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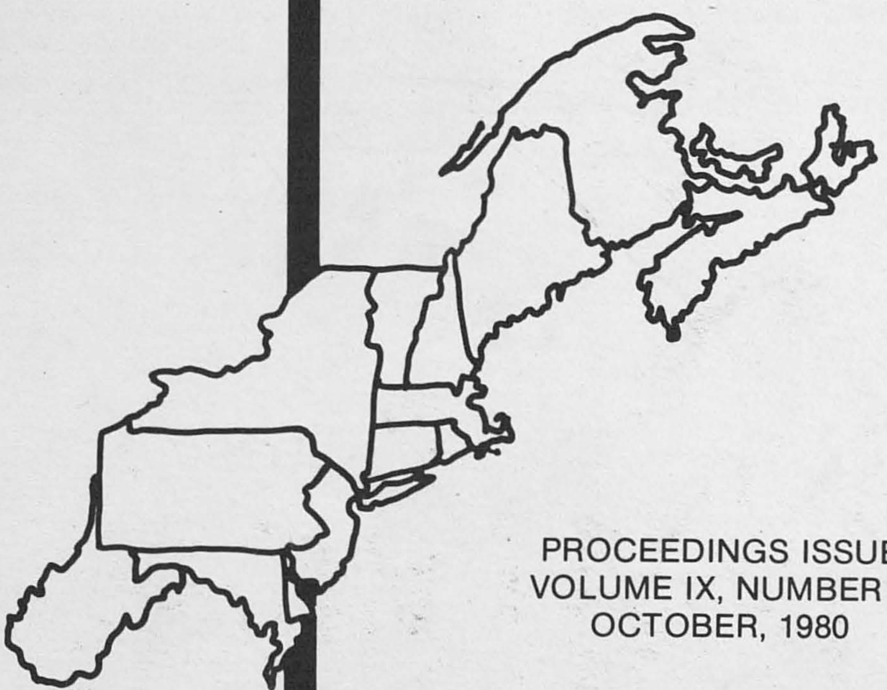

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STRUCTURAL CHANGE IN THE NEW ENGLAND EGG INDUSTRY: A MARKOV ANALYSIS

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In recent years there has been a noticeable trend toward a small number of large farms and declining output in the Connecticut, Massachusetts and New Hampshire egg industries. This is partly due to increases in the costs of feed grains and freight rates [Skinner]. A significant change in farm income and cost after 1973 is also observed by Hwang. The purpose of this paper is to examine the changes in the size distribution of egg farmers in this three-state region over time as a Markov process. Also, the occurrence of a marked structural change in the egg industry during the period 1967 to 1978 is statistically examined. We also seek answers to questions such as the following: how many years can different-size egg farms survive in the face of increasing feed and energy costs? What will be the size distribution of egg farms, total number of layers, and egg output in the next decade?

This paper begins with a description of the survey procedure used to collect farm data. The methodology of estimating transition probability matrices and inferences is then presented. This is followed by a discussion of the estimated annual and average transition matrices, particularly noting changes in industry structure. From these matrices, the average life span of different size farms and their long-run equilibrium distribution are next calculated and discussed. Finally, projections of the numbers of farms, layers and egg output are presented.

FARM SURVEY

The Markov chain analysis of the regional egg industry structure required obtaining annual individual farm size data. A twelve year period, 1967 to 1978, was used to examine the size distribution of farms and patterns of structural change. This time period was of sufficient length to allow patterns of economic change to develop and thus permit an accurate assessment of industry structure and trends.

Complete lists of egg farms in business during 1967 in Connecticut, Massachusetts, and New Hampshire were obtained and a population of 721 egg farms in business was identified.[1] The sampling procedure was simply to contact as many farms as possible in order to trace their annual sizes from 1967 to 1978. The Connecticut Agricultural Department made available 107 individual farm size records over the study period. Also, mail questionnaires and a telephone follow-up procedure were used to gather information on an additional 395 farms. Together these sources yielded usable records on 502 of the 721 population farms or 70 percent of total producers listed, a very sizable representative sample.

In addition, the more recently dated producer lists were compared with the 1967 lists to identify new entrants into the egg industry. A new entrant is defined as either a farm that has been out of operation for at least a year and which later resumes production, or a newly built farm which is not an expansion of an already existing unit. Any operators appearing only on the more current lists were contacted to ascertain whether their farms qualified as new entrants. This procedure identified twelve new entrants during the study period. Therefore, the analysis was based on a sample of 514 farms.

ESTIMATION AND INFERENCE

Six layer size categories, or Markov states, as shown in Table 1, were used to classify sample farms. Movements of individual sample farms among various Markov states for successive years were used to estimate elements of both annual and average transition probability matrices. The maximum likelihood estimates of the elements of the annual transition probability matrices were calculated based on the following formula:[2]

$$p_{ij}(t) = n_{ij}(t) / \sum_{j=1}^{r} n_{ij}(t) \qquad (1)$$

where $p_{ij}(t)$ is the estimated probability of moving from state i to state j in one time period and $n_{ij}(t)$ denotes the number of farms that moved from state i in time period (t–1) to state j in time period t. After calculating annual matrices for each successive pair of years from 1967-1968 through 1977-1978, weighted average matrices for the periods 1967-1973 and 1973-1978 were computed. The elements of these matrices were calculated from the following formula:

$$\hat{P}_{ij} = \sum_t n_{ij}(t) / \sum_t \sum_j n_{ij}(t) \qquad (2)$$

where the summations are over t = 1, 2, ..., T, and j = 1, 2, ..., r.

To determine whether annual matrices differed significantly from an average probability matrix, the null hypothesis, H_o: $\hat{p}_{ij}(t) = \hat{p}_{ij}$, for t = 2, ...T, was tested by calculating a chi-square statistic according to the following formula:

$$\chi^2 = \sum_i^r \sum_j^r \sum_t^T n_i(t-1)[\hat{P}_{ij}(t) - \hat{P}_{ij}]^2 / \hat{P}_{ij} \qquad (3)$$

with r(r–1) (T–1) degrees of freedom.

Finally, a transition matrix was tested to see if it was the same as a certain given matrix $[p^*_{ij}]$. The null hypothesis, H_o: $\hat{p}_{ij} = p^*_{ij}$, for i,j = 1,2, ..., r, was tested by calculating a chi-square statistic according to the following formula:

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{r} n_1 \frac{(\hat{P}_{ij} - P^*_{ij})^2}{P^*_{ij}} \qquad (4)$$

with r(r–1) degrees of freedom.

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[1]Complete lists of egg farms in business during 1967 in Connecticut, Massachusetts, and New Hampshire were obtained, respectively, from the Marketing Division of the Connecticut Agricultural Department, Hartford; Massachusetts Agricultural Department, Boston; and University of New Hampshire, Durham. In addition to the 1967 producer lists, the Farm Bureau Federation provided a 1978 list of member producers for Connecticut, Massachusetts and New Hampshire. Also, the U.S.D.A. furnished 1973 and 1978 lists of egg farms that were producer-packers.

[2]For the derivations and details of formulae see Anderson and Goodman.

Table 1.
The 1967 Sample Farm Distribution

Markov State	Farm Size Class (no. layers)	Avg. Class Size (no. layers)	Sample Farms Per Class (no. farms)	Sample Farm Distribution (in percent)
1	—	—	12	—
2	1,600- 9,999	5,500	362	72.1
3	10,000-19,999	13,500	92	18.3
4	20,000-49,999	27,300	37	7.4
5	50,000-99,999	68,100	8	1.6
6	100,000 or larger	—	3	0.6

ANNUAL TRANSITIONS

Some insights into the dynamic patterns of farm change in the egg industry can be obtained by examining the annual transition matrices. For instance, Markov state 1 represents the class that farms going out of business join, as well as the one from which new farms enter the industry. By far the greatest tendency was for farms leaving the industry never to return and for new farms to enter the industry with only a very small probability.[3] During the period 1967 through 1973, the probability that farms in state 2 would exit from the industry was between 7 and 10 percent. However, beginning in 1973, the probability of exit for a state 2 farm increased to 13.5 percent. This probability of exit continued to climb to 19.5 and 21.7 percent for the periods 1974-1975 and 1975-1976, respectively.

An examination of state 3 farms revealed a similar trend of rapidly increasing exit probabilities between 1973 and 1977, with a leveling off during 1977-1978 transition. Although similar trends of exit prevailed between the state 2 and state 3 farms, the probabilities of exit for the latter size farms were invariably smaller. During this period of high exit rates from states 2 and 3, the probabilities of remaining at the same size or expanding to a larger size diminished.

In contrast, larger farms in size classes 4, 5, and 6 were characterized by greater stability and significantly less tendency to reduce size or exit. For instance, in the period 1973 to 1977, farms in states 5 and 6 evidenced zero probabilities of exit while farms in size class 4 averaged less than a 2 percent probability of exit.

The rapid rise in exit rates of state 2 and 3 farms in the period 1973-1976 suggested that some element(s) of instability was present.

STRUCTURAL CHANGE IN THE EGG INDUSTRY

A review of all potential causes of structural change in the regional egg industry, including changes in key economic, social, and institutional variables, indicated that only feed price had markedly changed during this period. For instance, in mid-1973, the price of feed to New England producers abruptly increased to well over $6.00 per hundredweight, compared to the previous decade's average price of approximately $4.00 per hundredweight. Since 1974 the cost of laying mash has remained at this higher level, averaging approximately $7.00 per hundredweight. Egg prices also increased at this time, but at a relatively slower rate than feed prices. Thus feed price increases were used as the major variable to explain the occurrence of structural change. The effect of this feed price increase is indicated by questionnaire responses from farmers who had exited from the industry. Most cited low economic returns, and in many cases specifically the feed price increase, as their primary reason for leaving the industry.

Another important factor placing pressure on state 2 and 3 farmers to exit was the type of production technology utilized by them. Over 90 percent of all exit farms employed older floor-type laying houses, with the remainder being the more modern cage-type systems. The adoption of the cage-type laying house has progressively reduced the cost of producing a dozen eggs as compared to the floor system. It has greatly reduced labor requirements, especially the fully-automated house, while dramatically increasing the number of layers housed within a given floor space. These factors have placed pressure on farmers with floor-type operations in need of replacement to either modernize their facilities or leave the industry. Many elected to remain at their present size and technological state of production and then eventually either retire or find off-farm work. Therefore, farmers under pressure to exit due to technological advance found the feed cost increase of 1973 as "the straw that broke the camel's back" and the accelerated exit rate of these farms resulted. In addition, the small output volume of state 2 and 3 farms has made it increasingly difficult for them to successfully compete with large farms in marketing their product. Thus the marked increase in feed prices served as a catalyst in bringing about the rapid increase in exit rates of state 2 and 3 farms, which in most cases were operating at a less technologically advanced level.

TESTS OF STATIONARITY AND CHANGE

The rapid increases in the rates of exit for state 2 and 3 farms suggested a dramatic shift in the size distribution of the region's egg farms occurring at this time. In order to support the hypothesis of a structural change, average transition probability matrices were calculated for the two periods 1967-1973 and 1973-1978 and statistically compared. Table 2 shows the average probability matrices for these periods.

For each average matrix, a stationarity test was performed using formula (3). The chi-square statistics yield the calculated values of 101.3 for 1967-1973 and 45.6 for 1973-1978 with 180 and 150 degrees of freedom respectively. The results support the hypothesis of stationarity within each period at 1 percent significance level.[4]

[3] If more than 12 potential entrants were assumed in 1967, the probability of entrance would be negligibly small. For a discussion of potential entrants, see Stanton and Kettunen.

[4] For degrees of freedom n greater than 30, chi-square values are not available in most statistical tables. However, the transformed variable

$$z = \sqrt{2x^2} - \sqrt{2n - 1}$$

is approximately distributed as a standard normal. In our stationarity tests, the z values are −47.1 and −7.74 respectively, and their absolute values are greater than the standard normal table value of 2.58 at 1 percent significance level.

Table 2.
Selected Transition Probability Matrices

Period	Size Class	1	2	3	4	5	6
		Size Class					
1967-73 average	1	0.9777	0	0	0	0.0037	0
	2	0.0854	0.8854	0.0239	0.0054	0	0
	3	0.0493	0.0266	0.8975	0.0266	0	0
	4	0.0167	0.0042	0.0250	0.8958	0.0500	0.0083
	5	0.0147	0	0	0.0294	0.8971	0.0588
	6	0.0270	0	0	0	0	0.9730
1973-78 average	1	0.9992	0.0008	0	0	0	0
	2	0.1672	0.8148	0.0166	0.0015	0	0
	3	0.1125	0.0365	0.8298	0.0182	0.0030	0
	4	0.0188	0.0047	0.0141	0.9249	0.0376	0
	5	0.0125	0	0	0.0250	0.9125	0.0500
	6	0	0	0	0.0217	0	0.9783
1977-78 average	1	1.0000	0	0	0	0	0
	2	0.1250	0.8523	0.0227	0	0	0
	3	0.0638	0.0213	0.8936	0.0213	0	0
	4	0.0250	0	0	0.9250	0.0500	0
	5	0.0588	0	0	0	0.8824	0.0588
	6	0	0	0	0.0909	0	0.9091

Thus, the average transition matrices represent the stationary Markov chain for the corresponding periods.

The hypothesis of structural change was tested by using formula (4) to compare the two stationary transition matrices. Each matrix was tested against the other matrix for a significant difference. The conclusion remained the same regardless of whether the 1967-1973 or 1973-1978 matrix was considered given. The calculated chi-square values are 131.3 and 122.9 respectively and are greater than the table value of 50.9 with 30 degrees of freedom. The hypothesis that the two stationary transition matrices are the same is rejected at the 1 percent significance level. In other words, there is statistical support for a significant structural change occurring in the egg industry after 1973.

LONG-RUN EQUILIBRIA

A vector depicting the equilibrium size distribution of farms in the egg industry can be calculated from the transition probability matrix. In a Markov chain, if a process is started in each of the states with probabilities given by elements of the vector π, then the probabilities for being in each of the states after n periods are given by πP^n, where P is the transition matrix. For a large n, πP^n, is approximately equal to w, where w is the long-run equilibrium probability vector with the property $wP = w$. The determination of w is independent of the initial starting vector.

There are two alternative methods of calculating the equilibrium vector w. One procedure is to raise the power of P sufficiently large so that P^n approaches a matrix W, in which each row is the same probability vector w. The power n may be as large as 40 to 50 in the problem under study. An alternative method makes use of the relation $wP = w$ together with the fact that the sum of the elements of the vector w is unity. More specifically, these relations are used to form a system of n linearly independent equations and n unknowns from which the unique values of w can be solved. This latter method was used to calculate the equilibrium vectors in the present study.

Table 3 depicts the equilibrium vectors calculated from the transition matrices for selected time periods. The equilibrium vectors based on the 1967-1973 and 1973-1978 transition matrices exhibit markedly contrasting results. In particular, if the factors underlying the 1973-1978 matrix prevail into the future approximately 99 percent of all egg farms will go out of business. In contrast, the 1967-1973 transition matrix implies an equilibrium vector characterized by 55 percent of all farms exiting from the industry and 38 percent of the farms remaining in size classes 4, 5, and 6.

Table 3.
Equilibrium Vectors for Alternative Situations

Matrix Period	1	2	3	4	5	6
	Size Class					
1967-73	0.5486	0.0159	0.0508	0.1120	0.0701	0.2026
1973-78	0.9929	0.0044	0.0004	0.0007	0.0003	0.0013

AVERAGE LIFE SPAN OF EGG FARMS

The annual transition matrices from 1973 through 1978 are quite similar in that four out of five matrices represent absorbing Markov chains.[5] In each of these four matrices class 1 is the absorbing state. Thus once a farm has ceased operating it will not later resume production. For example, based on the 1977-1978 matrix, an absorbing chain, each egg farm will gradually go out of business. Given the business situation prevailing in 1977-1978, it is therefore of interest to inquire into the average number of years a farm in each size class will remain in operation prior to exiting from the industry.

If the stochastic process is an absorbing Markov chain, the transition matrix can be partitioned as follows:

$$P = \begin{bmatrix} I & 0 \\ R & Q \end{bmatrix}$$

To compute the mean number of years a farm is in a given transient state before exiting, the original position's contribution to the mean passage time is added to each of the other steps' contribution. The original position contributes 1 if and only if the farm stays in the same size class. After one step the farm moves to size class k from size class i with probability p_{ik}. If the new state is absorbing, it contributes Q for the step, and Q^2 for the second step and so on. Thus, the total number of times the process is in size class j is equal to $I + Q + Q^2 + ... = (I-Q)^{-1}$ for the original size class i. Using the 1977-1978 transition matrix, the mean time a farm starting in any size class will remain in business was calculated.

As shown in Table 4, a state 2 egg farm will remain in this size class for approximately 7 years and will stay in class 3 for 1½ years. Since the mean number of years spent by a farm in a given starting state before exiting is the sum of the elements in each row, class 2 farms will remain in business an average of 9½ years. A similar analysis can be followed for the other farm classes. In general, the results conform to reasonable economic expectations as larger size operations were calculated to remain in production longer than smaller farms.

[5]A state in a Markov chain is an absorbing state if it is impossible to leave. A Markov chain is absorbing if it has at least one absorbing state and from every state it is possible to move to an absorbing state.

The last column of Table 4 shows the standard deviation of the mean number of years spent in business for each farm size class.[6] Note that the standard deviation relative to the mean (coefficient of variation) is smaller for large-size than small-size farms.

PROJECTION OF FARM NUMBERS

The number of egg farms in each size class can be projected by using the recursive relation of the Markov process, $n(t) = n(t-1)P$, where $n(t)$ is a distribution vector in period t and P is a transition probability matrix. In order to project future farm numbers, the initial distribution of farms by size class must be known. A similar methodology was employed by Colman and Leech to project milk output in England and Wales. Although the regional egg farm population (farms housing more than 1,600 layers) in 1967 was 721 farms, the size distribution of farms was unknown. Therefore, to determine the initial state vector for 1967 it was assumed that the population of farms had the same percent distribution as farms in the sample. This distribution is shown in the last column of Table 1.

Table 5 shows the farm number projections for the period 1967-1988. The 1967-1973 transition matrix was used to make projections for that period whereas the 1973-1978 matrix was employed to project farm numbers from 1974 to 1979 and selected future years. This projection procedure appeared reasonable given the occurrence of structural change beginning in 1973.

The most marked shifts in farm numbers were projected for classes 2 and 3 over the years 1967 to 1988, with rapid declines from 520 to 22 and 132 to 16 farms respectively. The number of farms in class 4, in contrast, rises slowly from 1967 to 1973, and then slowly decreases. The class 5 population shift is characterized by an initial slow growth in the number of farms through 1982, followed by a slow downward trend. This slow decrease in farm numbers may reflect the movement of some state 5 farms into size class 6, with a slower rate of entrance into class 5 from smaller classes to offset the upward movement of these expanding farms. An invariant increase in farms of size greater than 100,000 birds is observed over the entire period, 1967-1988.

Despite a slight increase in class 6 farms, the total farm population decreases dramatically. By 1976 the three-state egg industry consisted of less than one-half the number of farms operating in 1967. This trend is projected to continue into the future with only 25.4 percent and 16.9 percent as many farms remaining in business in 1982 and 1988, respectively.

Table 4.
Mean Number of Years in Business Before Exiting, Based on the 1977-78 Transition Matrix

Size Class	Size Class 2	3	4	5	6	Mean Total Number of Years	Standard Deviation
2	6.99	1.49	0.64	0.27	0.17	9.56	12.74
3	1.40	9.70	4.13	1.76	1.14	18.12	22.89
4	0	0	20.00	8.50	5.50	34.00	34.53
5	0	0	10.00	12.76	8.25	31.01	34.95
6	0	0	20.00	8.50	16.50	45.00	36.09

[6]For the variance formula used in these calculations, see Kemeny and Snell.

Table 5.
Projection of Egg Farm Numbers, by Size Class, 1967-1979, 1982, 1985 and 1988

Year	Class 1 Exit Entry Pool	Class 2 1,600-9,999	Class 3 10,000-19,999	Class 4 20,000-49,999	Class 5 50,000-99,999	Class 6 More Than 100,000
1967	12	520	132	53	12	4
1968	64	464	132	55	13	5
1969	110	415	131	56	15	6
1970	150	371	130	58	17	7
1971	187	332	127	60	18	9
1972	219	298	124	62	20	10
1973	247	267	121	65	22	11
1974	307	222	106	63	23	12
1975	357	185	92	62	24	13
1976	399	155	81	60	24	14
1977	435	130	70	58	25	15
1978	467	109	61	56	25	15
1979	492	92	53	54	25	16
1982	550	55	36	48	25	19
1985	587	34	24	43	24	21
1988	611	22	16	38	23	23

PROJECTION OF LAYER NUMBERS AND EGG OUTPUT

In order to determine the annual number of layers in size classes 2 through 5, the number of farms in each class as projected by the Markov analysis was multiplied by the average layer size of each class (shown in column 3 of Table 1). The layer projections by size class are shown in Table 6. Since size class 6 is defined as an open interval with no upper bound ($\geqslant$100,000 layers), it has no meaningful class mid-point. Thus the above layer projection method could not be used. Rather, the total number of farms in class 6 and their annual sizes for the period 1967-1978 were determined from confidential records and interviews. Therefore, regression analysis was used to predict class 6 layer numbers for 1979, 1982, 1985 and 1988. The projected layer numbers for farm size classes 2 through 6 were then summed to obtain the projected regional total number of layers for each study year.

As shown in Table 6, when the layer projections for the years 1967-1976 are compared with the layer totals reported by the U.S.D.A., the calculated values are seen to range within 0.5 to 5.8 percent of the U.S.D.A.'s. An unexplained marked decrease in layer numbers reported by the U.S.D.A. for 1977 and 1978 accounts for the larger discrepancies with projected layer numbers for these years. It appears the U.S.D.A. numbers for these two years are much too low.

An examination of Table 6 indicates that layer numbers for the years 1979, 1982, 1985, and 1988 will stabilize at an approximate level of 6.6 to 6.7 million birds. Although layer numbers are projected to stabilize, the distribution of layers by farm size class will continue to shift. For example, in 1967 farms in states 2 and 3 housed approximately 62 percent of all layers; farms in states 5 and 6 only 18 percent. By 1978 this situation had reversed with state 2 and 3 farms housing only 18 percent of all layers while farms 5 and 6 housed 60 percent. This trend is expected to continue with state 5 and 6 farms projected to house 80 percent of all layers by 1988.

Egg output, shown in the last column of Table 6, was calculated by multiplying the projected number of layers by the rate of lay. In general, egg output parallels trends in projected layer numbers. Egg output was projected to reach a peak of 146.7 million dozens in 1973. Although output exhibits a fluctuating pattern of increase

Table 6.
Projection of Egg Output and Total Number of Layers by Size Class, 1967-1979, 1982, 1985 and 1988

Year	Size Class 2	3	4	5	6	Total Layer Numbers Projected	USDA*	Percent Deviation	Rate of Lay** (eggs/year)	Egg Output Projected (million dozens)
	(1,000 layers)									
1967	2,860	1,782	1,447	817	563	7,469	7,933	-5.8	221	137.6
1968	2,552	1,782	1,502	885	823	7,544	7,818	-3.5	221	138.9
1969	2,283	1,769	1,529	1,022	1,022	7,625	8,006	-4.8	220	139.8
1970	2,041	1,755	1,583	1,158	1,322	7,859	7,895	-0.5	222	145.4
1971	1,826	1,715	1,638	1,226	1,115	7,520	7,353	+2.3	225	141.0
1972	1,639	1,674	1,693	1,362	1,205	7,573	7,641	-0.9	232	146.4
1973	1,469	1,634	1,775	1,498	1,313	7,689	7,754	-0.9	229	146.7
1974	1,221	1,431	1,747	1,566	1,358	7,323	7,111	+2.6	232	141.6
1975	1,018	1,256	1,693	1,634	1,627	7,228	6,923	+4.2	236	142.2
1976	853	1,094	1,638	1,634	1,902	7,121	6,783	+5.0	238	141.2
1977	715	959	1,583	1,703	2,082	7,042	5,990	+17.3	238	139.7
1978	600	837	1,529	1,703	2,139	6,808	6,076	+11.8	240	136.2
1979	506	716	1,474	1,703	2,321	6,720	—	—	243	136.1
1982	303	486	1,310	1,703	2,807	6,608	—	—	249	137.1
1985	187	324	1,174	1,634	3,292	6,611	—	—	255	140.5
1988	121	216	1,037	1,566	3,778	6,718	—	—	261	146.1

*Agricultural Statistics, U.S.D.A.

**The rates of lay for 1967 through 1978 are the weighted averages of figures for Connecticut, Massachusetts and New Hampshire reported in Agricultural Statistics, U.S.D.A. The weights are the number of layers in each state and are approximately 65 percent, 25 percent and 15 percent for Connecticut, Massachusetts and New Hampshire respectively. The rates of lay for 1979 through 1988 are the linear projections based on increment of two eggs per year.

for the years 1967 to 1973, a steady downward trend was observed beginning in 1975 and continuing through 1979. In the 1980's egg output is predicted to show slight increases from approximately 137 to 146 million dozens, due primarily to increased rates of lay.

Since the average layer size of each farm class is assumed to remain constant over the study period, annual changes in layer numbers and egg output result partly from changes in farm numbers in each size class as projected by the Markov analysis.[7] This procedure is reasonable since changes in individual farm size usually result from either an expansion or contraction in capacity by a large enough increment to cause reclassification of the farm into another size class. Also, this method of output determination closely conforms to and reflects the actual ongoing process by which changes in industry output occur. That is, although many farms remain at the same size for a number of years, some choose to either expand or contract their capacity, while others leave the industry. It is the net effect of these individual farm changes that causes industry output to vary.

SUMMARY AND CONCLUSION

A twelve year period, 1967 to 1978, was used to examine the size distribution of farms and patterns of structural change. A sample survey was conducted based on a population of 721 egg farms in business in 1967. The analysis was based on a sample of 514 farms, in which 12 farms were identified as new entrants into the industry.

An examination of the average transition probability matrices for the periods 1967-1973 and 1973-1978 revealed a structural change in the Connecticut, Massachusetts and New Hampshire egg industries coincident with the abrupt increase in feed prices beginning in mid-1973. Based on the chi-square stationarity tests performed on the annual transition probability matrices, the following conclusion is obtained. Although the average transition probability matrices for the periods 1967-1973 and 1973-1978 may be considered stationary, the two transition matrices are significantly different. In particular, the exit rates of farms with less than 20,000 birds doubled in the years 1973-1978 compared to 1967-1973 period. On the other hand, the larger farm sizes demonstrated a greater degree of stability over the entire period 1967 to 1978.

Equilibrium analysis indicated that if factors underlying the 1973-1978 transitions prevail into the future, approximately 99 percent of all egg farms will go out of business in the long-run. If the Markov chain follows the pattern of the 1977-1978 transitions, small-size farms that house 10,000 birds or less will go out of business within 10 years on the average, while the largest size farms housing 100,000 birds or more will survive on the average for 45 years. If the average transition pattern of 1973-1978 prevails in the next decade, by 1988 there will be only 22 farms with less than 10,000 birds, 16 farms averaging 13,500 birds, 38 farms with 27,300 birds, 23 farms that have an average of 68,100 birds, and 23 farms with 100,000 birds or more. However, the total number of layers will not decrease substantially as some egg farms will expand to a larger size. Therefore, egg output in 1988 will be larger than in 1978 provided technology improves the rate of lay to more than 244 eggs per bird per year.

Since 80 percent of all layers are projected to be housed on farms larger than 50,000 layers by 1988, the integration of production with input-supplying and marketing functions can be expected to continue. This trend toward more vertical integration within the egg industry will continue to have impacts upon input-supply industries and egg pricing practices. In addition, since fewer but larger, more technologically advanced farms are projected, it is

[7]Output also changes due to both the assumed increases in the rates of lay over the study period and the regression analysis prediction of class 6 layer numbers.

reasonable to expect that the egg industry would not respond to adverse economic events with the same pattern of dramatically increased exit rates observed during the period 1973 to 1975.

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