quarter lags of egg and broiler profitabilities as well as egg type testings largely explain quarterly pullet hatchings. Therefore, in a current quarter (assuming profitability is known), the following quarter's hatch may be estimated. This hatch then influences layer numbers 3 quarters from the current

TABLE 1. LAGGED MAJOR VARIABLES INFLUENCING PULLET REPLACEMENT HATCHINGS AND LAYER NUMBERS, BY QUARTERS

Time Period	t-6	t-5	t-4	t-3	t-2	t-1	t
Major variable	Egg Profitability						
	Egg-type Testings						
	Broiler Profitability						
			Pullet Replacement Hatch				
							Layer numbers

quarter. The limited effect of current prices on each quarter's estimated total egg production may be taken into account at the time of estimation.

Tests of the system involved estimating total egg production within the period of fit (1959-68), and outside the period of fit (1969), from the layer number and rate of lay equations. Quarterly production for 1959-68 is closely described. Outside the period of fit, first quarter 1969 is somewhat overestimated, but estimates for following quarters are reasonably close to actual production (see Chart 2).

Another important consideration in this analysis is the separation of the eggs used for hatching from total egg production. Discussion and appraisal of the demand for table egg production can then be ex-

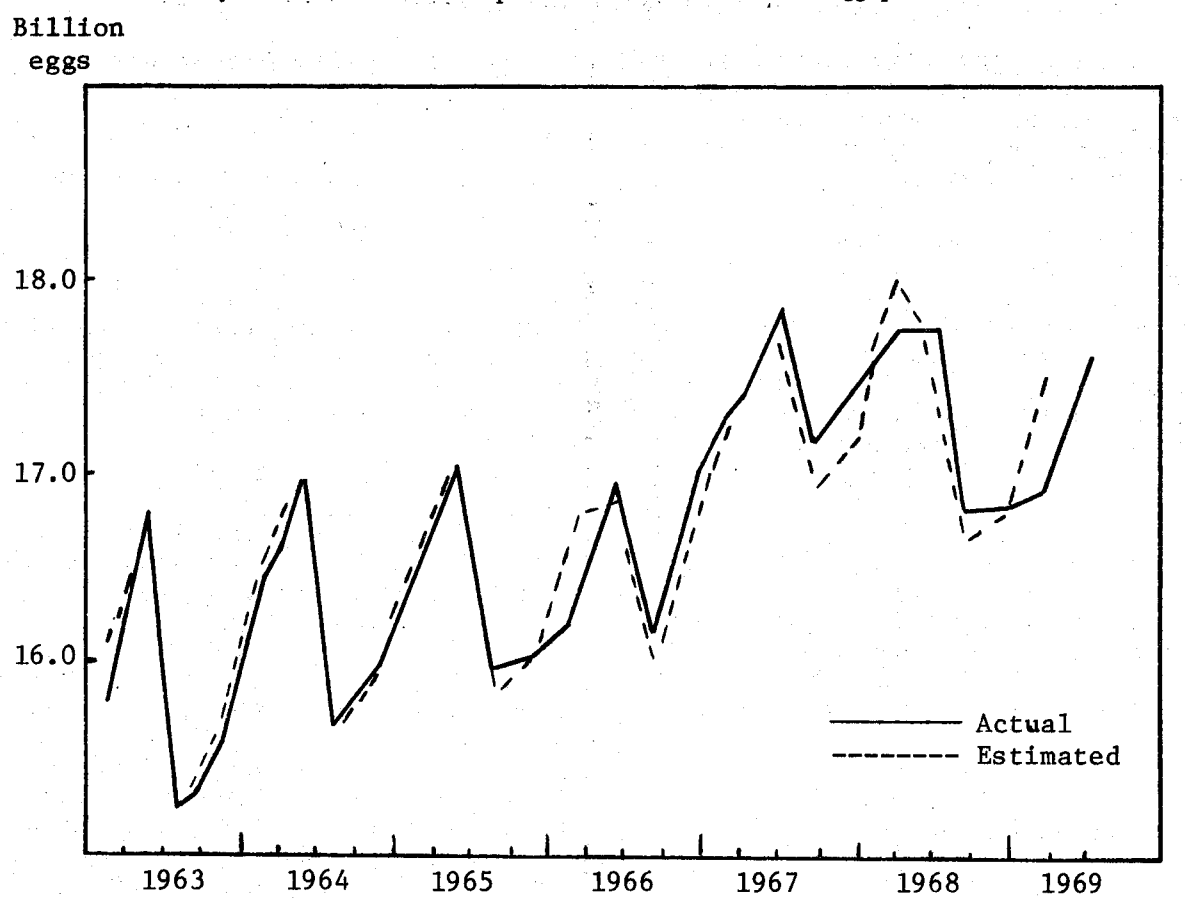

CHART 2: TOTAL EGG PRODUCTION, BY QUARTERS, 1963-mid 1969

amined in measuring the elasticity of demand and factors influencing egg prices.

Additional work is needed on the quarterly demand for eggs to complete the supply-demand relationships. However, the supply system presented here provides a basis for a more detailed analysis of the quarterly demand-supply framework for eggs.

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