

August 8, 1969

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I am submitting herewith a dissertation written by Lew E. Brinkley, entitled "The Measurement of Marketing Efficiency of Tennessee Egg Handling Firms." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Agricultural Economics.

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THE MEASUREMENT OF MARKETING EFFICIENCY OF TENNESSEE
EGG HANDLING FIRMS

A Dissertation
Presented to
the Graduate Council of
The University of Tennessee

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

by

Lew E. Brinkley

December 1969

ACKNOWLEDGMENT

The author wishes to express his gratitude to everyone who helped make this study possible. He is especially indebted to the Department of Agricultural Economics for financial assistance throughout the graduate program.

Appreciation is expressed to the commercial egg handlers in Tennessee for their voluntary cooperation in this study.

Acknowledgment is made of the assistance given by the secretarial and statistical employees of the Department of Agricultural Economics for their help in processing the data and typing.

Special appreciation is due Dr. M. B. Badenhop for his assistance and encouragement throughout the study. Appreciation is also expressed to Mr. B. D. Raskopf, Dr. Irving Dubov, Dr. T. J. Whatley, Dr. Charles L. Cleland, Dr. Hans E. Jensen, and Dr. Harold W. Henry for their suggestions.

And finally, the author wishes to express his gratitude to his wife, Barbara, for her patience and understanding during the graduate program.

ABSTRACT

The primary objectives of this study were to determine the nature and scope of the egg marketing system of Tennessee and the relative costs and efficiencies being achieved by firms of different sizes and organizational structures.

This study was based on a survey of 75 Tennessee egg handling firms made in 1968. The primary data were used along with secondary data obtained from the Census of Agriculture, the Statistical Abstract of the United States, and Agricultural Statistics.

The structure of the commercial egg industry in Tennessee and the South in general has changed tremendously in recent years. The number of farms with layers has declined while the size of flocks has increased for those remaining in the industry. Seventy-nine farms accounted for 60 percent of Tennessee's egg production in 1967. Tennessee was still a slightly deficit state in 1967, but its neighbors to the south were large egg surplus producing states.

Egg handling firms in Tennessee procured their eggs from four sources--their own flocks, contract flocks, independent producers, and dealers. Each of these firms performed some of the marketing functions of assembling, transferring, washing, candling, grading, cartoning, packing, and delivering.

Tennessee's egg marketing system was made up of organizations which are producers, producer-contractors, dealers or wholesalers, dealer-producers, dealer-contractors, or dealer-producer-contractors.

The cost per dozen for producing eggs was computed for each of 36 producers included in the study. The firms were grouped into low, medium, and high cost groups. The low-cost group averaged 110,357 layers per firm and had production costs of 25.24 cents per dozen. The medium cost group averaged 28,769 layers per firm with production costs of 27.99 cents per dozen; whereas the high cost group averaged 18,286 layers per firm with production costs of 31.84 cents per dozen. Since the average price received by egg producers in Tennessee in 1967 was only 32.9 cents per dozen, many firms operated at a loss.

Economies of scale were found to exist for all marketing operations. The costs of assembling, in-plant handling, and delivering were computed for each firm. Stepwise regression equations were developed to explain why costs varied among firms. Cases assembled per man-hour, labor wage rate, and volume explained 94 percent of the variation in cost per case for assembling and 55 percent of the variation in delivering. Labor wage per hour, percentage of eggs cartoned, costs of cartons, cases per man-hour and volume explained 69 percent of the variation in in-plant handling costs.

Since 64 of the 75 firms studied performed the in-plant handling functions of transferring, washing, candling, and grading, these firms were compared to see if the larger firms were more economically efficient. The Farrell approach was used to separate technical efficiency from overall or economic efficiency. The efficiency indices indicated that the larger firms were more technically and economically efficient.

While economies of scale for marketing were found throughout the range of firms studied (50 cases per week up to 6,500 cases per week) most economies were reached at the 1,200 case per week level.



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CHAPTER I

THE MEASUREMENT OF MARKETING EFFICIENCY OF TENNESSEE EGG HANDLING FIRMS

I. INTRODUCTION

Egg production has traditionally been an important source of nutrition and income on Tennessee farms. Since 1924 the sale of eggs has accounted for between four and ten percent of the total cash receipts from the marketing of all crops and livestock each year (53). The increasing importance of the egg enterprise is pointed out by the fact that during the past ten years (1959-68) cash farm income from the sale of eggs annually averaged \$26.6 million compared with \$10.6 million for the ten-year period, 1924-33 (Table I).

The changes in total production and dollar sales are not as striking as the changes which have occurred in the structure of the egg industry of Tennessee. As Table I indicates, egg production in Tennessee rose from 845 million to 1,172 million eggs between 1924 and 1968. The number of farms with layers declined from 224 thousand in 1924 to 55 thousand in 1968, but production of eggs per layer doubled. The increase in commercial egg production is stressed by the fact that the dollar value of eggs sold per farm rose from an average of \$63 in 1924 to \$3,765 in 1968. The changing structure is most evident when one

TABLE I

PRODUCTION AND MARKETING OF EGGS IN TENNESSEE, 1924-68

Year	Egg production					Price per doz. ¢	Farm income (000) \$	Farms with layers		Farms selling eggs			
	Layers (000) No.	Eggs per layer No.	Used on farm Mil.	Sales Mil.	Total Mil.			Farms (000) No.	Layers per farm No.	Farms (000) No.	Cases per farm No.	Sales (000) \$	Sales per farm \$
1924	8366	101	262	583	845	23.2	15505	224	37	179	9.0	11271	63
1925	8406	103	256	606	862	27.0	18473	222	38	177	9.5	13635	77
1926	8371	113	272	676	948	26.5	20007	221	38	175	10.7	14928	85
1927	9190	109	283	719	1002	21.9	17502	220	42	173	11.5	13122	76
1928	8652	106	260	660	920	25.3	18659	219	40	172	10.7	13915	81
1929	7384	111	240	576	816	27.4	17833	218	34	170	9.4	13152	77
1930	7321	112	245	574	819	21.8	14243	217	34	167	9.5	10428	62
1931	6752	114	257	513	770	15.7	9656	221	31	164	8.7	6712	41
1932	6785	111	273	481	754	11.6	6941	226	30	161	8.3	4650	29
1933	6950	105	269	464	733	11.5	6699	230	30	159	8.1	4447	28
1934	6766	105	259	453	712	15.2	8613	235	29	156	8.1	5738	37
1935	7026	106	255	487	742	20.4	12104	240	29	153	8.8	8279	54
1936	6855	104	254	460	714	19.8	11302	236	29	150	8.5	7590	51
1937	6703	111	278	468	746	19.3	11612	231	29	147	8.8	7527	51
1938	6416	117	291	462	753	17.9	10890	227	28	144	8.9	6892	48
1939	6939	113	288	497	785	16.0	10174	223	31	141	9.8	6627	47
1940	6340	110	277	423	700	17.3	9832	219	29	139	8.5	6098	44
1941	6619	122	273	537	810	21.7	14286	217	31	136	11.0	9711	71
1942	7698	126	278	692	970	27.3	21567	215	36	133	14.5	15743	118
1943	9226	127	288	883	1171	34.5	32976	213	43	130	18.9	25386	195
1944	9108	127	294	862	1156	30.6	28993	211	43	127	18.9	21981	173
1945	8466	129	297	795	1092	36.4	32548	208	41	124	17.8	24115	194
1946	8160	131	301	768	1069	36.2	31796	207	39	121	17.6	23168	191
1947	7814	134	288	762	1050	42.1	36381	205	38	119	17.8	26733	225
1948	7657	135	286	748	1034	43.7	37182	203	38	116	17.9	27240	235
1949	7503	143	288	783	1071	42.3	37330	202	37	113	19.2	27601	244

TABLE I (continued)

Year	Egg production					Price per doz. ¢	Farm income (000) \$	Farms		Farms selling eggs			
	Layers (000) No.	Eggs per layer No.	Used on farm Mil.	Sales Mil.	Total Mil.			Farm layers (000) No.	Layers per farm No.	Farms (000) No.	Cases per farm No.	Sales (000) \$	Sales per farm \$
1950	7221	144	291	746	1037	33.0	28243	196	37	105	19.7	20515	195
1951	6946	149	265	771	1036	45.1	38636	189	37	96	22.3	28977	302
1952	7014	147	263	769	1032	38.8	33141	183	38	88	24.3	24864	283
1953	6786	149	253	760	1013	44.7	37511	176	39	79	26.7	28310	358
1954	6302	152	251	706	957	36.5	28957	170	37	71	27.6	21474	302
1955	6016	159	241	717	958	38.0	30337	163	37	68	29.3	22705	334
1956	5988	167	234	768	1002	40.6	33901	151	40	61	35.0	25984	426
1957	5959	169	218	788	1006	36.1	30264	139	43	54	40.5	23706	439
1958	5665	171	215	756	971	41.2	33338	127	45	47	44.7	25956	552
1959	5634	181	213	804	1017	33.5	28391	115	49	41	54.5	22445	547
1960	5228	183	186	771	957	38.0	30305	105	50	36	59.5	24415	678
1961	4871	187	170	739	909	37.6	28482	95	51	31	66.2	23155	747
1962	4916	189	151	776	927	36.1	27888	85	58	26	82.9	23345	898
1963	4853	190	136	786	922	37.6	28889	75	65	21	104.0	24628	1173
1964	5058	194	122	857	979	36.3	29614	64	79	15	158.7	25924	1728
1965	5031	193	102	870	972	36.7	29726	61	82	13	185.9	26607	2047
1966	5103	198	79	932	1011	39.9	33616	59	86	12	215.7	30989	2582
1967	5892	199	72	1100	1172	32.9	32132	57	103	10	305.6	30158	3016
1968	5721	205	61	1111	1172	36.6	35746	55	104	9	342.9	33886	3765

Source: U. S. Department of Agriculture, Agricultural Statistics, Washington: Government Printing Office; and Census of Agriculture, Washington: Government Printing Office, selected years.

realizes that of the 10,000 farms selling eggs in 1967, 79 farms accounted for 60 percent of the state's total production (33).

Tennessee is not the only Southern state to experience rapid growth in the commercial egg industry (Table II). Southeastern states accounted for less than 13 percent of the United States egg production in 1945 but produced over 32 percent of the total in 1967. The gross income from eggs in the Southeastern states was over 37 percent of the 48 state total in 1967. Table III points out that the Southeastern states' percentage of all farm marketings has stayed relatively constant for the past two decades, while its percentage of cash receipts from eggs increased from ten to 37 percent of the country's total. This dramatizes the shift from row crops and other enterprises to egg production in the South and the decline in the relative importance of egg production in other parts of the country.

Several hypotheses are made as to why egg production has shifted to the South. First, the desire for a high quality product by Southern consumers and merchants was influential. Second, the increase in egg production was a carry-over from increased broiler production in the South (57, p. 1). Favorable climate, relatively low labor costs, and improvements in road and transportation facilities encouraged feed manufacturing companies, hatcheries, and processing companies to expand broiler production (57, pp. 1-2). Third, many farmers who were anxious to supplement incomes from row crops entered into broiler production. Often these farmers were financed by feed companies and produced the broilers on a contract basis. As the market for broilers became

TABLE II

EGG PRODUCTION AND GROSS INCOME FROM EGGS IN SOUTHEASTERN STATES
AND UNITED STATES, 1945, 1955 and 1967

State and	Production		Gross income	
	1945 (Millions)	1955 (Millions)	1945 (\$1,000)	1955 (\$1,000)
United States	651	2,645	20,756	27,813
Alabama	740	3,134	21,019	18,789
Arkansas	655	1,213	22,419	46,910
Georgia	1,190	1,469	39,592	55,219
North Carolina	384	1,234	12,966	20,405
South Carolina	1,084	1,172	32,396	30,084
Tennessee	1,039	860	33,904	32,136
Virginia	383	362	11,377	12,954
Louisiana	616	584	18,277	19,188
Mississippi	196	505	7,301	20,371
Florida	6,938	7,794	22,747	283,869
Total	55,197	69,956	1,714,109	1,923,611
48 states	12.56	13.09	32.51	14.75
Percent of 48 states				

Source: U. S. Department of Agriculture, Agricultural Statistics, 1946, 1956 and 1968
Washington: Government Printing Office.

TABLE III

RELATIONSHIP OF CASH RECEIPTS FROM EGGS TO CASH RECEIPTS FROM FARM MARKETINGS,
SOUTHEASTERN STATES, 1945, 1955 and 1967

State and	Cash receipts from eggs			Cash receipts from all farm marketings		
	1945	1955	1967	1945	1955	1967
United States	(\$1,000)	(\$1,000)	(\$1,000)	(\$1,000)	(\$1,000)	(\$1,000)
Alabama	12,903	21,700	83,376	277,568	459,565	602,424
Arkansas	14,445	12,768	88,294	311,930	547,703	852,114
Georgia	14,560	40,891	152,883	397,140	655,986	1,029,313
North Carolina	28,617	45,727	88,068	629,069	935,465	1,299,203
South Carolina	8,251	15,906	37,424	246,255	346,661	414,792
Tennessee	23,478	22,452	30,158	340,216	431,087	585,423
Virginia	26,333	25,915	31,802	334,088	430,880	519,916
Louisiana	7,034	9,418	33,237	259,036	359,504	594,074
Mississippi	12,328	14,755	75,688	331,691	554,119	780,876

TABLE III (continued)

State and	Cash receipts from eggs			Cash receipts from all farm marketings		
	1945 (\$1,000)	1955 (\$1,000)	1967 (\$1,000)	1945 (\$1,000)	1955 (\$1,000)	1967 (\$1,000)
United States	5,145	18,673	53,995	384,136	626,171	1,062,212
Florida						
Total	153,094	228,205	663,925	3,511,129	5,347,141	7,737,347
48 states	1,463,797	1,745,927	1,776,156	21,517,452	29,263,899	43,218,835
Percent of 48 states	10.45	13.07	37.37	16.31	18.27	17.90

Source: U. S. Department of Agriculture, Agricultural Statistics, 1946, 1956 and 1968
 Washington: Government Printing Office.

saturated, many inputs were shifted to egg production (57, p. 1).

Fourth, new techniques of production such as automatic feeding, watering, and egg gathering, as well as improved methods of handling manure and sanitation problems were incorporated into the design and installation of new production facilities. Finally, it is hypothesized that minimum wage laws and the increased availability of non-farm employment opportunities augmented the commercial egg industry.

Just as with other agricultural industries producing commodities with low price and income elasticities of demand, expansion of many firms in the egg industry has resulted in unstable and generally low egg prices in recent years, as shown in Table I, page 2. Many commercial egg producers with limited capital have been forced out of business. Firms still existing or considering entering the industry must decide what type arrangement they must have to yield them the greatest return.

II. THE PROBLEM

The rapid change in the industry structure have brought about different production and marketing organizational arrangements. The number of independent producers and wholesalers is decreasing, and there is a trend toward larger and more specialized plants in the South (20, p. 7).

The firms handling eggs in Tennessee procure their eggs from any combination of four different sources--their own flocks, contract flocks, independent producers, and dealers. Each of the firms performs

four or more of the functions of producing, assembling, washing, candling, grading, cartoning, packing, and delivering.

Little current information is available to show the actual efficiency which exists under different organizational arrangements. Likewise, little information is available to show the average level of costs associated with the different production and marketing functions.

Managers in the industry should be especially interested in the costs of grading and cartoning in firms of different sizes. Consumers should be concerned with the retail costs and quality which would be expected if the industry became concentrated into large, integrated, and/or financially strong firms. They would also be interested in knowing the advantages or disadvantages of producing and grading eggs on small farms. Concern with improving efficiency in egg handling was expressed on the Federal level several years ago. The Agricultural Marketing Service has published information which provides egg handlers with data on various techniques of egg cleaning, grading, packing, storing, and delivering (57). Also, specifications are available for the construction of packing plant buildings (16).

The egg industry has been one of the most dynamic agricultural enterprises in Tennessee, characterized by capital rapidly replacing labor as an input factor. The question of whether it is economically rational to mechanize further or fully automate a plant is an executive problem facing all progressive managers. Research is needed to describe what exists in the industry and to determine if and why egg handling costs vary between different sized firms.

Managers in the industry can use basic cost and efficiency data compiled from actual firms to determine the relative efficiency of their capital and labor. These data should be useful for both managerial planning and control. In planning, the firm can review its competitive position and decide how it can compete most effectively. For control purposes, the firm can use data available on the more efficient firms as a standard. If it measures its own performance and discovers that it is less efficient than other firms, then it can take corrective action.

One recourse available to a manager taking corrective action is to lower his cost per dozen in egg handling. Even if the firm is not large enough or unique enough to possess market power and alter its revenue function, it will certainly want to be aware of its cost function.

III. OBJECTIVES OF THE STUDY

The objectives of this study were:

1. To determine the nature and scope of the egg marketing system of Tennessee, emphasizing changes which have taken place during the last decade relative to size of firm and type of organizational structure.
2. To determine the influence of organizational structure upon the types of marketing functions performed.
3. To determine how buying and selling prices are established.
4. To relate total investment in plant and equipment to labor efficiency in firms of different sizes.

5. To determine if firms which adopted new technology and increased in size were more economically efficient than small labor-intensive firms.

6. To determine the general cost functions which will predict the cost of assembling, in-plant handling, and delivering under different volume and handling conditions.

IV. PROCEDURE

This study is based on a survey taken early in 1968 which obtained detailed information on the performance of Tennessee egg handling firms for 1967. Seventy-five firms were included in the study. These firms were selected from a population of 137 firms that either produced or handled at least 2,600 cases of eggs per year, and these 75 accounted for 99 percent of all the eggs produced in the State. The firms were stratified into two groups. The first stratum was composed of those firms that handled 20,800 or more cases of eggs per year. This entire stratum of 28 firms was studied due to the limited number of such firms. The second stratum consisted of those firms that handled from 20,799 to a minimum of 2,600 cases of eggs per year. The remainder of the firms were selected from the second stratum by simple random sampling. Firms which handled less than 2,600 cases of eggs per year were considered too small to be commercial operations. Figure 1 shows the distribution by county and the relative size of firms.

Questionnaires prepared by the Southern Poultry Marketing Research Committee in conjunction with regional Egg Marketing Project SM37 were used to obtain the information analyzed in the study.

Appendix A consists of a copy of the questionnaire and indicates the type of information obtained. Managers of sample firms were interviewed at the plants. Detailed information was obtained from accounting statements, plant processing records, and plant machinery specifications. These primary data served as the basis for calculating the efficiency ratios and indices mentioned in the study.

The primary data were used along with secondary data obtained from the Census of Agriculture, the Statistical Abstract of the United States, and Agricultural Statistics to describe historical changes which have occurred in the industry. An estimate of whether a state was a surplus or deficit area was obtained by comparing its July 1, 1967, population and its 1967 production to the 1967 per capita egg consumption for the United States. The percentage change in egg production between 1957 and 1967 was calculated for all states. Maps were used to delineate surplus and deficit areas and areas which have increased or decreased production in the past decade. The various organizational structures are described, and the influence of structural relationships upon size and type of handling operation are pointed out.

The egg handling operations performed by the different firms are described in detail. Various levels of technology used by different firms to perform the same operation are pointed out. Realistic physical

goals in terms of manpower requirements needed to perform the major handling functions in different sized firms are presented based on the actual performance of the most efficient firms in each size group.

Firms which were performing the same bundle of marketing services were compared to see if large-scale, capital-intensive technology was economically efficient. An efficient unit isoquant representing maximum technical efficiency in the substitution of capital for labor in egg handling plants was developed. The actual prices paid by the firms for various inputs were used to determine which firms were the most economically efficient.

Egg handling costs were computed for each firm. The costs were separated to determine if they were assembly costs, in-plant handling costs, or delivery costs. The costs were also categorized into per unit fixed and operating costs in keeping with traditional economic theory.

Data on cost of egg production obtained from the firms which produced eggs were used as the basis for determining combined production and marketing costs for firms of different sizes and different types of organizational structures.

Since actual depreciation figures vary among firms, depending on the depreciation schedule used for income tax purposes, it was decided that depreciation should be standardized. Depreciation was standardized at an annual rate of 5 percent for buildings, 10 percent for equipment, and 12.5 percent for trucks. An interest on investment charge of 5 percent was computed for considering opportunity costs. Fixed costs included interest, building depreciation, equipment depreciation, truck

depreciation, insurance, taxes, and management. Operating costs included packaging costs, truck operating costs, leased transportation, utilities, telephone, advertising, labor, and sundries.

An estimate of the firms which were operating at their plant's rated capacity was made. One hundred percent plant capacity utilization was determined by multiplying the rated in-plant grading capacity, given in cases per hour, by 40 hours per week for 52 weeks per year. The percentage actually achieved by each firm was then computed based on the firm's output for 1967. It was hypothesized that a high percent plant capacity utilization was negatively correlated with per case handling costs.

Firms were grouped on the basis of volume and costs computed for each group. The average percentage cartoned, the average percentage of plant capacity utilized, the average wage rate for management, the average wage rate for labor, the average investment per plant, the percentage assembled, the percentage delivered, and the average number of cases handled per man-hour were computed for each group.

Stepwise regression models were used to explain cost variation among firms for assembling, in-plant handling, and delivering. Regression equations were developed from both linear and curvilinear models. The R^2 value was used as the criteria for selecting a final model. R^2 indicates the percent of variation in the dependent variable explained by the independent variables. All the coefficients in the final model had to be significant at the .05 level to be included.

V. REVIEW OF LITERATURE

The changes which have occurred in egg production and marketing in recent years have been phenomenal, but egg marketing specialists in the 1930's were also amazed at the changes which had occurred during the 1920's (1, p. 1). After 1931, egg prices were high relative to grain prices and a rapid expansion occurred in the poultry and egg industry in many sections of the country (1, p. 1). The Northeastern states contained over one-third of the country's population in 1930, and farmers in those states had an advantage of producing eggs near the point of consumption (1, pp. 2-4). Producers either sold eggs directly to customers or to peddlers who supplied retail stores (1, pp. 2-4). Egg auctions where buyers and sellers met were numerous (1, pp. 2-4). Local cooperatives were organized in the New England states in the 1930's for the purpose of establishing brand names which would be associated with high quality and consequently would increase returns to the members (1, pp. 2-4).

The Midwestern states had enough surplus grain per farm to support a flock of 50 to 400 layers in 1930 (1, pp. 5-6). Much of the poultry throughout that area was of mixed breeds, however, and the eggs produced were not of uniform color (1, pp. 5-6). The heterogeneous product and the scattered location of the farm flocks made it impossible to market a product with quality comparable to that produced on the East and West Coast (1, pp. 5-6).

The favorable climate and the increasing population on the West Coast led to the development of specialized egg farms in that area (1, pp. 7-9). Consequently, California moved from seventeenth to third place in egg production in the country between 1909 and 1929 (1, pp. 7-9).

In 1930 there were practically no farms in the South with flocks of 1,000 layers or more (1, pp. 7-9). The cooperation of the U. S. Department of Agriculture and the state colleges helped farmers and young people of the area to learn more about poultry and egg production and how to make their eggs worth more when marketed (1, pp. 7-9). Production in Tennessee remained unconcentrated throughout the 1940's and 1950's. Raskopf obtained data from "254 wholesale egg dealers, 995 retail stores, 81 eating places, 43 agencies handling frozen and dried eggs, 21 cold storage plants and 118 hatcheries" (32, p. iii) in 1949-50. Of these, "75 percent of the wholesalers, 24 percent of the retailers, and 25 percent of the eating places reported difficulty in buying high quality eggs" (32, p. iii). A summary of that study was made available to the Tennessee Department of Agriculture in January, 1951, and the Tennessee Egg Law was later revised (32, p. iii). The enforcement of laws with regard to quality and the development of new production technology simultaneously encouraged commercial operations. Among the technological advances was an automatic feeder system developed in 1948 which helped revolutionize the production stage (45).

The 1960's brought improved transportation facilities, with the construction of the Interstate Highway System. Strawn and Parry pointed out that states bordering Tennessee to the east, south, and west offer Tennessee a source of eggs and increase the pressure for efficient production within the state (48, p. 2). However, they estimated that the effects of the Interstate Highway System on the optimal routing of commercial eggs would be slight and that most economies would come through lower transit time rather than improved route alignments (48, p. 2).

Raskopf and Nelms recently published information on commercial egg transportation costs in Tennessee based on data obtained from those firms included in the present study which assembled and delivered eggs (34, pp. 31-35). A group of ten low-cost firms had average assembly costs of 12.30 cents per case, while a group composed of ten high-cost firms averaged 29.70 cents per case in assembling eggs (34, pp. 34-35). A group composed of 23 firms which delivered eggs had average delivery costs per case of 18.84 cents, while another 23 firms averaged 73.66 cents per case in delivering (34, pp. 34-35). The distinguishing differences causing this variation were labor wage per hour, cases handled per man-hour, volume, and percent of truck capacity utilized. Regression models were used to show the functional relationships among these variables. These models were utilized later in this study to determine total costs of assembling, in-plant processing, and delivering.

Since production density affects assembly costs, a review of technical production possibilities is appropriate. Moreng, Helbig, and Shultze have developed a production unit such that only one person is

required to care for 34,000 layers which are placed on a "large merry-go-round unit designed to move birds to a central work point and allow for efficient collection of eggs, feeding of manure removal, and water distribution" (29, pp. 730-31). Estimated costs for each unit fully equipped and installed were \$117,000 or \$3.50 per layer (29).

Production costs for an experimental unit were estimated at less than 26 cents per dozen (29, pp. 730-31). A Pennsylvania study for a flock size of 15,000 caged layers estimated production costs to be 33 cents per dozen in 1966 (28, p. 25).

Probably the largest egg packing plant in the world is located in California (17, p. 28). The plant is located on the same farm with 1,500,000 hens (17, p. 28). Most of the eggs are graded and packed on one of the six 60-case-per-hour handling machines (17, p. 28). The organization also has a breaking and pasteurizing room which can handle 6,000 pounds of eggs an hour for breaking and freezing (17, p. 28).

A study in California indicated that egg quality can still be improved considerably by new egg cleaning techniques (6, p. ii). A survey of a number of egg cleaners used in egg grading and packing plants showed that "all but one did a fair to poor job of cleaning, although the one that cleaned well checked too many eggs" (6, p. ii). Some of the tested equipment introduced spoilage organisms into the eggs being cleaned because they recirculated wash water, rather than using a continuous flow of fresh water (6, p. ii). It is hypothesized that the same quality problems experienced in California are found elsewhere since many California firms use the latest technology. As a result of

that study, an experimental cleaner which should clean effectively with minimum breakage and spoilage was designed, constructed, and laboratory tested (6, p. 11).

The concern over which regions of the country should, or would likely, supply the nation's eggs in the future has led to studies of interregional competition on eggs (36, p. 10). Judge provided a methodological advancement with his spatial equilibrium model which divided the country into 12 regions (36, p. 11). Basic data needed for each region were (36, p. 11):

(1) Market demand relationships for eggs; (2) Values of the predetermined variables; that is, supply of eggs, population, and disposable income; and (3) the flow-equilibrium solution, using equilibrium regional prices and consumption with regional production to derive interregional movements. . . . In the flow-equilibrium solution, the West North Central and Northern Plain States were exporters of eggs. . . . Population and production changes to 1959 were projected, using changes from 1944-46 to 1951-53. On this basis, the West North Central and some of the Middle Atlantic and Upper South Atlantic states were exporters.

Stemberger studied the competitive position of North Carolina and concluded that the state could produce and market eggs as cheaply as Midwestern competitors (36, pp. 11-12). He pointed out that the Midwest had an advantage in lower feed costs but that labor and housing costs were lower in North Carolina (36, pp. 11-12). He hypothesized that North Carolina could organize to obtain cost advantages in assembly since it was a newer production area (36, pp. 11-12).

Of all those who have studied interregional competition, Seale seems to have been the best predictor of what has happened (36, pp. 11-12). He made projections up to 1970 of the flows of eggs between 40 areas and

a processing outlet using 1958-60 base period data (36, pp. 11-12). His methodology was as follows (36, pp. 11-12):

He developed costs of transporting eggs, supply and demand estimated, and equilibrium quantities, flows, and prices for the base and projected periods by reactive programming procedures. Supplies for 1958-60 were adjusted for eggs used for hatching and nonfarm production. Supplies for 1970 were projected from changes from 1946 to 1960. Population changes were used to derive 1970 demand with 1958-60 equilibrium prices. Major flows in 1958-60 were from the West North Central States to the Northeast, Southeast, South Central, and Mountain States; from the Carolinas, Georgia, Mississippi, and Arkansas to adjacent States; from California to adjacent States; and from New Jersey to the adjacent States to the north. Projected flows for 1970 were similar, but with expanded flows from the Southeastern States toward the Northeast and Florida; from Arkansas, Mississippi, and Alabama toward the South Central Area; from New Jersey and Pennsylvania toward adjacent States; and from California and the Pacific Northwest to adjacent States. The West North Central Area was shown as shipping shorter distances east, west, and southeast.

Rogers and Bluestone have urged Midwestern egg handlers to improve their egg quality, develop greater production density, and have larger flocks (36, p. iv). Therefore Southern egg handlers must strive for increased efficiency or give up the market they have captured.

The dynamic nature of the egg industry in the South has been described by Saunders and James (39, pp. 2-3). Emphasizing the changes which have occurred in Georgia, they indicated that whereas egg production was once a small-scale supplementary enterprise, it is now highly commercialized (39, pp. 2-3). They hypothesized that adverse cost-price relationships have stimulated the commercialization by forcing producers and handlers to reduce their production and marketing costs to more efficient levels in order to attain satisfactory levels of net returns (39, pp. 2-3).

Jones and Thompson indicated that larger firms tend to have greater overall labor efficiency than smaller firms (22, pp. 47-49). They stated that this is due to the ability of these larger organizations to utilize specialized factors which lead to increased productivity (22, p. 49). They concluded that the productivity of workers is far more important in cost reduction than the level of wages paid (22, p. 49). They also suggested that some managers are more adept at increasing the productivity of workers in large-scale operations (22, p. 49).

Peeler and King used economic-engineering data in a study of egg grading and packing costs (31). They suggested that the largest plant studied (a synthetically designed plant with 16 machine installations and a rated capacity of 320 cases per hour) would be the most economic plant to build (31, p. 28). They emphasized that:

As plant size is increased, fixed cost of management is spread over a larger volume; thus reducing per unit cost for management. With increased volume, thus reducing per unit cost for management. With increased volume, better qualified management can be employed without increasing the cost per case handled for the management factor. Better management would be expected to not only reduce operational costs, but also be a strong selling force for the product (31, p. 28).

Peeler and King limited their study to in-plant costs, and they cautioned that increased unit costs of assembly will more than offset reductions in internal plant costs of processing if the productive density of the supply area is sufficiently thin (31, p. 28). Likewise, the nearness to markets and the distribution costs must be considered (31, p. 28).

Jones also used the traditional method for determining economies of scale; i.e., the synthetic or model building approach using economic engineering data (20). Seven model plants of 7, 12, 18, 36, 52, 80, and 120 cases per hour capacity respectively were developed (20, p. 15). Economies of scale in operation were found throughout the range (20, pp. 66-67). Optimum capacity was defined as 100 percent plant capacity, and it was concluded that costs increased 10 to 13 percent when the plants only operated at 80 percent of capacity (20, pp. 66-67). When two shift operations were considered, the four largest plants would find it more economical to operate a second shift rather than build a larger plant (20, pp. 66-67). However, the three smallest plants would probably find it more advantageous to build a larger plant rather than operate a second shift (20, p. 67). Jones assumed a quality of Grade A or better for 90 percent of the eggs and that the eggs were packed in cartons (20, p. 67). He hypothesized that when egg quality dropped, costs increased substantially (20, p. 67).

Bird, again using economic engineering data, found two pronounced types of economies possible in the operation of egg handling plants:

- (1) those associated with changing the size or scale of the plant; and
- (2) those associated with internal cost factors in a given size of plant

(2, p. 49). Economies of scale were most pronounced as plants reached a size of 48 cases per hour, although they were still possible in larger plants (2, p. 49). Increasing the size of plant from 6 to 48 cases per hour lowered costs 56 cents per case. Costs were lowered 8 cents per

case when the size of plant was increased from 48 cases per hour to 96 cases per hour (2, p. 49).

Internal factors which were believed to affect egg handling costs were: quality of eggs, yearly hours or days of operation, number of shifts per day, efficiency of labor, wage rates, and egg handling methods (2, p. 49). Specifically, it was believed that egg handling costs could be decreased by handling quality controlled eggs, operating two or more shifts per day, working the plant more hours per year even though overtime had to be paid, and seeing that workers were effectively employed (2, p. 50).

Ratcliffe conducted a comprehensive study of 23 cooperatives in the North Central, Northeastern, and Western states to measure and determine why costs and labor output varied among the associations (35). Total costs were broken down into direct or variable costs and indirect or fixed costs. Direct costs were found to account for an average of 83 percent of the total; indirect costs, 17 percent (35, p. iii).

Unit direct costs varied mainly because of (1) differences in wage rates and other labor costs, (2) differences in unit output per man-hour, and (3) differences in cost of materials and equipment for the candling and cartoning operation (35, p. iii). Hourly labor costs varied from \$1.06 in the North Central area to \$2.60 for the Western area (35, p. iii). Labor efficiency as measured by output per man-hour varied greatly among associations for assembling, condling, cartoning, and for stocking eggs in storing rooms (35, p. iii). The North Central associations had the lowest average indirect costs--31 cents per case,

compared with 40.8 and 48.3 for the Northeast and Western associations respectively (35, p. 111).

There have also been studies comparing different organization structures. Jones and Smalley collected data from vertically integrated firms in 1961 and concluded that highly integrated firms were more profitable than independent producers (21). They found that economies of distribution existed for feed and chicks as well as for assembly of eggs (21, p. 51). They concluded that more economies of scale existed at the production level than at the grading and delivering levels (21, p. 51).

McCarthy and Williams hypothesized that production-marketing channels--not individual firms--compete with each other in the egg industry (27). They also suggested that even though one unit is efficient it is doomed to failure unless all units making up the system are efficient (27, p. 2). They suggested the use of simulation models to analyze and compare various production-marketing channels, and they have constructed a model composed of four basic systems: (1) barnyard, (2) part-time, (3) commercial, and (4) integrated production-marketing channels (27, p. 8). The integrated system had considerably lower costs which they attributed to centralization of the entire operation under a single management down to the retail level geared to market demands (27, p. 8). Also, many of the costs connected with buying and selling activities between individual firms were eliminated (27, p. 8).

VI. CONCEPTUAL AND ANALYTICAL FRAMEWORKS

Tennessee's egg handling plants vary considerably in scale, level of technology, and type of operations performed. This is consistent with the theory of the firm in the long-run, where a manager has the alternative of adjusting plant size and rate of output in order to attain maximum profit.

A survey of firms at a given point in time finds them operating in the short-run; i.e., "a time period so short that the firm does not have time to vary in quantity such resources as land, buildings, heavy machinery and top management" (26, p. 129). The short-run is, however, "long enough to allow variation in the quantities of such resources as labor, raw materials," (26, p. 130) and other operating factors.

A firm's cost curves are usually presented on a per unit basis somewhat as follows (26, pp. 134-138):

Average Fixed Cost--total fixed cost divided by output per unit of time.

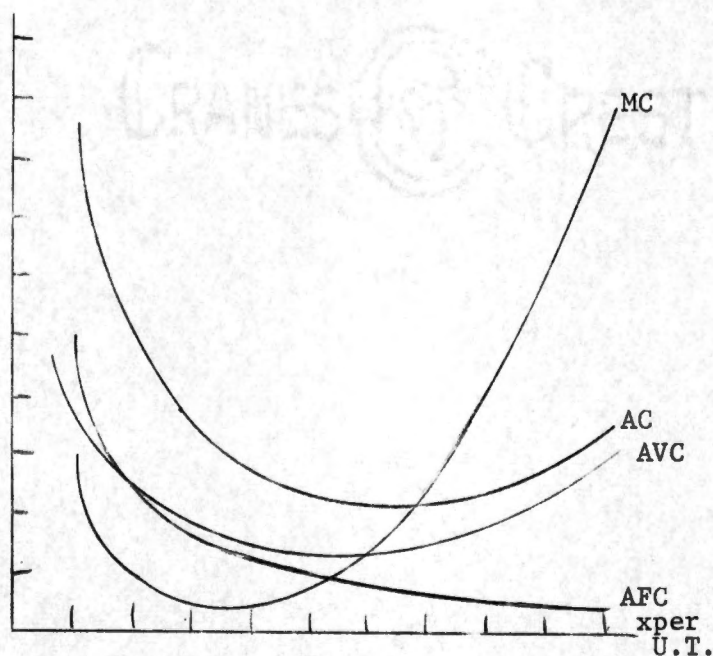
Average Variable Cost--total variable cost divided by output per unit of time.

Average Cost--average fixed cost plus average variable cost or total cost divided by output per unit of time.

Marginal Cost--the change in total cost associated with a one-unit change in output per unit of time.

The complete set of textbook curves is given in Figure 2.

Leftwich points out that "the marginal cost curve cuts the average variable cost curve and the average cost curve at their respective minimum points. An increase in fixed costs would shift the average cost curve



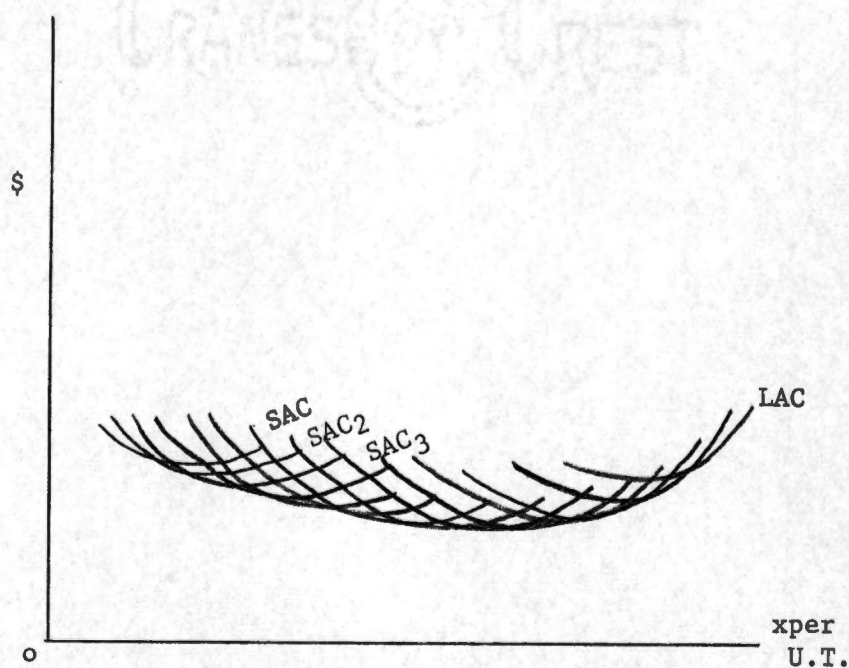
Source: Leftwich, Richard H., The Price System and Resource Allocation, New York: The MacMillan Company, 1965, p. 135.

Figure 2. Theoretical cost curves of a hypothetical firm.

upward and to the right in such a way that the marginal cost curve would still intersect it at its minimum point. No change in the marginal cost curve would be involved since marginal cost is independent of fixed cost" (26, p. 140). The price received for the product cannot be less than minimum average variable cost for sustained periods of time or the firm will be forced to shut down unless it is financially strong. The firm must recover all costs in the long-run.

The long-run average cost curve is usually thought to be a U-shaped curve (26, p. 143). This curve is sometimes referred to as an envelope curve or planning curve, where each point is associated with a minimum point on a particular short-run average cost curve (26, p. 143). (Figure 3.)

The long-run average cost (LAC) curve theoretically declines to some minimum point because of economies of scale (26, pp. 143-44). Then at some point, still larger scales of plant become less efficient and the curve rises (26, pp. 143-44). As Adam Smith pointed out long ago, specialization and division of labor should aid in lowering costs up to a point (26, p. 144). Theoretically, beyond some size the difficulties of coordinating and controlling the firm increase tremendously (26, p. 145). The decision-making is delegated, and occasionally the plans of subordinates fail to harmonize, resulting in costly slowdown (26, p. 146). Friedman believes that "entrepreneurial capacity" varies and if there were no other limiting factors, the limited capacity of management would eventually cause marginal and average cost curves to turn upward at some point and keep a firm from expanding without limit (15, pp. 96-97).



Source: Leftwich, Richard H., The Price System and Resource Allocation, New York: The MacMillan Company, 1965, p. 143

Figure 3. Short-run average cost curves and long-run planning curve.

It is fallacious to believe that a firm will always operate at the level where average cost is at a minimum because profit depends on the revenue function as well as the cost function (26, p. 140). Firms will build optimum scales of plant and operate them at the minimum point on the short-run and long-run average cost curves only in pure competition in the long-run (26, pp. 146-47). Marginal revenue (which equals price in pure competition) is the change in total revenue associated with a one unit increase in sales (26, p. 161). The total revenue function is typically presented as a continuous linear function, and profits are said to be maximized where marginal cost equals marginal revenue (26, p. 161). Brems has pointed out that cost functions might have kinks or be discontinuous due to various stages in the production process (14, p. 552).

Sammet, Bressler, and French pointed out that when the long-run total cost curve is discontinuous and the total revenue curve is continuous then "profits are actually maximized where marginal cost is not equal to marginal revenue" (14, p. 554) and the profit maximizing position cannot be determined by simple calculus (14, p. 554). Therefore, "the cost function must be examined over its entire range and the maximum profits calculated for each continuous section of the curve" (14, p. 554).

A problem facing the manager in the short-run and indeed, in the long-run as well, is deciding how much to produce and at what rates. This involves comparing cost and revenue functions. And since the long-run cost function cannot be computed directly,

it must be determined through the short-run by comparing costs of plants of many sizes and technologies and combining these into a function representing the least cost of producing at any rate of output for any number of hours per demand or sale period. (14, p. 554)

Ideally, the long-run cost function would consider: "(1) fixed cost of durable factors; (2) the problem of the selection of alternative production techniques and their integration; and (3) uncertainty and the need for flexibility" (14, pp. 571-72).

When a manager decides on the size of plant and the level of technology, he is faced with at least two types of uncertainty:

- (1) uncertainty with respect to future product and input prices, and
 - (2) "uncertainty as to the amount of return over variable costs required to replace and maintain the durable items of the plant" (14, pp. 575-77).
- To insure against uncertainty, flexibility is built into the plant.

Four types of flexibility are the most common (14, p. 578). The first is flexibility to adjust to seasonal changes in output (14, p. 578). The most efficient way to obtain this flexibility is through variation in hours of plant operation (14, p. 578). An alternative to variation in hours of operation is "the use of many small identical machines rather than larger units which would be more efficient if regularly fully utilized" (14, p. 578).

A second type of flexibility permits adjustment to changing factor prices and innovations (14, p. 578). It is obtained by substituting variable inputs for fixed inputs (14, p. 579). Labor can be laid off rapidly, but fixed inputs are less easily released (14, p. 579).

This flexibility allows a waiting period to decide what type innovations to incorporate into the plant without fear of rapid obsolescence (14, p. 579).

A third type of flexibility is the use of nonspecialized equipment (14, p. 579). If there is considerable variation in the type of product handled, this may be more economical than specialized machinery for each product (14, p. 579).

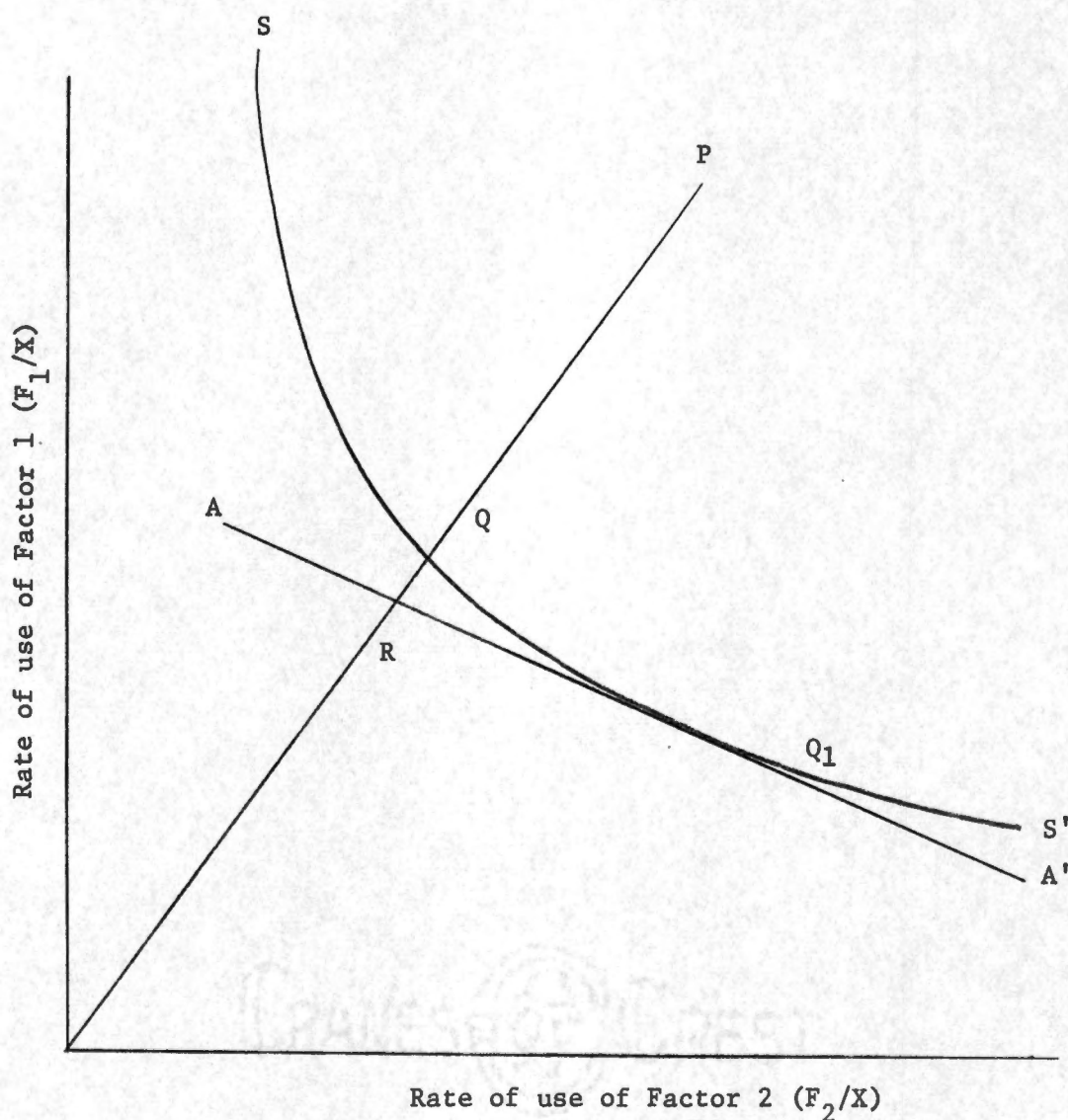
A fourth type of flexibility comes from building a plant which can easily be expanded or contracted rather than installing permanent machinery which is efficient, based on current technology, but difficult to alter (14, p. 579).

Ideally, an analysis of an industry would consider the various revenue and cost factors mentioned previously along with the degree of adjustment to possible suboptimum operating conditions, perhaps by means of flexibility. The accounting and records data available on the Tennessee egg handling firms did not contain enough information to meet all the previously mentioned requirements. The data are particularly inadequate with regard to estimates of revenue received and the extent to which flexibility is built into the systems. This does not preclude, however, the measurement of costs and productive efficiency. The findings can still be useful to firms in the industry and indicate directions the industry will likely follow in the future.

Bressler, Boles, Seitz, Sitorus, and Brown presented papers at the Western Farm Economics Association in 1966 which discussed new techniques of measuring efficiency (59, pp. 129-61). They have refined a

concept first mentioned by Farrell (11, pp. 253-90) and later applied to farm management survey data by Farrell and Fieldhouse (12, pp. 252-67). King transferred interest in the Farrell approach to the Southeast in a paper presented at a meeting of the Association of Southern Agricultural Workers in 1967 (24).

The Farrell approach is especially appealing since it is an attempt to measure the relative efficiency of different firms in an industry by considering all inputs and their relative prices simultaneously (24, p. 178). King has summarized the concept by using a two-input, single output example as shown in Figure 4 (24, p. 178). The curve SS prime represents an efficient unit isoquant because it "represents the smallest quantity of Factor 1 which can be used to produce one unit of output as the amount of Factor 2 used is varied" (24, p. 178). Points below SS prime cannot be obtained with existing technology (24, p. 178). Point P indicates the performance of a hypothetical firm. A line drawn from the origin to a point P intersects the SS prime line at a point Q (24, p. 178). Technical efficiency is defined as the ratio of $\frac{OQ}{OP}$ (24, p. 178). Line AA prime is a price ration line reflecting the relative prices of the two inputs (24, p. 178). The distance RQ gives "a measure of the price inefficiency associated with the selection of the technically efficient but more costly point Q as compared with the minimum outlay point Q prime" (24, p. 180). Price efficiency is defined as $\frac{OR}{OQ}$ (24, p. 180). Economic efficiency is the product of technical and price efficiency and is defined as $\frac{OR}{OP}$ (24, p. 180). Ideally, accurate technical and input price data can be obtained from firms in a given



Source: King, Richard A., "Marketing Efficiency: Technical, Price and Economic," paper presented at Association of Southern Agricultural Workers, New Orleans, Louisiana, January, 1967, p. 179.

Figure 4. The efficient unit isoquant for two factors as presented in the Farrell approach.

industry and technical, price, and economic efficiency indices can be computed (24, p. 180). Bressler pointed out the complementarity of the Farrell approach with established theory of the firm by stating that "economic efficiency is equivalent to the inverse ratio of average cost, where the lowest observed average cost (at given prices) represents an index of 100 percent" (59, p. 135). The Farrell approach may not be appropriate if economies of scale are the main objective of research, but its findings should be consistent with those obtained from an economies of scale study (59, p. 135).

The problem of estimating an efficient unit isoquant can be approached on the basis of two methods. One is to use data obtained from an economic-engineering study; another method is to use empirical data available on individual firms within an industry. Although the latter method was applied in this study, there are advantages in using the first method. An economic engineering study allows many factors to be held constant which would vary in the real world. The most direct method known to date for determining technical efficiency as described by Farrell is that proposed by Boles (59, p. 137). His computational procedure requires only a fraction of the time which would be required if the model were handled as a general linear programming model (59, p. 137). His model is deterministic and retains the linear programming assumptions of "linearity, additivity, and divisibility" (59, p. 137). Boles' computational procedures, which were utilized in this study, are included in Appendix B.

Quantitative measures of efficiency are needed because "efficiency has an important bearing on general welfare, and improved efficiency will usually be consistent with generally accepted welfare goals" (7, p. 3) according to Bressler. However, "If maximum efficiency requires strict control over many economic activities or the socialization of certain sectors of the economy, for example, we may choose more freedom and less efficiency" (7, p. 3), Bressler states.

Kohls defined marketing efficiency as the maximization of the input-output ratio, where outputs were consumer satisfaction with goods and services produced by the inputs (25, p. 8). Kohls, then, divided marketing efficiency into operational efficiency and pricing efficiency (25, pp. 9-10). Operational efficiency focuses on reducing costs of performing a function, while pricing efficiency is concerned with improving the buying, selling, and pricing aspects of the marketing system to make it responsive to the consumer's desires (25, pp. 9-10). Increased operational efficiency could possibly lead to decreased pricing efficiency if it gives a firm monopoly power (25, pp. 9-10). Using Kohls' classification, this study is primarily concerned with improving operational efficiency, although problems related to pricing efficiency in egg marketing in Tennessee and the nation are mentioned. Pricing efficiency of a marketing system as described by Kohls is of course different from pricing efficiency in the purchasing of inputs by a marketing firm as described by Farrell.

A recent study by Rogers and Voss pointed out that the pricing system for eggs has not kept pace with the industry (37, p. 1). They summarized some of major problems as follows (37, p. 2):

Some major base price quotations fluctuate too often and sometimes without apparent justification on the basis of overall supply-demand changes. Thus, these quotations now appear less representative of conditions across the country than formerly and more reflective of temporary conditions at terminal markets. Base price quotations still center around wholesale trading despite the displacement of wholesalers by assembler-packers as the focal point in egg marketing channels. . . . Better market information is needed on prices, volumes, and market conditions to minimize the subjective judgment required, help achieve more stable prices, and facilitate more orderly egg marketing practices.

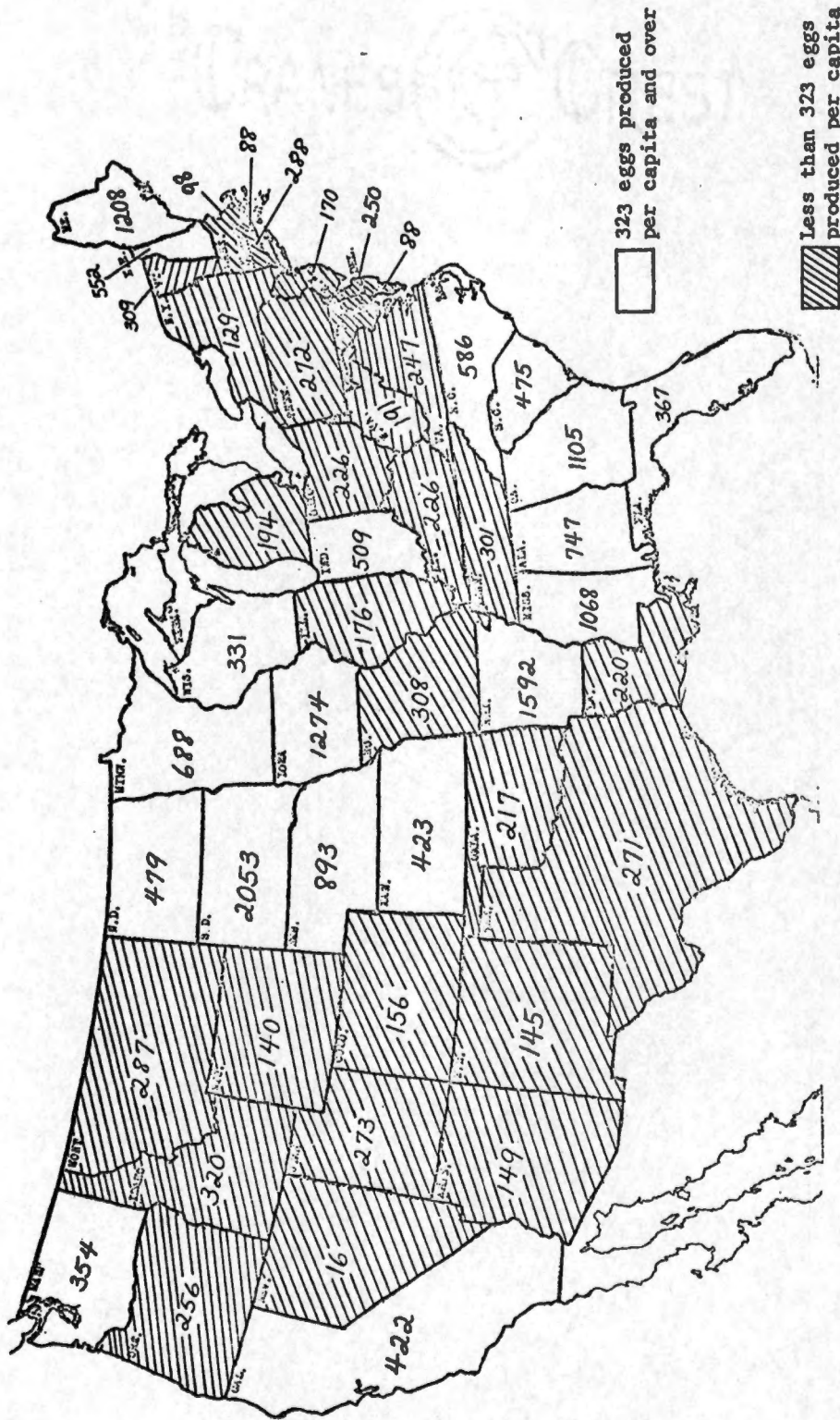
Some of the alternative pricing systems discussed were "computerized buying and selling; using base prices at the delivered-to-retailer level of trading; committee pricing; decentralized pricing; administered pricing; futures-oriented pricing; and pricing under orders or agreements" (37, p. 2). None of the alternatives mentioned were developed to a workable basis. It was concluded that the present system is so institutionalized that changes will need to be made over a considerable length of time and that action at many levels in the industry and by government will be required (37, p. 3).

CHAPTER II

TENNESSEE'S EGG MARKETING SYSTEM

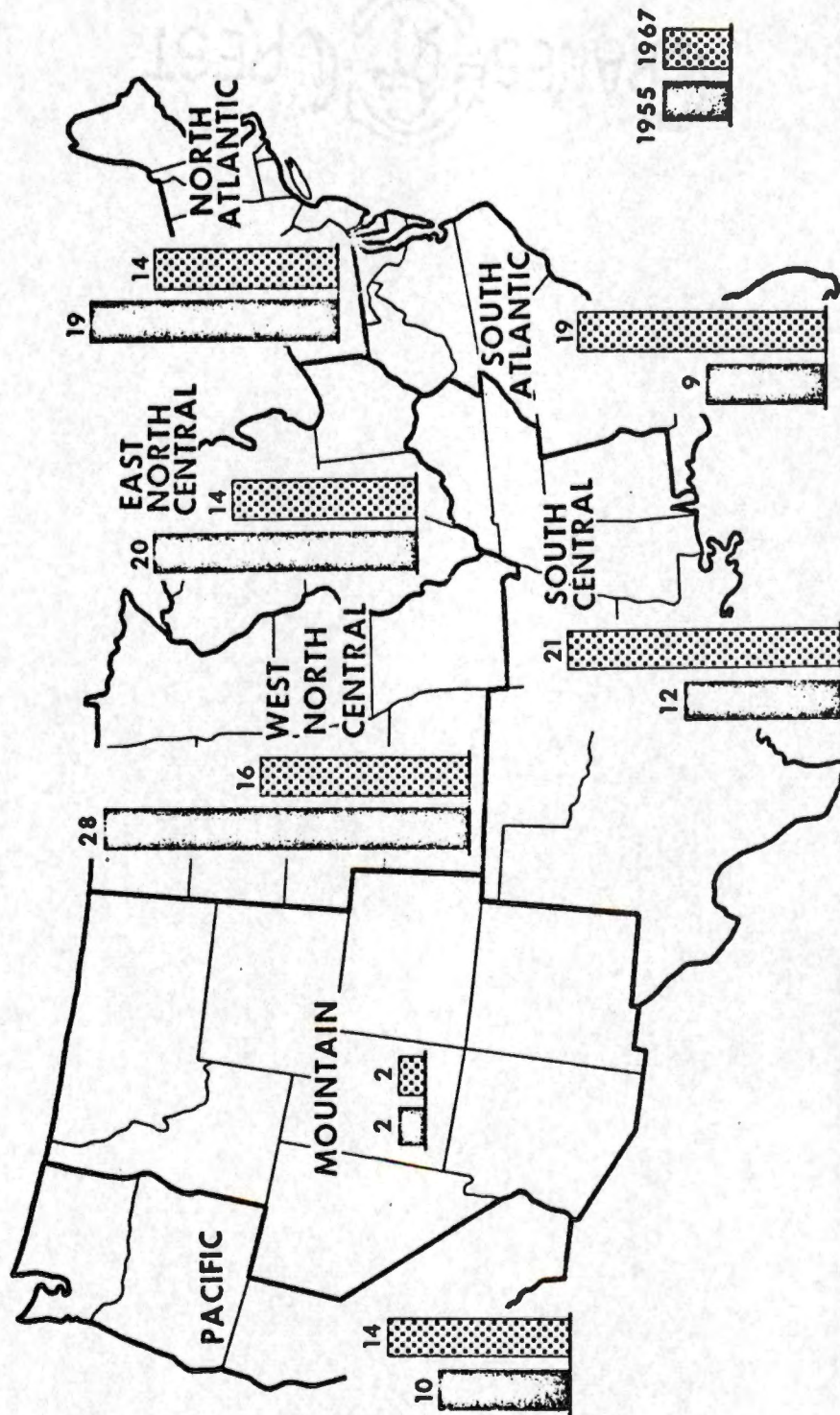
An indicator of whether a state is a surplus or deficit producer of eggs is its per capita production of eggs. The nation's per capita consumption of eggs for 1967 was 323 eggs and for 1968 it was 320 eggs (52, p. 6). Based on the July 1, 1967 population estimate for Tennessee and its 1967 egg production, per capita production was calculated to be 301. (Figure 5.) This suggests that Tennessee is a slightly deficit area. The same calculation for other states suggests that Tennessee's neighbors to the south, east, and west produce a tremendous surplus of eggs. For instance, Arkansas had a per capita production of 1,592 eggs, and Mississippi had a per capita production of 1,068 eggs. This should assure an ample supply of eggs for wholesalers in the Memphis area. Alabama and Georgia had a per capita production of 747 and 1,105, respectively. Egg handlers in Nashville, Chattanooga, and Knoxville could readily supplement their supplies from these states.

As indicated earlier, egg production was mainly a supplementary enterprise in the South until the last decade. Figure 6 points out how production has shifted to the South by indicating the percentage of eggs produced in different regions in 1955 and 1967. Figure 7 shows the percentage increase in production by states from 1957 to 1967. Tennessee increased its production 23 percent between 1957 and 1967. Arkansas



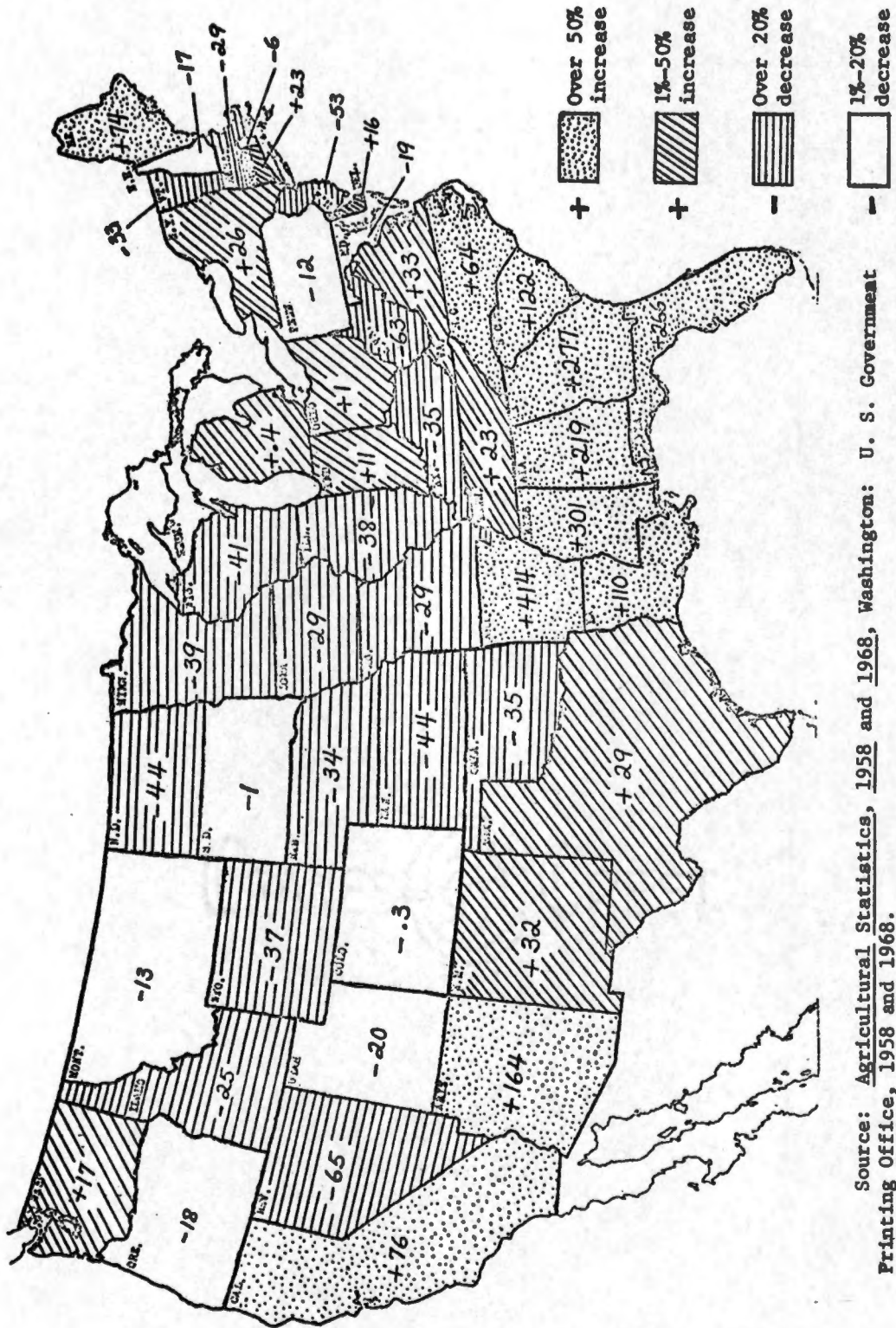
Source: Agricultural Statistics, 1967; Statistical Abstract of the United States, 1968, Washington: U. S. Government Printing Office, 1968.

Figure 5. Egg production per capita by states, United States, 1967.



Source: George B. Rogers and Leonard A. Voss, Pricing Systems for Eggs, Marketing Research Report No. 850, Washington: U. S. Government Printing Office, May 1969.

Figure 6. Percentage of U.S. egg production by regions, 1955 and 1967.



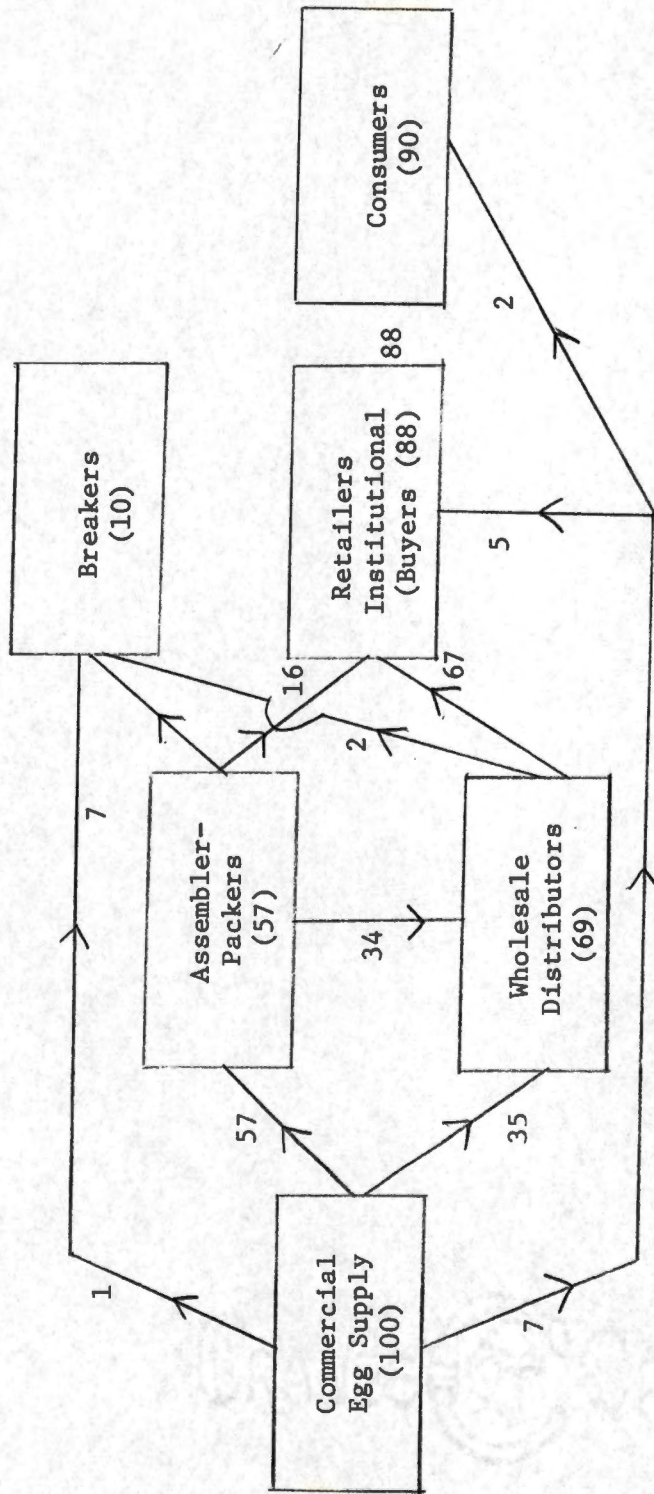
Source: Agricultural Statistics, 1958 and 1968, Washington: U. S. Government Printing Office, 1958 and 1968.

Figure 7.. Percentage change in egg production by states, United States, 1957-1967.

and Mississippi showed the greatest percentage increase with increases of 414 and 301, respectively. Indiana made an 11 percent increase in production, while most of its Midwestern neighbors declined during the period. The data in Figure 7 show that North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Wisconsin and Iowa are still egg-surplus states. California experienced a 76 percent increase in production between 1957 and 1967 and is still leading the industry in total production.

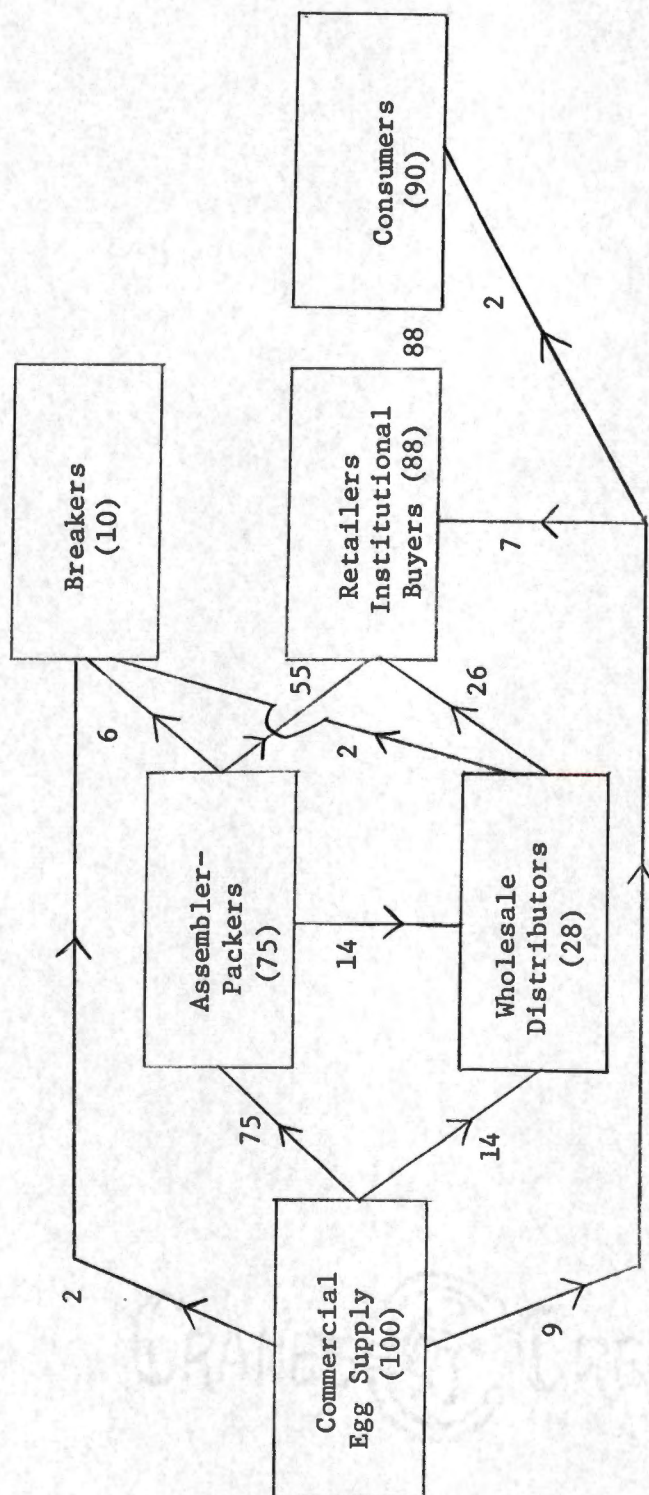
Many large owner-integrated operations have emerged all across the nation, as well as "firms which coordinate production, input-supplying, and marketing without complete ownership" (37, p. 8). Increasingly, these organizations "are dealing directly with retailers and other ultimate sellers and user" (37, p. 8). Figure 8 indicates the marketing channels which existed in late 1957 and the percentage of the commercial egg supply moving through these various channels for the nation as a whole. For example, 57 percent of the eggs moved through assembly-packers and 35 percent through wholesale distributors. Figure 9 indicates how these percentages had changed by 1967. Only 14 percent of the commercial egg supply of the nation moved through wholesalers in 1967.

Tennessee's egg industry has become highly commercialized and its marketing channels have changed in relative importance. The 14 largest producers in the state were included in this study; and it is estimated that their production amounted to 36 percent of total production of the state in 1967, based on their records and figures obtained



Source: Rogers, George B. and Leonard A. Voss, Pricing Systems for Eggs, Marketing Research Report No. 850, Washington: U.S. Government Printing Office, May, 1969, p. 7.

Figure 8. Commercial egg marketing channels, percentage of U.S. production excluding eggs used for hatching, export, and consumption on farms, 1957.



Source: Rogers, George B. and Leonard A. Voss, Pricing Systems for Eggs, Marketing Research Report No. 850, Washington: U.S. Government Printing Office, May, 1969, p. 7.

Figure 9. Commercial egg marketing channels, percentage of U.S. production excluding eggs used for hatching, export, and consumption on farms, 1967.

from the State Crop Reporting Service. Since much of Tennessee's production is highly commercialized and since Tennessee's metropolitan areas are not a great distance from surplus states, Tennessee's egg marketing system is consequently made up of different types and sizes of handling firms. For example, the 75 firms in this study ranged in volume handled from 50 cases per week up to operations that handled as many as 6,500 cases per week. (Appendices C and D.) The system can be broken down into organizations which are primarily producers, producer-contractors, dealers or wholesalers, dealer-producers, dealer-contractors, or dealer-producer-contractors.

Firms which were primarily producers were still the most numerous of the marketing groups. Of the 75 firms studied, 36 fell into this category. The average volume handled per firm was relatively small--244 cases per week. The firms varied widely in the proportion of eggs sold through retail and wholesale channels. If the manager chose to supply retail stores, he was faced with the problem of renting or buying grading machines, cartoning equipment, and delivery equipment.

The cost per dozen for producing eggs was computed for each of the producers. Table IV summarizes these data by showing low, medium, and high cost groups of firms. The low-cost group averaged 110,357 layers per firm and had production costs of 25.24 cents per dozen. The medium cost group averaged 28,769 layers per firm with production costs of 27.99 cents per dozen; whereas the high cost group averaged 18,286 layers per firm with production costs of 31.84 cents per dozen. Since the average price received by egg producers in Tennessee was 32.9 cents

TABLE IV

COST OF COMMERCIAL EGG PRODUCTION,
55 TENNESSEE FIRMS, 1967

Item	Group I	Group II	Group III	All Firms
Number of Firms	19	18	18	55
Layers Per Firm	110,357	28,769	18,286	53,523
Eggs Produced per Layer	245	234	228	241
Investment per Layer	\$3.94	\$4.04	\$5.50	\$4.13
- - - - - Cents per dozen - - - - -				
Production Costs				
Feed	14.46	16.45	17.14	15.08
Layer Depreciation	5.59	6.23	7.15	5.87
Labor	1.79	1.69	2.06	1.80
Management	.41	.62	1.63	.57
Interest	.96	1.03	1.45	1.03
Equipment Depreciation	.59	.63	.67	.60
Building Depreciation	.67	.56	.53	.63
Utilities	.12	.18	.24	.14
Medicants	.18	.19	.37	.20
Litter	.14	.12	.13	.14
Insurance	.10	.09	.15	.10
Telephone	.01	.01	.02	.01
Taxes	.06	.06	.07	.06
Miscellaneous	.18	.13	.24	.18
Total	25.24	27.99	31.84	26.41
Contractee Cost	5.01	5.12	7.18	5.26

per dozen in 1967 (Table I, pages 2 and 3), firms in the high cost group would have incurred losses if they had to perform many marketing functions.

Three distinct organizational arrangements were prevalent for producers. (Figure 10.) In general, the producer did one of the following: (1) cleaned, graded, cartoned, and delivered eggs to retail outputs; (2) cleaned, graded, bulk cased, and delivered to a wholesaler for a selling price usually based on the Chicago or New York markets; (3) produced the eggs on contract and bulk cased them to be cleaned and graded by the contractor for a guaranteed price. The marketing operations in Figure 10 will be described in detail in the following chapter and the relative efficiency of each firm will be determined.

Managers of production units were asked how their selling price was determined. The modal response from managers of firms with less than 20,000 layers was that they tried to get nine cents per dozen over the Chicago or New York market price quotations for eggs they cleaned, graded, cartoned, and delivered to retail outlets. The modal response from managers of firms with less than 20,000 layers was seven cents per dozen. The average price received by producers in the State was too low for these goals to have been realized by all firms. Fifteen producers sold eggs to wholesalers for the price quoted on the New York market. The usual arrangement is to receive the market price quotation for clean graded eggs delivered to the wholesaler in bulk cases. A one cent per dozen deduction is made if the wholesaler assembles or if the

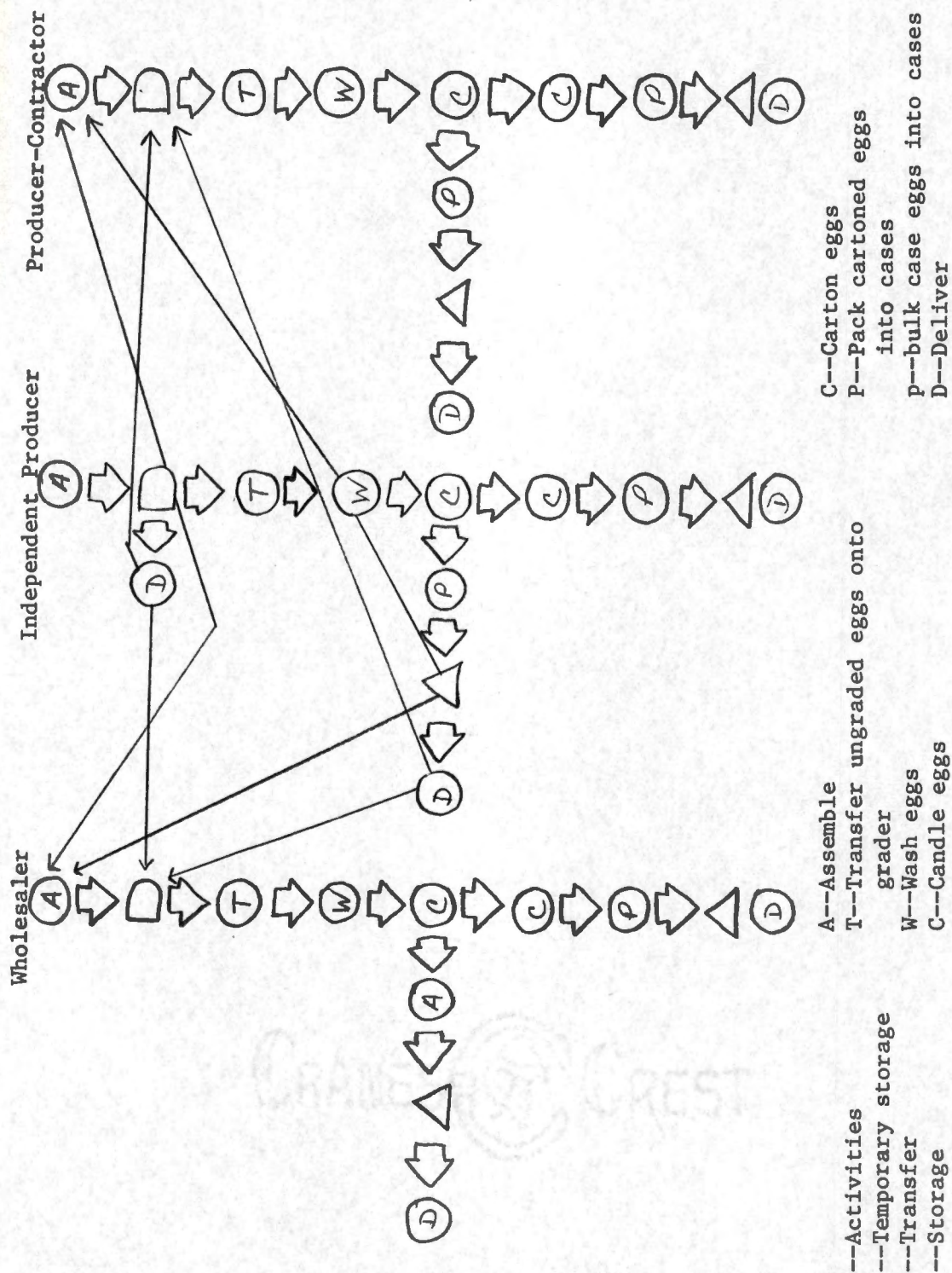


Figure 10. Prevalent marketing functions and channels, Tennessee firms, 1967.

eggs are unclean or ungraded. The producer and wholesaler exchange cases and packing materials.

Many producers with limited capital preferred to have their feed, layers, medicants, and packing materials furnished along with a specified price and a guaranteed market. With this arrangement the producer only had to supply building, equipment, and associated costs of utilities, nest materials, and litter.

The producer-contractor represented a growing segment of the industry. These firms typically owned facilities for producing a considerable volume of eggs themselves and contracted for the rest. They usually owned a feed mill also, and frequently some hatching equipment and facilities for growing replacement flocks. The producer-contractor supplied the feed, medicants, and hens. The producer with whom the contract was made (the contractee) supplied the labor, buildings, equipment, and utilities. Some payment was made to the contractee if eggs were cleaned and graded on the farm or if the contractee delivered the eggs to the contractor. The contractor generally operated large-scale grading facilities. Ten such firms were in this category and averaged 1,183 cases per firm per week. These firms seldom purchased eggs from independent producers or dealers.

Vertical and horizontal integration existed in several firms. Six firms, or 8 percent of those sampled, had their own hatchery. Twenty-nine firms, or 39 percent of those sampled, had their own feed mill or operated farm supply businesses; thirteen of those twenty-nine, or 17 percent, were commercial operations and not just for their own

use. A few firms were members of a parent organization engaged in feed manufacturing or egg-breaking and processing industries.

For firms which produced eggs on contract, the contractee cost per dozen was 5.01, 5.12, and 7.18 for the low, medium, and high cost groups, respectively (Table IV, page 46). The most common (modal) payment for contract eggs was 5 cents per dozen. This suggests that the contractees in the high cost group lost money or received low returns for management and labor. The difference in rate of lay was probably responsible for most of the production cost differences. The high feed cost, layer depreciation cost, and medicant cost per dozen suggests that the contractor also suffered from low efficiency in production. The 5 cent per dozen payment seems equitable if the contractee is required to perform no marketing functions.

The independent dealer or wholesaler was a carryover from past decades and often delivered poultry as well as eggs. This firm seldom made formal contracts but stood ready to purchase eggs from independent producers without retail outlets. The firm usually regraded the eggs and distributed them under its own brand name. Twenty such dealers were included in the sample; they handled an average of 642 cases per week per firm. Sixteen firms handled poultry or other meats in addition to eggs. The range for the volume handled by dealers was from 50 cases per week to over 3,800 cases per week.

Although the number of wholesalers had declined, the size of those still rehandling and delivering eggs to retail outlets had increased, and they performed an important function. Since the

wholesaler was responsible for quality, the eggs had to be removed from bulk cases, washed if dirty, recandled, cartoned, and repacked. The chances for spoilage and waste were necessarily increased. Since the wholesale market was used as an outlet for producers unable to find other outlets, the time span between production and consumption was often several weeks. The regrading by the wholesaler was evidently adequate because the percentage of eggs which were sold as Grade A did not differ appreciably between firms or channels. Most of the quality deterioration would have occurred before the wholesaler received the eggs, since most wholesalers in Tennessee used refrigerated transportation and storage facilities.

Since production is still slightly higher during the spring months, (37, p. 8) the large storage facilities at large wholesalers helped balance supply with demand over time. The large wholesalers also stood ready to supply wholesalers in egg-deficit regions of the Northeast. Eggs should move from surplus areas to deficit areas, and the prices should vary among the areas only by differences in shipping and handling costs. The role of the wholesaler as an equilibrating mechanism was needed, since many small producers were unable to sell all their eggs directly through retail channels, did not produce on contract, and did not have trucks suitable for long-distance hauling.

Firms in Tennessee which processed and delivered poultry and other meats often handled eggs as a complementary enterprise. Few of these firms bought uncleaned, ungraded eggs and performed all marketing functions. Most purchased cleaned, graded eggs from large integrated

firms, stored the eggs until needed, and then recandled and cartoned the eggs. This suggests that complementarity between these products continues in the delivery stage even after specialization occurs in the production of poultry and eggs.

Five firms were producer-contractor-dealers; two of which were among the largest firms studied. These firms not only produced or contracted for a large portion of their volume but also bought and sold a considerable volume on a spot basis.

Three firms in the sample were dealer-contractors (but not producers). One of these was among the largest firms studied. These dealers contracted for a large portion of their eggs and also made spot purchases of large quantities of eggs.

Only one firm in the state could be classified as a dealer-producer. This large firm engaged in production and also made spot purchases of eggs from independent producers or other dealers. This firm had grading facilities and cartoned and delivered a high proportion of all the eggs it handled under its own brand name.

It appeared that managers presumed economies of scale to exist in wholesale egg handling. When wholesalers which handled under 10,000 cases per year were asked what margin they needed between their purchasing and selling price for eggs they assembled, graded, cartoned, and delivered, the most frequent (modal) response was 10 cents per dozen. Managers in the 10,000 to 100,000 case per year indicated they needed 9 cents per dozen, while those handling over 100,000 cases per year

indicated 7 cents per dozen as their goal. The number in each category was small, but the responses were in the expected direction.



CHAPTER III

ANALYSIS OF MARKETING COSTS AND EFFICIENCIES

In 1967, the egg handling firms in Tennessee included in this study handled a total of 3,029,564 thirty-dozen cases with a total assembling, in-plant handling, and delivery cost of \$5,059,903 according to the plant records, accounting statements, and standardized depreciation allowances of the firms. Of this amount \$773,532, or 15.4 percent, was fixed costs--composed of interest on investment, building depreciation, equipment depreciation, truck depreciation, insurance, taxes, and management. (Table V.) Operating costs totaled \$4,286,371 and included costs of packaging, truck operations, leased transportation, utilities, telephone, advertising, and labor. Operating costs accounted for 84.6 percent of the costs incurred by all 75 firms in the aggregate.

The relative importance of the cost factors varied considerably among firms depending on the type of operation and level of technology used, but four components accounted for 88 percent of the costs for the industry as a whole. In the aggregate, cost of packaging materials was the most important item, accounting for 38.6 percent of total cost. Labor cost was next in importance, amounting to 30.7 percent. Truck costs, a necessity if the firm assembles or delivers, amounted to 11.3 percent of the entire bill. Management costs accounted for another 7.3

TABLE V

COSTS ASSOCIATED WITH ASSEMBLING, IN-PLANT HANDLING, AND DELIVERING EGGS,
75 TENNESSEE EGG HANDLING FIRMS, 1967

Item	Group I Under 10,000		Group II 10,000 to 29,999		Group III 30,000 to 49,999		Group IV Over 50,000		All Firms
	Cases Per Year 27 Firms	(¢/doz.) (%)	Cases Per Year 24 Firms	(¢/doz.) (%)	Cases Per Year 10 Firms	(¢/doz.) (%)	Cases Per Year 14 Firms	(¢/doz.) (%)	
Interest	.27	3.97	.16	2.76	.19	3.41	.12	2.21	.15 2.69
Building Depreciation	.08	1.18	.05	.86	.09	1.62	.05	.92	.06 1.08
Equipment Depreciation	.18	2.65	.14	2.41	.13	2.33	.10	1.85	.11 1.97
Truck Depreciation	.20	2.95	.12	2.07	.10	1.79	.06	1.11	.08 1.44
Insurance	.05	.70	.03	.52	.05	.90	.04	.74	.04 .72
Taxes	.03	.44	.01	.17	.02	.36	.01	.18	.01 .18
Management	1.05	15.45	.60	10.39	.28	5.02	.34	6.27	.41 7.36
Total Fixed Costs	1.86	27.34	1.11	19.18	.86	15.43	.72	13.28	.86 15.44
Packaging	1.62	23.82	1.97	34.02	1.85	33.16	2.30	42.44	2.15 38.60
Truck Operation	.59	8.68	.50	8.63	.47	8.42	.44	8.12	.46 8.26
Leased Transportation	---	---	.06	1.04	---	---	.11	2.03	.09 1.62
Utilities	.10	1.48	.08	1.38	.10	1.79	.06	1.11	.07 1.26
Telephone	.05	.74	.03	.52	.05	.87	.04	.74	.04 .72
Advertising	.03	.44	.02	.35	.02	.37	.05	.92	.04 .72
Labor	2.31	33.97	1.87	32.30	2.07	37.10	1.56	28.78	1.71 30.70
Miscellaneous	.24	3.53	.15	2.58	.16	2.87	.14	2.58	.15 2.68
Total Operating Costs	4.94	72.66	4.68	80.82	4.72	84.57	4.70	86.72	4.71 84.56
All Costs	6.80	100.00	5.79	100.00	5.58	100.00	5.42	100.00	5.57 100.00

percent. The final 12 percent was made up of factors such as interest on investment, building depreciation, equipment depreciation, utilities, telephone, advertising, insurance, and taxes. Appendices E - J contain the cost and labor efficiency factors for each firm.

The firms were divided into four groups according to the volume handled to determine if economies of scale existed in the industry (Table V, page 55). Group I consisted of 27 firms which handled under 10,000 cases in 1967; their cost averaged 6.80 cents per dozen. Group II was composed of 24 firms which handled 10,000 to 29,999 cases in 1967 and had average costs of 5.79 cents per dozen. Ten firms fell in the category of 30,000 to 49,999 cases per year and averaged 5.58 cents per dozen. Fourteen firms were in the largest category and handled over 50,000 cases in 1967. Firms in the largest category had an average handling and marketing cost of only 5.42 cents per dozen.

Table VI indicates how the groups varied in the extent to which they assembled, cartoned, and delivered. It also points out how the number of cases handled per firm, the investment per firm, management wage per hour, labor wage per hour, and the percentage of plant capacity utilized differed on the average between firms of different sizes. For example, in Group IV, managers received \$4.69 per hour and laborers received \$1.63 per hour--considerably more than they received in the smaller firms. Group IV's increased investment per firm evidently resulted in more cases being handled for each man-hour of management and labor being worked. Group IV delivered the largest proportion, 98 percent, cartoned as high a percentage of the eggs it

TABLE VI
COST AND EFFICIENCY FACTORS ASSOCIATED WITH ASSEMBLING, IN-PLANT HANDLING,
AND DELIVERING EGGS, 75 TENNESSEE EGG HANDLING FIRMS, 1967

Item	Group I Under 10,000 Cases Per Year 27 Firms	Group II 10,000 to 29,999 Cases Per Year 24 Firms	Group III 30,000 to 49,999 Cases Per Year 10 Firms	Group IV Over 50,000 Cases Per Year 14 Firms	All Firms
Cases Per Firm	6,000	16,748	41,163	146,703	40,394
Investment Per Firm, Dollars	9,896	16,026	47,742	107,598	35,141
Management Wage Per Hour	2.14	2.55	2.64	4.69	3.35
Labor Wage Per Hour	1.38	1.34	1.49	1.63	1.54
Cases Per Man Hour	1.54	2.04	2.24	3.23	2.70
Percent of Eggs Assembled	10.49	21.50	75.07	69.27	60.57
Percent of Eggs Cartoned	47.63	60.50	55.37	60.19	58.90
Percent of Eggs Delivered	87.40	89.50	90.63	97.56	95.00
Percent Plant Capacity Utilized	48.50	72.81	77.85	84.88	74.11

handled as the other groups, and assembled only slightly less than Group III. In summary, the larger firms generally performed more functions, paid more per hour for management and labor, utilized their plant capacity better, and had lower overall costs per dozen for handling and marketing eggs (Figure 11).

The various marketing functions performed by Tennessee egg handling firms are described below. All of the firms did not perform all of these functions. For example, when production is adjacent to the grading facility, assembling is eliminated. Twenty-nine firms assembled eggs, 69 firms delivered eggs, and 64 firms transferred, washed, candled, and graded eggs.

Assembling. One driver per truck is used to transport bulk cased eggs from the producer or wholesaler to the grading facility. Three prevalent methods are used to move the eggs from trucks into the grading plant: (1) hand trucks; (2) roller-track conveyors; or (3) pallets and fork lift trucks. Only large-volume facilities used the last method. Plastic filler-flats or dividers can be used to hold the eggs in place while stacked on pallets, and the use of cases can be eliminated for smooth roads and short-distance hauling. The eggs either move directly to the transferring and grading stage or into temporary storage and then to that stage. Egg assembly does not include the gathering of eggs at the production level. The cost of gathering was included as a production cost.

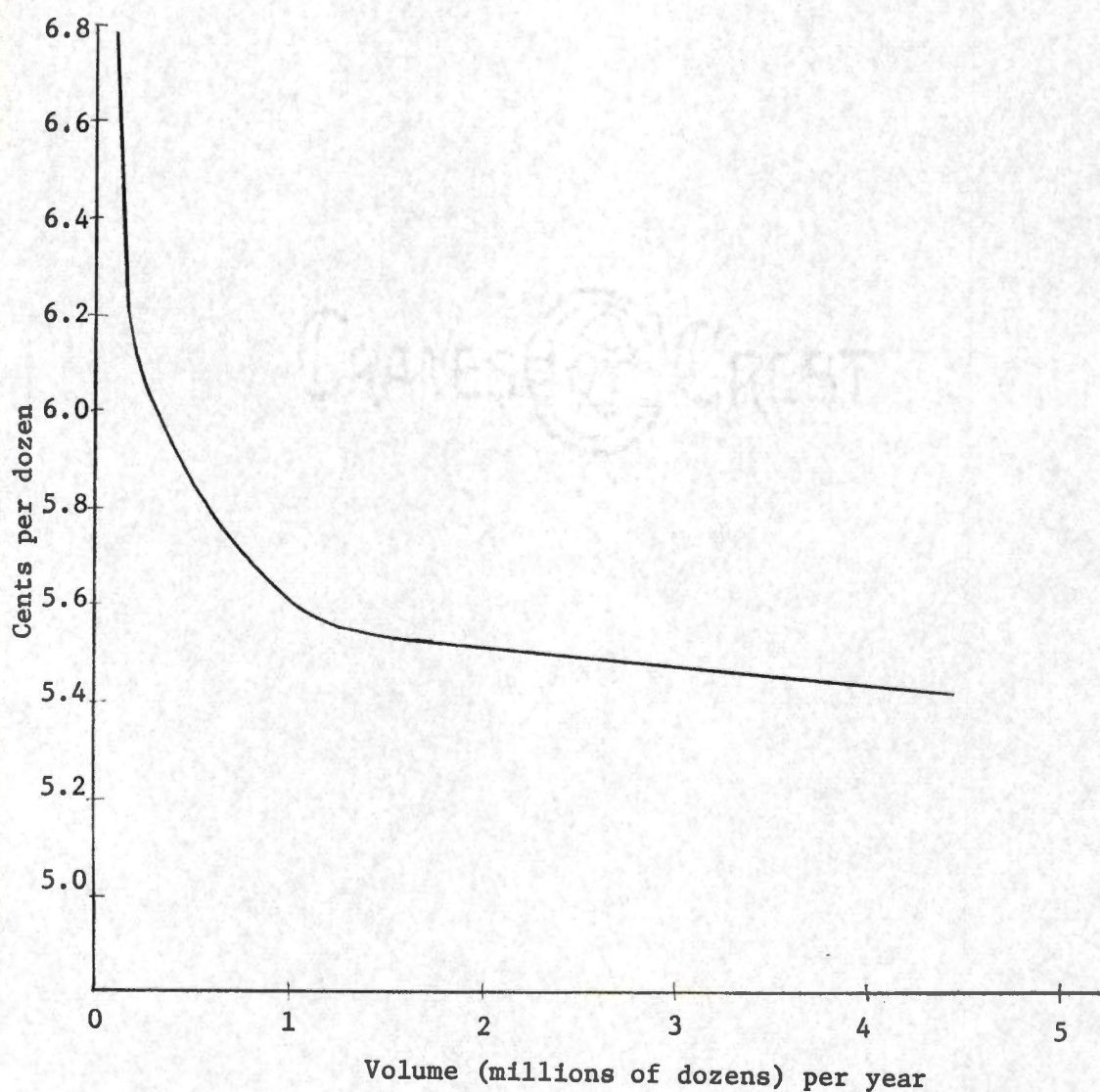


Figure 11. Cost of handling eggs, including assembling and delivering, based on averages computed from plant records, 75 Tennessee firms, 1967.

Transferring. An employee removes the eggs from bulk cases or from the plastic filler-flats by hand or by aid of a vacuum lift. Thirty eggs or one filler-flat can be transferred at one time with a vacuum lift. The eggs are then placed onto a continuous roller conveyor which automatically moves them into the washer.

Washing. The eggs are conveyed through the washer mechanically. Warm water containing a detergent is sprayed onto the eggs as they are being brushed with nylon brushes. The eggs are then conveyed past a fan which dries them.

Candling. After the eggs leave the washer they travel by roller conveyor into a dark partitioned area where an employee visually inspects them as they travel over high power lights. This worker removes eggs which are cracked, discolored, irregularly shaped, or which contain blood or meat spots. Larger plants have electronic blood spot detectors at this stage which detect low quality eggs which the human eye would miss.

Grading. The eggs are automatically weighed on scales and are usually automatically sorted into jumbo, extra-large, large, medium, small, and peewees. From here the eggs are either cartoned and packed or bulk cased.

Cartoning. After being graded, the eggs are placed into cartons. Some firms use cartons which are designed to be set up mechanically and automatically closed. The date of cartoning is often stamped on the

cartons automatically. Most Tennessee firms place the eggs in cartons by hand, but all of the larger firms have machines which can carton the eggs automatically. The machines pack the eggs small end down in cartons or filler flats for bulk cases. Some firms use preformed cartons. These cartons require more space before they are used but are extremely strong and durable for long-distance shipping.

Packing. After the cartons have been closed and stamped, they must be placed in cases before delivery. Some firms with established routes use strong wire cases for delivery. However, cardboard cases are usually used since they are less expensive and may be lost. Eggs not cartoned must also be packed in bulk cases. Filler-flats are used to separate layers of eggs packed in this manner. One standard case contains thirty dozen eggs whether packed in cartons or with filler-flats. After eggs are packed, the cases are usually stacked on pallets. These pallets are moved by hand trucks, roller track conveyors, or fork lift trucks to a refrigerated storage area.

Delivering. Eggs are loaded from the storage area onto trucks by hand trucks, fork lift trucks, roller tracks, or simply by hand. One man is usually used per truck to deliver the eggs to retail stores, chain store warehouses, or other institutions. Most larger firms have refrigerated delivery trucks; few smaller ones use them. Truck capacity varies from 25 cases per load for small trucks up to 900 cases per load for large tractor-trailer rigs used for interstate highway travel.

The in-plant operations are independent of assembly and delivery. The machines used for these operations are usually purchased as a unit and are connected by conveyor belts operated by a single motor which determines the output rate. The method of transferring varies considerably and obviously presents a bottleneck for the subsequent operations. The rate at which the eggs are washed and candled is largely determined by the speed of the conveyor.

A comparison of firms in an industry is most meaningful if the firms are performing the same functions. Sixty-four of the 75 firms studied performed the functions of transferring, washing, candling, and grading. Since the firms varied considerably in the percentage of eggs cartoned or bulk cased those operations were omitted from the following efficiency measurement. The Farrell approach was used to measure the technical efficiency of the firms by utilizing the computational procedures developed by Boles (See Appendix B). Since washing and grading were performed mechanically only three inputs were needed to describe the in-plant operations prior to the cartoning or bulk casing operations. These input factors are: (1) labor hours per case in transferring the eggs to the washer, (2) labor hours per case in candling the eggs before they are conveyed to the grader and (3) dollars invested in plant and equipment required for washing and grading per case.

In the following analysis a firm was defined as 100 percent technically efficient if it was on the efficient unit isoquant since it had obtained one unit of output with a minimum quantity of the three inputs. Economic efficiency was computed for each firm by multiplying

the quantity of each input used by its respective price and summing the costs. Bressler states that "economic efficiency is equivalent to the inverse of average cost, where the lowest observed average cost (at given prices) represents an index of 100 percent" (59, p. 135). The firm with the lowest cost per case for transferring, washing, candling, and grading was given a value of 1.0 and an index was computed which rated the efficiency of all firms relative to the low cost firms. While several firms may be 100 percent technically efficient, the 100 percent economically efficient firm was obtained the unit of output at minimum cost. The difference between technical efficiency and economic efficiency is therefore attributed to price efficiency.

A summary of the efficiencies achieved in performing the marketing services mentioned above is given in Table VII. The effects of size upon efficiency was obtained by grouping the firms into different size groups and computing the average technical, price, and economic efficiency for each group and by showing the number of firms in different efficiency categories. The firms were grouped as in Table V, page 55, namely under 10,000 cases per year, 10,000-29,999 cases per year, and over 50,000 cases per year. The large-volume firms were generally more technically efficient. Four of the five firms on the efficient unit isoquant were from Group IV. The average technical efficiency for the four groups was .370, .480, .555, and .8880, respectively. Even though the larger firms may have paid more for labor per hour, they were using a factor-mix which resulted in higher economic efficiency.

TABLE VII

TECHNICAL, PRICE, AND ECONOMIC EFFICIENCY FOR TRANSFERRING, WASHING, CANDLING,
AND GRADING EGGS, 64 TENNESSEE FIRMS, 1967

	Group I			Group II			Group III			Group IV			All Firms		
	Tech.	Price	Econ.	Tech.	Price	Econ.	Tech.	Price	Econ.	Tech.	Price	Econ.	Tech.	Price	Econ.
Efficiency	.370	.835	.309	.480	.920	.442	.555	.834	.462	.880	.650	.572	.535	.823	.440
Av.															
Percent	No. of Firms			No. of Firms			No. of Firms			No. of Firms			No. of Firms		
99+	1	10	0	0	8	0	0	3	0	4	1	1	5	22	1
70-98.9	0	6	0	2	10	1	1	5	1	8	5	2	11	26	4
50-69.9	3	5	2	5	1	4	5	2	2	0	4	5	13	12	11
30-49.9	11	1	2	11	0	13	3	0	6	1	3	5	26	4	26
Less than 30	7	0	10	1	0	11	1	0	1	0	0	0	9	0	22

A comparison of the efficiency achieved by Tennessee egg handling firms in cartoning and packing is difficult since the percentage cartoned varies so greatly between firms. Estimates of overall handling costs will be given in the following chapter. These estimates will show how overall costs vary as the percentage cartoned varies in different volume firms holding certain factors constant. Realistic manpower requirements and goals for each operation will also be presented based on the performance of the most efficient firms.



CHAPTER IV

ESTIMATED COST FUNCTIONS FOR ASSEMBLING, IN-PLANT HANDLING, AND DELIVERING EGGS, BASED ON MULTIPLE REGRESSION MODELS

A primary objective of the study was to estimate assembling, in-plant handling, and delivering costs per case. Stepwise regression provides a means by which multiple regression equations can be computed by first considering the variable that reduced the error sum of squares the greatest amount when regressed upon the dependent variable (49, p. 2). The remaining variables subsequently enter the equation in a stepwise manner according to their partial correlation with the dependent variable, after considering the variables which have already been added (49, p. 2). The variables are entered subject to a F value constraint determined ex ante; the entrance of a variable into the regression equation is permitted only if the calculated F value of the variable is greater than the established F value (59, p. 375).

Several regression models were developed by Nelms to estimate assembly and delivery costs per dozen (30). Seven variables taken directly from the questionnaires used in this study were included in the analysis. These variables are: (1) total labor in hours, (2) wage rate per hour, (3) total miles traveled per year, (4) number of sources or outlets, (5) number of trucks, (6) size of trucks, and (7) total volume

of eggs handled in 1967. Four variables not directly available from the data were computed. These variables are: (1) percent truck capacity utilized, (2) cases assembled or delivered per mile traveled, (3) cases assembled or delivered per man-hour, and (4) cases assembled or delivered per source or outlet.

I. THE ASSEMBLY COST FUNCTIONS

After eliminating the insignificant variables at the 0.05 level, the following equations were chosen to estimate the cost per case of assembling eggs based on the data from 29 firms in this study which did assemble.

The equation was: (30, p. 27)

$$Y = .78 - .62X_1 - .010X_2 + .10X_3$$

(,15) (.002) (.004)

Y = assembly cost per case of eggs in cents

X₁ = percent truck capacity utilized in assembly

X₂ = cases assembled per man-hour

X₃ = labor wage rate per hour

These three variables are associated with 76 percent of the variability in assembly costs. A one percent increase in the utilization of truck capacity will decrease assembly costs by .62 cents per case. Percent truck capacity utilized is the average number of cases assembled per assembly route divided by the number of cases the truck can haul when fully loaded (multiplied by 100). An increase of one case assembled per man-hour is estimated to reduce costs by .01 cent per

case on the average. Assembly cost per case increases 10 cents if labor wage rate increases one dollar. The values in parentheses indicate the standard errors for the beta coefficients under which they appear.

An alternative assembly cost model was developed to allow for economies of scale. The new equation excluded variable X_1 (percent truck capacity utilized) and added $\frac{1}{X_4}$ where X_4 represented volume assembled per year. Variable X_3 (labor wage rate) and variable X_2 (cases assembled per man-hour) were retained from the previous model. The introduction of volume as a reciprocal changes the model from a linear model to a curvilinear model and is more consistent with economic theory. It is appropriate when costs are assumed to decline rapidly with increases in volume and then level off at higher volumes. It does not allow for diseconomies of scale, since average costs per unit (and by definition marginal costs) are not assumed to be higher for the large volume firms. The existence of large firms in other states suggested that Tennessee's plants had not reached optimum size. Economic theory states that marginal and average cost curves must turn upward at some point and keep the firm from expanding without limit. This model was superior in that R^2 was increased to .94. The predictive equation was: (30, p. 51)

$$Y = .24 + 316.07 \frac{1}{X_4} + .05X_2 - .007X_3$$

(25.84) (.02) (.001)

II. THE DELIVERY COST FUNCTIONS

The data mentioned previously were to estimate the following equation for delivering: (30, p. 35)

$$Y = .35 - .02X_2 + .20X_3 - .0000007X_4$$

(.003) (.04) (.0000003)

Y = delivery cost per case of eggs in cents

X₂ = cases delivered per man-hour

X₃ = labor wage rate per hour

X₄ = total volume of eggs delivered in cases in 1967

The variation in cases per man-hour wage rate per hour, and total volume of eggs distributed explained 53 percent of the variation in delivery costs per case.

An alternative model for delivery was developed as it was for assembly. The purpose again was to look at economies of scale. The variables retained were $\frac{1}{X_4}$, where X₄ represents volume, X₃, labor wage per hour, and X₂ cases per man-hour. The model was generated as follows: (30, p. 52)

$$Y = .25 - .02X_2 + .18X_3 + 812.10 \frac{1}{X_4}$$

(.003) (.04) (291.90)

As in the assembly analysis, the generated model proved to be statistically superior to the linear model and had an R² of .55.

III. THE IN-PLANT HANDLING COST FUNCTIONS

Plant records were used along with other accounting data to compute the cost per dozen for performing the various in-plant egg handling operations. Stepwise multiple regression models were used to determine the factors which explain the greatest amount of the variation in cost per dozen for in-plant handling.

The first model developed included all the seemingly relevant variables available. Variables included were: Volume (dozens per year), cost of cartons (cents each), percentage of plant capacity utilized, labor cost (wage per hour), total investment in plant and equipment per case, quality of the eggs handled, source of eggs (own flocks, contract, independent producer, or wholesaler), cases handled per man-hour, and percent of eggs cartoned. Quality and source of eggs were not significant at the .05 level and the following predictive equation was developed:

$$\begin{aligned} Y = & 2.843 - .015 X_2 + 1.355 X_3 + 726 X_4 + .026 X_5 - .354 X_6 \\ & (.006) \quad (.399) \quad (.184) \quad (.004) \quad (.069) \\ & + .429 X_7 - .000002 X_8 \\ & (.142) \quad (.0000008) \end{aligned}$$

where

Y = in-plant handling costs in cents per dozen

X_2 = percent plant capacity utilized

X_3 = labor wage rate per hour

X_4 = dollars invested in plant and equipment per case handled
in 1967

X_5 = percent of eggs cartoned

X_6 = cases handled per man-hour in plant

X_7 = cost of cartons in cents each

X_8 = volume in dozens handled in plant in 1967

The R^2 value for this model was .79. While this model was a good predictor it was based largely on computed values. A simpler model was developed which could utilize data readily available to managers in the industry and also allow for economies of scale. The alternative model developed explained 67 percent of the variation of the cost per dozen with the use of the five independent variables determined to be significant by the previous model. Volume was entered as a reciprocal in order to allow for economies of scale.

The cost function was determined to be:

$$Y = .778 + 1.261X_1 + .021X_2 + .337X_3 - .175X_4 + 167150 \frac{1}{X_4}$$

(.445) (.004) (.121) (.035) (43429)

where

X_1 = labor cost per hour

X_2 = percentage of eggs cartoned

X_3 = cost of cartons in cents each

X_4 = cases processed per man-hour

$\frac{1}{X_5}$ = volume handled in dozens in 1967

An economies of scale curve can be traced out if factors other than volume are held constant. For example, assuming a labor cost of \$1.60 per hour, 100 percent of eggs cartoned, a carton cost of 3 cents each, and 5 cases handled per man-hour in the plant, it will cost 6.70 cents per dozen for a firm that processes 100,000 dozen per year; 5.37 cents per dozen for a firm that processes 500,000 per year; and 5.04 cents per dozen for a firm that processes 10,000,000 dozen per year (Figure 12). Evidently most of the economies are reached at the 1,000,000 dozen per year level, although costs per unit are still declining.

Economies of scale are to be expected if all firms pay the same price for inputs; if quantity discounts are available more economies may exist. For Tennessee egg handling firms some apparent diseconomies existed. The larger firms paid more per hour for their labor, and they often paid more for cartons. A more expensive carton is needed for mechanical forming, closing, and long-distance hauling. Also, the larger firms often had a more colorful carton, and the cost was computed to be materials cost when it is in fact a form of advertising.

Another possible diseconomy which might have been overlooked by an economic-engineering study is the cost of cases and packing materials and the number of times these items are reused. Larger firms in

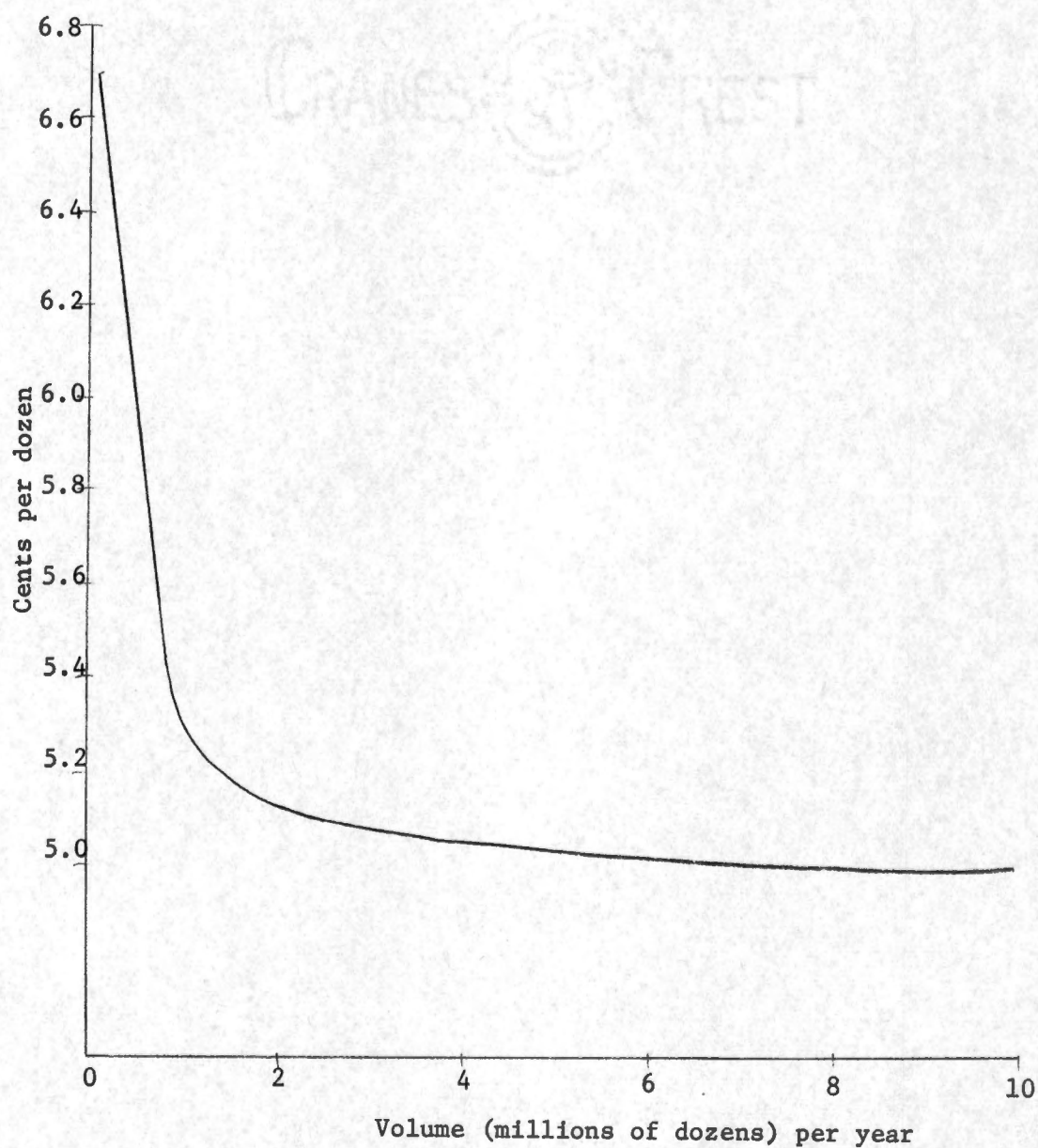


Figure 12. Cost of handling eggs in plant, cost function computed by stepwise multiple regression, Tennessee firms, 1967.

general, and especially those shipping long distances, do not get to reuse materials to the extent that smaller firms do.

The predictive equation tells us that economies of scale do exist. For example, even if the firm handling 100,000 dozen per year pays only \$1.15 per hour, cartons 100 percent, pays only 2 cents each for cartons, and handles 4 cases per man-hour, its cost would drop from 6.70 cents to only 6.05 cents per dozen--still higher than that of the larger firms.

IV. TOTAL COSTS OF MARKETING

Since assembly, delivery and in-plant processing are independent stages, the previous equations can be considered additive to compute a total cost of marketing. By plugging various quantities into the volume portion of the estimating equations, it is possible to consider economies of scale. Many combinations are possible; Table VIII represents one set of costs with various size operations making certain assumptions. The assumptions were that labor cost \$1.60 per hour, all eggs were cartoned, cartons cost 3 cents each, 5 cases handled per man-hour in-plant, 8.4 cases assembled per man-hour, and 9.7 cases delivered per man-hour.

The total processing and marketing cost per dozen for firms handling 100,000 dozen per year (64 cases per week), 300,000 dozen per year (192 cases per week), 500,000 dozen per year (321 cases per week), 1,000,000 dozen per year (641 cases per week), and 10,000,000 dozen per year (6,410 cases per week) was 9.4, 7.5, 7.1, 6.8 and 6.6 cents per

TABLE VIII
COST PER DOZEN OF MARKETING EGGS AS ESTIMATED BY
REGRESSION MODELS;* VARIOUS VOLUMES,
TENNESSEE FIRMS, 1967

Volume (doz./yr)	Assembly (cents/doz.)	Delivery (cents/doz.)	Processing (cents/doz.)	Total Cost (cents/doz.)
100,000	1.1866	1.3450	6.8231	9.3547
300,000	.9760	.7950	5.7087	7.4797
500,000	.9336	.6860	5.4859	7.1055
1,000,000	.9020	.6023	5.3188	6.8231
10,000,000	.8736	.5280	5.1683	6.5699

*Assuming average values for labor efficiency, \$1.60 per hour wage rate, 100 percent assembled, cartoned and delivered.

dozen, respectively. Figure 13 shows assembly, delivering and in-plant handling costs for these volumes.

After determining which firms were the most economically efficient, the data were examined more closely to estimate labor requirements for firms performing all functions in different size operations. Table IX shows the number of full or part-time employees required per operation for a one-shift 40-hour work week.

Specialization was difficult for the 200 case per week firms. In firms handling 400 cases per week the manager usually assembles and delivers in addition to supervising the plant. Only one extra man is needed when 10 case per hour grading equipment replaces 5 case per hour equipment. This tremendous increase in efficiency continues by adding only one or two employees and changing the grading equipment capacity up to a 30 case per hour grading system. With present technology, 60 case per hour grading units are the largest used. The large grading plant in California uses six 60 case per hour units set up parallel to each other. No firms in Tennessee were using more than one 60 case per hour machine per plant although a few plants used one 60 case per hour machine and one 30 case per hour machine. The average output was 80 cases per hour plant. Employee man-hour requirements given in Table IX are based on that combination. The Tennessee firms processing over 6,000 cases per week were using two grading machines and operating two shifts.

The right hand side column in Table IX gives goals for each operation. These goals have been achieved by the most technically

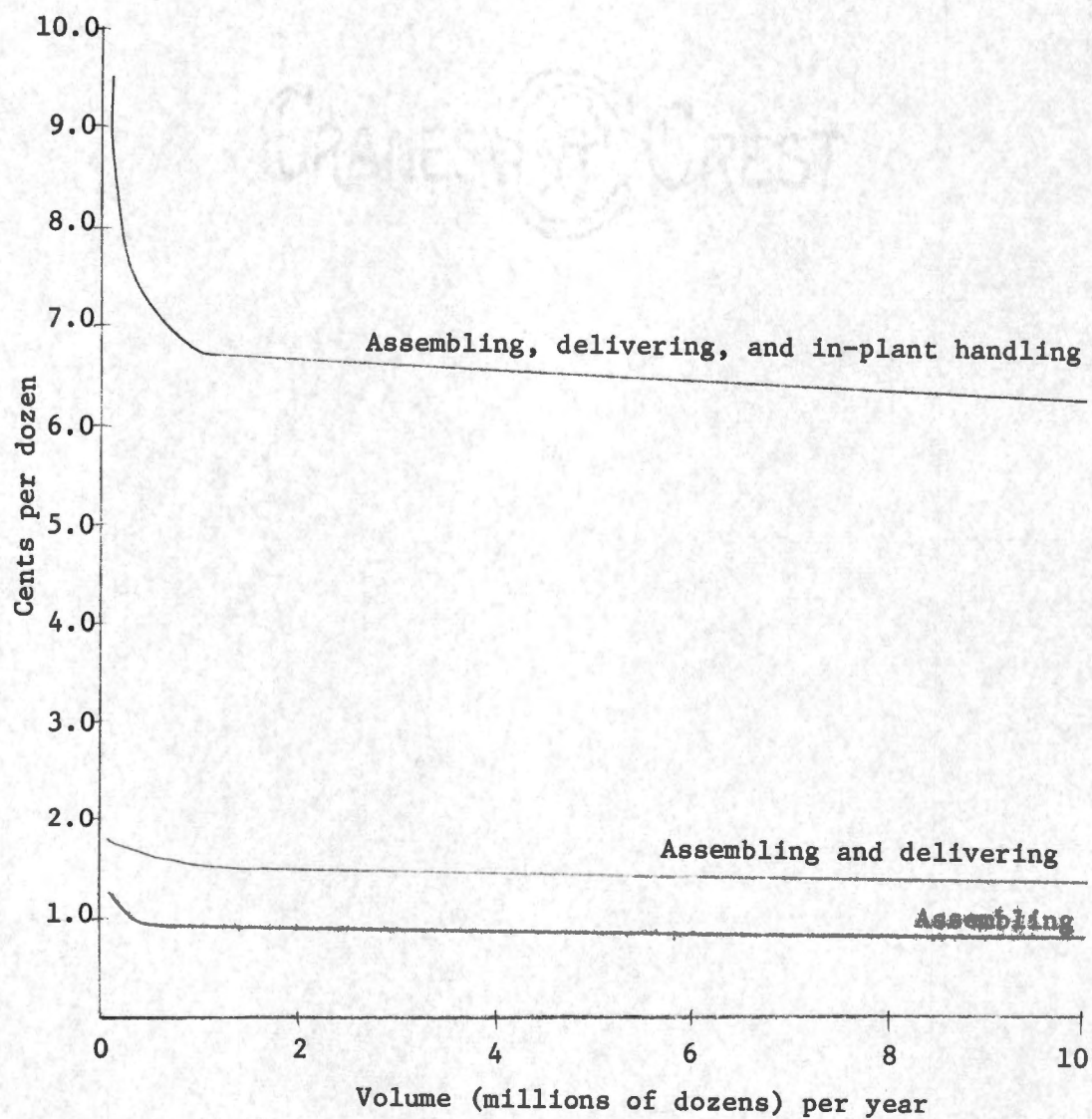


Figure 13. Costs of assembling, delivering, and in-plant handling of eggs as estimated by regression models, Tennessee firms, 1967.

TABLE IX

COMMERCIAL EGG-HANDLING PLANT MAN-POWER REQUIREMENTS AND GOALS, BY MAJOR OPERATIONS AND VARYING OPERATING CAPACITIES IN CASES PER HOUR

Plant operation	Plant operating capacity in cases per hour							Goal in rate per person in cases per hour	
	5	10	15	20	30	40	80		
	Number of full or part-time employees used per plant								
(a) Assembling	1*	1*	1	1	2	2	3	4	25
(b) Transferring	1	1	1	1	1	1	2	2	40
(b) Grading	1	1	1	1	1	1	2	2	40
(b) Cartoning	1	1	1	1	1	1	2	2	40
(c) Packing-Leading	1*	1	1	2	2	3	4	6	15
(d) Delivering	1*	1	1	2	2	3	4	6	15
(e) Management or supervision	1*	1*	1	1	2	2	3	4	20
(f) Total	5	6	7	8	10	13	20	26	
Cases per man-hour	1.0	1.7	2.1	2.5	3.0	3.0	3.0	3.0	
Cases weekly	200	400	600	800	1200	1600	2400	3200	

* Denotes one person performing several functions.

(a) 10 firms assembled 25 cases per man-hour with 45 miles of travel per 100 cases. (d) 23 firms delivered 15 cases per man-hour with 80 miles of travel per 100 cases.

(b) 7 firms transferred, graded, or cartoned at the rate of 40 cases per man-hour. (e) 17 firms reported handling 20 or more cases per man-hour for other functions including supervision, secretarial, maintenance, etc.

(c) 13 firms packed and loaded eggs at the rate of 15 or more cases per man-hour. (f) equivalent full-time employees.

efficient firms in the industry. For example, seven firms transferred, graded, and cartoned at the rate of 40 cases per man-hour or more and 13 firms packed and loaded eggs at the rate of 15 cases per man-hour or more.

Managers in the industry must improve their technical and economic efficiency by studying each of their existing operations in detail after deciding upon the type of marketing system best suited for them. A review of existing operations could lead them to change to a different marketing system.

The manager considering improving operations under his present system or changing systems must be concerned with anticipated demand and price situations, the goals of his firm or parent organization regarding sales, the availability of funds for investment, the interest rate on borrowed funds, investment tax credits, expected life of various machines, maintenance requirements for various machines, anticipation of technical obsolescence, available labor supply, prevailing wage rates, strength of labor unions, and other factors. Recognizing that these factors differed for each firm in Tennessee, some general recommendations are given.

Efficiency in assembling is obtained by increased production density, assembling more cases per stop, and by locating the plant close to the concentrated production area. This function can conceivably be eliminated entirely by using conveyors which transfer eggs from the production area into the grading facility. The use of pallets and fork-lift trucks can be utilized for loading at concentrated production

areas or warehouses and for unloading at grading plants. Close examination of road maps should help in avoiding excessive overlapping of assembly routes. The use of linear programming transportation models should be seriously considered by larger firms.

The most technically and economically efficient grading facilities in Tennessee were those which handled over 1,000 cases of eggs per week. A producer with less than 30,000 layers should consider producing for a contractor and avoid marketing costs unless he is able to receive a price higher than the 1967 price of 32.9 cents per dozen. A manager with 30,000 layers in one production unit can take advantage of most economies of scale in production. A manager with 30,000 layers can use 10 case per hour grading equipment by employing five workers 40 hours per week. A producer with 90,000 layers can utilize 30 case per hour grading equipment by employing only eight workers. Most gains in labor efficiency in terms of cases handled per man-hour are reached at the 30 case per hour or 1,200 case per week level. In Tennessee some firms with two 30 case per hour grading systems were only slightly less efficient than the firms with one 60 case per hour system, and the smaller units allowed for more flexibility.

Vacuum lift transferring is recommended for all firms that clean and grade eggs which are assembled in bulk cases or on filler-flats.

Automatic cartoning is recommended for 30 case per hour and layer plants. The employees listed as cartoning operators in Table IX (page 78) are actually only supplying cartons and maintaining the cartoning machines in the larger plants. Automatic packing is also recommended

machines in the larger plants. Automatic packing is also recommended for larger firms. Cases can be closed, sealed, and dated automatically.

Loading can be made easier by use of fork-lift trucks and pallets. The same general principles apply to efficiency in delivering which applied to assembling. The delivery route must be simplified. Time and motion studies could be helpful in analyzing this operation and the operations mentioned previously.

A philosophy of work simplification should be encouraged in all firms. Monetary rewards and recognition could encourage employees to improve efficiency in performing all marketing functions.

CHAPTER V

SUMMARY AND CONCLUSIONS

The structure of the commercial egg industry in Tennessee and the South in general has changed tremendously in recent years. Sale of eggs from farms selling eggs has increased while the number of farms with layers has declined rapidly. Seventy-nine farms accounted for 60 percent of Tennessee's egg production in 1967. Favorable climate, relatively low labor costs, and improvements in road and transportation facilities first encouraged commercial broiler production in the South. As the market for broilers became saturated many inputs were shifted to commercial egg production.

Tennessee was still a slightly deficit state in egg production in 1967. However, Mississippi and Arkansas are large egg surplus producing states and provide an ample supply for wholesalers in the Memphis area. Alabama and Georgia are also surplus producing states and provide a supplementary supply to egg handlers in the Nashville, Chattanooga, and Knoxville areas. Egg handling firms in Tennessee procure their eggs from four sources--their own flocks, contract flocks, independent producers, and dealers. Each of these firms performs some of the marketing functions of assembling, washing, candling, grading, cartoning, packing, and delivering.

Organizational structures and marketing channels have been changing rapidly with the emphasis toward vertical integration and actual participation in production by feed manufacturers and retail food outlets. A few large owner-integrated operations have emerged where firms furnish layers, feed, and medicants, and contract for the eggs produced without owning the buildings and equipment used for production.

Tennessee's egg marketing system is made up of organizations which are primarily producers, producer-contractors, dealers or wholesalers, dealer-producers, dealer-contractors, or dealer-producer-contractors. For the 75 firms included in this study the volume handled per firm ranged from 50 to 6,500 cases per week.

The cost per dozen for producing eggs was computed for each of 36 producers included in the study. The firms were grouped into low, medium, and high cost groups. The low-cost group averaged 110,357 layers per firm and had production costs of 25.24 cents per dozen. The medium cost group averaged 28,769 layers per firm with production costs of 27.99 cents per dozen; whereas the high cost group averaged 18,286 layers per firm with production costs of 31.84 cents per dozen. The average price received by egg producers in Tennessee was 32.9 cents per dozen in 1967. Firms in the high cost group would have suffered losses or received low returns to management and labor if they had to perform many marketing functions. In general, producers either (1) clean, grade, carton, and deliver eggs to retail outlets; (2) clean, grade, bulk case, and deliver eggs to a wholesaler for a selling price usually

based on the Chicago or New York markets; or (3) produce eggs on contract and bulk case them to be cleaned and graded by the contractor for a guaranteed price.

The number of wholesalers in Tennessee has declined and the trend toward direct buying and selling between large organizations has increased tremendously in recent years. Further research is needed to provide ways of improving the overall pricing system of eggs. However, no system would raise prices greatly during periods of large supplies.

Ten producer-contractors were included in the study. The average volume handled was 1,183 cases per firm per week. The model price received by contractors was 5 cents per dozen. This price seemed equitable based on the costs incurred by the contractor. Producer-contractors typically operated large grading facilities.

Vertical and horizontal integration existed in several firms. Six firms had their own hatchery. Twenty-nine firms had their own feed mill or farm supply business; 13 of those 29 were commercial operations and not just for their own use.

The wholesale outlet is still important in Tennessee, rehandling and delivering eggs to retail outlets. The role of the wholesaler as an equilibrating mechanism was needed, since many producers were unable to sell all their eggs through retail channels, did not produce on contract, and did not have trucks suitable for long-distance hauling. The regrading by the wholesaler was evidently adequate because the percentage of eggs which were sold as Grade A did not differ appreciably between firms or channels.

The 75 firms varied considerably with regard to the type of marketing functions performed. Twenty-nine firms assembled eggs, 60 firms delivered eggs, and 64 firms performed the in-plant handling functions of transferring, washing, candling, and grading.

The technical, price, and economic efficiency of the 64 firms was computed using the Farrell approach. A firm is 100 percent technically efficient if it obtains one unit of output with a minimum of inputs. A firm is 100 percent economically efficient if it produces a unit of output at minimum per unit costs. The larger firms were more technically and economically efficient in their in-plant handling operations (excluding cartoning and packing). The average economic efficiency for firms which handled under 10,000 cases per year, 10,000-29,999 cases per year, 30,000-49,999 cases per year, and over 50,000 cases per year was 31, 44, 46, and 57 percent, respectively.

The costs of assembling, in-plant handling, and delivering were computed and stepwise regression equations were developed which pointed out the factors which most influenced the cost per case for performing each of these functions. Cases assembled per man-hour, labor wage rate, and volume explained 94 percent of the variation in cost per case for assembling and 55 percent of the variation in delivering. Labor wage per hour, percentage of eggs cartoned, costs of cartons, cases per man-hour and volume explained 69 percent of the variation in in-plant handling costs. By holding certain factors constant, an economies of scale curve was traced out by the regression analysis. The assumptions were that labor costs \$1.60 per hour, 100 percent of the eggs cartoned,

cartons cost 3 cents each, 5 cases are handled per man-hour in-plant, 8.4 cases assembled per man-hour, and 9.7 cases delivered per man-hour. The total cost of assembling, in-plant handling, and delivering for firms handling 100,000 dozen per year, 300,000 dozen per year, 500,000 dozen per year, and 1,000,000 dozen per year was 9.4, 7.5, 7.1, 6.8, and 6.6 cents per dozen respectively. The values for the other variables which were held constant near their mean would in fact vary somewhat with volume. Actually, the increases in cases per man-hour at higher volumes tends to offset the increased materials and labor costs and the results are not changed substantially.

Although the picture generally looks bleak for small commercial producers, they still have feasible alternatives. They can produce on contract and take advantage of economies of scale open to the integrator in the production of replacement flocks and in the manufacturing of feed. Their risk and uncertainty is minimized. If they have adequate capital, low cost labor, and established retail outlets then they can justify performing all marketing functions. They can survive if they are receiving premium prices for high quality eggs. A true measure of economic efficiency would consider the price received for the output in conjunction with the prices paid for the inputs. This study looked primarily at costs.

Further study might include determining the optimum number, size and location of egg grading plants in the state or region. Since the top six producers in Tennessee produced more than one-fourth of the state's total production in 1967, the total number might be surprisingly

small. Conceivably, assembling could be eliminated by moving eggs directly from large laying houses into the processing plants as large firms are now doing. Location of these larger plants near metropolitan areas could also increase efficiency in delivering.



REFERENCES



REFERENCES

1. Benjamin, Earl W. and Howard C. Pierce. Marketing Poultry Products. New York: John Wiley and Sons, Inc., 1937.
2. Bird, Kermit. An Analysis of Egg Handling Costs and Efficiency. Oklahoma State Agricultural Experiment Station Bulletin B-568. Stillwater: Oklahoma State University, November, 1960.
3. Boles, J. N. "Efficiency Squared--Efficient Computation of Efficiency Indexes," Western Farm Economics Association Proceedings, 1966. Pullman: Washington State University, August, 1966.
4. Brems, Hans. "A Discontinuous Cost Function," American Economic Review, 42:577-586, September, 1952.
5. Brown, William G. "Discussion of Papers Presented on Production Functions and Productive Efficiency--The Farrell Approach," Western Farm Economics Association Proceedings, 1966. Pullman: Washington State University, August, 1966.
6. Bryant, A. W. Phoebe Betty Starr, and John A. Hamann. The Bacterial, Chemical, and Physical Requirements for Commercial Egg Cleaning. Marketing Research Report No. 740. Washington: U. S. Government Printing Office, April, 1966.
7. Bressler, R. G., Jr. "Efficiency in the Production of Marketing Services," Economic Efficiency Series Paper No. 6. Social Science Research Council Project in Agricultural Economics, University of Chicago, Summer 1950.
8. Bressler, R. G., Jr. "Research Determination of Economics of Scale," Journal of Farm Economics, 27:526-539, August, 1945.
9. Bressler, R. G., Jr. "The Measurement of Productive Efficiency," Western Farm Economics Association Proceedings, 1966. Pullman: Washington State University, August, 1966.
10. Carlson, Sune. A Study on the Pure Theory of Production. New York: Kelly and Millman, 1956.
11. Farrell, N. J. "The Measurement of Production Efficiency," Journal of the Royal Statistical Society, 120:253-290, December, 1957.

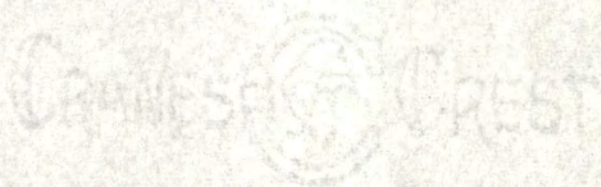
12. Farrell, M. J. and M. Fieldhouse. "Estimating Efficient Production Functions Under Increasing Returns to Scale," Journal of the Royal Statistical Society, 125:252-267, December, 1962.
13. Fox, Karl A. Intermediate Economic Statistics. New York: John Wiley and Sons, Inc., 1968.
14. French, Sammet, and Raymond G. Bressler. "Economic Efficiency in Plant Operations with Special Reference to the Marketing of California Pears," Hilgardia, 24:543-592, July, 1956.
15. Friedman, Milton. Price Theory. Chicago: Aldine Publishing Company, 1967.
16. Hamann, John A. and Thomas F. Todd. Improved Designs for Commercial Egg Grading and Packing Plants. Marketing Research Report No. 422. Washington: Government Printing Office, 1961.
17. Hartman, Roland C. "Egg City's Packing Plant: Designed for Efficient Product Flow," Poultry Tribune, 74:276-287, June, 1968.
18. Hoel, Paul G. Elementary Statistics. New York: John Wiley and Sons, Inc., 1967.
19. Johnston, J. Econometric Methods. New York: McGraw-Hill Book Company, Inc., 1960.
20. Jones, Harold B. Economies of Scale in Commercial Egg Packing Plants. University of Georgia Experiment Station Bulletin No. N.S. 120. Athens: University of Georgia, September, 1966.
21. Jones, Harold B., and H. R. Smalley. Vertical Integration Methods of Producing and Marketing Eggs: An Economic Evaluation, University of Georgia Experiment Station Bulletin No. N.S. 120. Athens: University of Georgia, May, 1966.
22. Jones, Harold B. and Jack C. Thompson. Marketing Costs and Labor Productivity in Commercial Egg Packing Plants. University of Georgia Experiment Station Bulletin No. N.S. 93. Athens: University of Georgia, June, 1962.
23. Judge, George C. Competitive Position of the Connecticut Poultry Industry. Agricultural Experiment Station Bulletin 318. Storrs: Connecticut Agricultural Experiment Station, January, 1956.
24. King, Richard A. "Marketing Efficiency: Technical, Price and Economic." Paper presented at Association of Southern Agricultural Workers, New Orleans, Louisiana, January, 1967. Copies of original paper may be obtained from King at North Carolina State University at Raleigh.

25. Kohls, Richard L. Marketing of Agricultural Products. New York: The MacMillan Company, 1965.
26. Leftwich, Richard H. The Price System and Resource Allocation. New York: The MacMillan Company, 1965.
27. McCarthy, E. Jerome and Robert J. Williams. "Simulation of Production-Marketing Channels." Unpublished manuscript, 1967.
28. Michalson, E. L. and R. H. McAlexander, and C. P. Stemberger. An Economic Analysis of Alternative Egg Production Systems. Bulletin No. 733. University Park: The Pennsylvania State University, June, 1966.
29. Moreng, R. E., J. D. Helbig, and J. V. Shultz. "The Cycle House," Agricultural Engineering, 49:187-201, December, 1968.
30. Nelms, B. W. "Analysis of Egg Handling Costs in Tennessee." Unpublished M. S. thesis, Knoxville: The University of Tennessee, June, 1969.
31. Peeler, R. J., Jr. and Richard A. King. In-Plant Costs of Grading and Packing Eggs. A. E. Information Series No. 106. Raleigh: North Carolina State University, August, 1963.
32. Raskopf, B. D. "Egg Marketing, Wholesale and Retail in Tennessee." Rural Research Series Monograph No. 267. Knoxville: The University of Tennessee, 1967.
33. Raskopf, B. D. "Size of Laying Flocks in Tennessee, 1967: A Preliminary Survey." Unpublished mimeograph. Knoxville: The University of Tennessee Agricultural Experiment Station, 1967.
34. Raskopf, B. D., and B. W. Nelms. "Commercial Egg Transportation Costs in Tennessee," Tennessee Farm and Home Science. Progress Report No. 68. Knoxville: The University of Tennessee Agricultural Experiment Station, December, 1968.
35. Ratcliffe, Harry E. Why Egg Handling Costs Vary in Selected Cooperatives. Marketing Research Report No. 552. Washington: Government Printing Office, July, 1962.
36. Rogers, George B. and Herman Bluestone. Competitive Position of the Midwestern Egg Industry. Marketing Research Report No. 784. Washington: U. S. Government Printing Office, February, 1967.

37. Rogers, George B. and Leonard A. Voss. Pricing Systems for Eggs. Marketing Research Report No. 850. Washington: U. S. Government Printing Office, May, 1969.
38. Samuelson, Paul A. Economics: An Introductory Analysis. New York: McGraw-Hill, 1967.
39. Saunders, Fred B. and Edward C. James. Costs and Returns from Commercial Egg Production in Georgia. University of Georgia Experiment Station Bulletin No. N.S. 124. Athens: University of Georgia, December, 1964.
40. Seale, A. D., Jr. Equilibrium Prices and Movements of Eggs in the United States for 1958-60 and 1970. Mississippi Agricultural Experiment Station Bulletin No. 690. Starkville: Mississippi State University, June, 1964.
41. Shepherd, Geoffrey S. and Gene Futrell. Marketing Farm Products. Ames: The Iowa State University Press, 1969.
42. Seitz, Wesley D. "Efficiency Measures for Steam-Electric Generating Plants," Western Farm Economics Association Proceedings, 1966. Pullman: Washington State University, August, 1966.
43. Sitorus, Bistok L. "Productive Efficiency and Redundant Factors of Production in Traditional Agriculture of Underdeveloped Countries: A Note on Measurement," Western Farm Economics Association Proceedings, 1966. Pullman: Washington State University, August, 1966.
44. Smith, Adam. The Wealth of Nations. Edwin Cannon, editor. New York: The Modern Library, 1937.
45. Sprague, D. C., A. S. Mowery and G. O. Bressler. Automatic Poultry Feeder Plan. Progress Report No. 2. University Park: The Pennsylvania State University, September, 1948.
46. Stemberger, A. P. and W. J. Jasper. North Carolina Eggs in Inter-regional Competition. A. E. Information Series No. 73. Raleigh: North Carolina State University, February, 1966.
47. Stigler, George J. The Theory of Price. New York: The MacMillan Company, 1952.
48. Strawn, Harry B. and Stanton P. Parry. Estimated Economic Impact of the Interstate Highway System on Marketing Eggs. Bulletin No. 405. Knoxville: The University of Tennessee Agricultural Experiment Station, May, 1966.

49. The University of Tennessee Computing Center. "BMD02R Stepwise Regression." Knoxville: The University of Tennessee, September 1, 1965.
50. U. S. Bureau of the Census. Census of Agriculture. Washington: Government Printing Office.
51. U. S. Bureau of the Census. Statistical Abstract of the United States, 1968. Washington: Government Printing Office, 1968.
52. U. S. Department of Agriculture. Poultry and Egg Situation. Washington: Government Printing Office, June, 1969.
53. U. S. Department of Agriculture. Agricultural Statistics. Washington: Government Printing Office, 1925-68.
54. Waile, Grather, and Peavis Cox. Marketing in the American Economy. New York: The Ronald Press Company, 1952.
55. Waugh, Frederick V. Readings on Agricultural Marketing. Ames: The Iowa State Press, 1954.
56. White, Morris. Relationship of Marketing Methods to Cost of Assembly, Grading, and Packing Table Eggs. Auburn University Experiment Station Bulletin No. 348. Auburn: Auburn University, October, 1963.
57. White, Morris. "Egg Marketing Practices and Systems in Seven Southern States." Unpublished paper presented at SM-37 technical meeting on poultry and egg marketing, November, 1968.
58. Winter, Evans R. Automatic Sizing and Packaging of Eggs. Marketing Research Report No. 424. Washington: Government Printing Office, 1960.
59. Woananen, M. V. (ed.). Western Farm Economics Association Proceedings, 1966. Pullman: Washington State University, August, 1966.
- 60 Yamane, Taro. Statistics: An Introductory Analysis. New York: Harper and Row, 1967.

APPENDIXES



APPENDIX A

Department of Agricultural Economics Tennessee Agricultural Experiment Station

CONFIDENTIAL

Code No. _____

Date _____

Regional SM-37

COMMERCIAL EGG MARKETING SYSTEMS

1. Primary business _____; % of business from table eggs _____;
2. Other (specify) _____%; _____%; _____%.
3. If this firm is part of a larger one, what are the egg operations of the parent firm? _____, _____, _____.

4. Cases (30 doz.) eggs handled:	<u>1965</u>	<u>1966</u>	<u>1967</u>
From own flocks (A flock is the hens on one farm)	_____	_____	_____
From contract flocks	_____	_____	_____
From independent producers	_____	_____	_____
Purchased from other dealers	_____	_____	_____

	<u>Size of flock</u>			
	<u>No.</u>	<u>Ave.</u>	<u>Range</u> <u>Largest</u>	<u>Smallest</u>
5. From how many flocks do you receive eggs	_____	_____	_____	_____
6. From how many dealers do you obtain eggs	_____			

7. Proportion of eggs handled that come from birds:

	<u>Yes</u>	<u>No</u>	
Housing insulated	___	___	In cages ___%; On floor ___%
			12" wide or less ___%
Mechanically ventilated	___	___	Wider than 12" ___%
			Cage arrangement _____
Sq. ft. per bird	___	___	Birds per cage _____ No.

8. Treatments of eggs obtained from producers or dealers:

Practice	Performed by:			
	Producer	Dealer	Your firm	Total
	% of eggs	% of eggs	% of eggs	%
Oil treated				
Cleaned				
Candled				
Sized				
Cartoned				
Bulk cased				

9. Proportion of eggs produced by your flocks that are cooled to 60° or under immediately after gathering and held at reasonable constant temperature not to exceed 60° F and relative humidity of about 70%
_____ %

10. Of all eggs you receive:

Percent delivered to you _____ %

Percent you pick up _____ %
100 -

Of eggs you pick up:

a. Percent in owned trucks _____ %b. Percent in rented or leased trucks _____ %
100 -

11. Percentage of eggs obtained in state _____ %; out of state _____ %

12. Trucks operated:

	Assembly trucks operated			Delivery trucks operated		
Size of trucks (Cases of eggs)						
Number trucks						
Refrigerated (No.)						
Non-refrigerated (No.)						
Cases of eggs handled per truck per week						
Average miles traveled per truck per week						

13. How much is egg assembly costing you? _____ ¢/case; _____ dozen.

14. How do you determine assembly cost? _____

15. How much does distribution cost you? _____ ¢/case; _____ dozen.

16. How do you determine distribution cost? _____

17. Cost of transportation per dozen _____ or per case _____ of eggs

18. Length of haul:

	Average Length of Haul in Miles (% of eggs)				
	Under 50	50-149	150-299	300-599	600 over
Assembly					
Distribution					

19. Cases or percent of eggs sold for year, 1967, by grade:

	AA	A	B	Under grades	Total
	<u>Year</u>	<u>Year</u>	<u>Year</u>	<u>Year</u>	
Jumbo					
Extra large					
Large					
Medium					
Small					
Pee Wee					
Other					
Total					

20. Cases handled in peak week of 1967 _____ When? _____

21. Cases handled in low volume week, 1967 _____ When? _____

22. Percentage of eggs handled, 1967:

Cases			
Loose pack	_____ %	In own cartons	_____ %
In cartons	_____ %	Other private labeled cartons	_____ %
	100%		100%

23. Prices paid for eggs, 1967:

		Producer paying price for eggs	
How determined		<u>On contract</u>	<u>Independent</u>
Period of contract			
	Written _____ Oral _____	Written _____ Oral _____	
Based on what quotation			
Differential			
Incentive			
Premiums: Quality			
Quantity			
Deductions:			
Pick up			
Washing			
Grading			
Cases			
Day of week price is made			

24. Has your basic paying price changed in the last 12 months?

If "yes," how? _____

25. Attach copies of contracts or explain oral contract.

26. How much margin must you have per dozen eggs between your buying and selling price? _____

27. How is your selling price determined? _____

28. Percent of eggs sold in 1967 in-state _____%; out-of-state _____%.

29. Total eggs sold (estimated 1967) _____ cases _____ dozen.

30. Market outlets for table eggs, 1967	In-state		Out-of-state	
	Percent	Range in miles	Percent	Range in miles
No.				
___ Chain stores				
___ Chain store warehouses				
___ Wholesalers				
___ Independent stores				
___ Egg breaking plants				
___ Direct to consumers				
___ Eating places-- institutions				
___ Military				
___ Export				
___ Grading plants				
	100%		100%	

31. Days from eggs laid to delivery _____

32. Methods of promoting egg sales _____

33. What changes in your company will likely be made in the next two years, and who will make the final decision? _____

34. Comments from management on problems and suggested changes in marketing system for eggs: _____

35. Egg grading plant workers by station of operation, 1967

Station or operation	Number workers*		Average hours worked per week	Hourly wages**	Cases per hour
	Full-time	Part-time			
Assemblers (truckers)					
Receiving					
Stocking					
Transferring					
Washing					
Candling					
Grading (Sizing)					
Cartoning					
Carton closing					
Floaters					
Packing					
Rolling out or loading out					
Maintenance & repair					
Plant cleanup					
Inspecting					
Foreman, supervisor					
Managers					
Bookkeepers					
Secretary					
Salesman					
Distributors (truckers)					
Total					

*Designate workers doing several jobs and specify hours worked at particular job for the workers who do several different jobs.

**Specify any fringe benefits.

36. Number weeks egg grading room operated in 1967 _____ (weeks); ave. hours per week _____.

Mechanized item	Equipment			Cases per hour		Employees required Number
	Type	Cost new	Rental	Rated	Ave. output	
Egg washer						
Egg dryer						
Candler						
Grader						
Sizer						
Bloodspot detector						
Carton maker						
Cartoners						
Packing table						
Carton closers						
Egg breaker						
Egg pasteurizer						
Packers						
Materials-handling						
Conveyor belt						
Pallets						
Counters						
Oilers						
Individual egg stampers						

Cold storage capacity: length _____; width _____; height _____;

or cubic feet _____; or cases of eggs _____

Height cases are stacked _____.

37. Disposition of further processed eggs, 1967

Outlet	In-state		Out-of-state	
	Percent	or Pounds	Percent	or Pounds
Bakeries				
Confectioners				
Noodlemakers				
Schools				
Mayonnaise or salad dressing plants				
Drying plants				
	100%		100%	

Egg breaking: Capacity _____ per hour

Eggs broken in 1967

Percentage of eggs received by breakers that were:

_____ cases	Undergrades	_____ %
or _____ dozen	Flock run	_____ %
or _____ eggs		_____ %

What is the trend in these percentages? _____

What is seasonal pattern of egg breaking? _____

Percent of broken-out eggs sold:	Liquid	_____ %	Whole	_____ %
	Frozen	_____ %	Yolk	_____ %
	Dried	_____ %	Albumen	_____ %

How are prices determined for liquid, frozen, and dried eggs? _____

If you do not have egg breaking facilities, where does your breaking stock go? _____

38. Costs of supplies for year 1967:

Cartons	\$ _____	Kind	_____
Cases	\$ _____		_____
Fillers & flats	\$ _____		_____
_____	\$ _____		_____
_____	\$ _____		_____
_____	\$ _____		_____

Other costs for year 1967:

Other

Utilities	\$ _____;	_____;	\$ _____
Telephone	\$ _____;	_____;	\$ _____
Advertising	\$ _____;	_____;	\$ _____
Freight	\$ _____;	_____;	\$ _____

39. Capital investment in egg marketing operation: Land \$ _____;
- Egg packing plant \$ _____; Other buildings \$ _____; Cleaning equipment \$ _____, Grading equipment \$ _____, Cooling equipment \$ _____; Trucks \$ _____, (For assembly \$ _____; for delivery \$ _____.) Other equipment \$ _____;
- Supplies cost per 1 yr. \$ _____
- Total investment in commercial egg marketing operation \$ _____.



40.

OPERATING AND FIXED COSTS
(for Production)

	Rate of lay: %	Mortality rate - %	
Feed:	Amount Tons	Labor:	(No. __) Duties
	Per layer Lbs.		Hours No.
	Per dozen eggs Lbs.		Wages per hour \$
	Cost per cwt \$		Cost \$
	Cost per doz. eggs-¢		
	% of total cost %		(No. __) Duties
	Ave. layer wt. Lbs.		Hours No.
Hen dep.:	Total cost of pullets-\$		Wage per hour \$
	Per layer ¢		Cost \$
	Per dozen eggs ¢		
	% of total cost %		(No. __) Duties
	Months in prod. No.		Hours No.
Mang.:	Duties:		Wages per hour \$
	Hours No.		Cost \$
	Salary (hourly) \$		
	(total) \$		(No. __) Duties
	Cost per layer ¢		Hours No.
	Cost per doz. eggs-¢		Wage per hour \$
	% of total cost %		Cost \$
Hous- ing:	Value \$		(No. __) Duties
	An. dep. @ 5%		Hours No.
	Cost per layer ¢		Wage per hour \$
	Cost per doz. eggs-¢		Cost \$
	% of total cost %		
Equip:	Value \$	All labor:	Persons (tot.) No.
	An. dep. @ 10%		Hours No.
	Cost per layer ¢		Cost \$
	Cost per doz. eggs ¢		Cost per layer ¢
Trucks:	% of total cost %		Cost per doz. eggs-¢
	Value \$		% of total cost %
	An. dep. \$		
	Cost per layer ¢		Total investment \$
	Cost per doz. eggs ¢		Interest \$
	% of total cost %		Taxes \$
Fuel	\$		Insurance \$
Repairs	\$		Cartons \$
Elect.	\$		Cases \$
Water	\$		Litter \$
Freight	\$		Medicants \$
			Telephone \$
			Records \$

APPENDIX B

COMPUTATIONAL PROCEDURES USED TO MEASURE TECHNICAL EFFICIENCY

The most direct method known to date for determining economic efficiency as described by Farrell is the method pioneered by Boles (3, p. 137). His computational procedure requires only a fraction of the time which would be required if the problem were handled as a general linear programming model (3, p. 137). His model is deterministic and retains the usual linear programming assumptions of linearity, additivity, and divisibility. Boles presented the mathematical specification and economic interpretation as follows (3, p. 137):

Assuming observations on n activities involving m factors of production, the j th activity is completely described by a vector containing $m + 1$ elements where Q_j is the quantity of the single product produced and F_{ij} represents the quantity of factor i used in the j th activity. To estimate the technically efficient unit isoquant, each activity is standardized to yield one unit of output so that the j th standardized activity is

$$P_j = (f_{1j} \ f_{2j} \ \dots \ f_{mj})'.$$

Prime indicates transpose, $f_{ij} = \frac{F_{ij}}{Q_j}$.) The objective is to classify each of the n points as either 100 percent efficient (on the efficient unit isoquant), or if less than 100 percent efficient, to compute an efficiency index.

The index of technical efficiency as proposed by Farrell is most easily visualized in the following terms. An activity, P_j , can be viewed either as one of n standardized activities, each producing one unit of output, or as a list of input quantities. The essential question to be asked about each activity, then,

is the following: Given the n activities and the j th list of inputs, what is the maximum amount of output that can be produced? By definition, the j th activity produces one unit of output. If some combination of activities can produce more than one unit while using no more resources than the j th activity, then the j th activity is inefficient, and the efficiency index is defined as the reciprocal of maximum output. Formally, then, there are n distinct linear programming problems in which the n productive activities form a constant coefficient matrix, A , and each of the activities in turn furnishes the coefficients of the "right-hand side," rhs. Let V be an $n \times 1$ vector of ones. The j th linear programming problem is:

$$\text{Maximize } X_0 = V'X$$

$$X \geq 0$$

$$AX \leq P_j.$$

Let $\bar{X}_0$ be the optimum value of the objective function; then the efficiency index is $\frac{1.0}{\bar{X}_0}$. The set of convex combinations of the optimum basis defines one facet of the technically efficient unit isoquant. A formal statement of the dual is:

$$\text{Minimize } W_0 = P_j'W$$

$$W \geq 0$$

$$A'W \geq V.$$

An economic interpretation of the dual is to select a set of nonnegative factor prices to minimize the cost of production of one unit of the j th activity subject to the condition that the cost of production of each of the n activities is greater than or equal to 1.0. For those activities in the optimal basis, the cost of production will be equal to 1.0, and the efficient facet coincides with a unit isocost hyperplane with all points, P_k , on the hyperplane or on the side away from the origin,

$$k = 1, 2, \dots, n.$$

An efficient computational scheme used a three-part classification: points that are so far unclassified as to efficiency, points that have been classified as efficient, and points that have been classified as inefficient. At the beginning, all n points fall in the first category. Disposal activities are added for each of the m factors and classified as efficient.

To begin the computations, an activity is selected that uses the minimum quantity of some factor, say the first. This activity becomes the first rhs (right-hand side) and the simplex algorithm is used to obtain the optimum solution. At this point, any activity in the optimum basis is classified as 100 percent efficient. If the rhs activity is less than 100 percent efficient, the efficiency index is computed and printed and the optimum basis and solution are printed.

At this point, each of the n activities is represented in terms of the current optimum basis. Consequently, if each element of a vector in terms of the current basis is nonnegative, the current basis would also be the optimal basis for that vector as the rhs vector. Geometrically, the significance of this is that the point in question lies in the convex cone spanned by the vectors in the current basis. All such vectors can be immediately classified as efficient or inefficient. As soon as a vector is classified as inefficient, its efficiency index is computed and no further computations are made with it. Efficient activities and unclassified activities are kept current with successive optimum bases.

At this point, some activities will typically still be unclassified by virtue of the fact that one or more elements are negative. (They lie outside the convex cone.) One of these is selected to become the new rhs. Alternative selection rules are possible; the best of those tried was to define an infeasibility index, the sum of negative elements, and select that unclassified vector with the algebraically largest (smallest magnitude) infeasibility index to be used as the next rhs.

It is efficient at this point to use the dual algorithm. Since the $Z_j - C_j$ elements are all nonnegative, the dual algorithm maintains a feasible dual solution and drives the primal to feasibility. This process is continued--(1), obtain an optimal basic feasible solution for some rhs, (2) classify all vectors in the cone, (3) select an unclassified vector with minimum infeasibility index as the new rhs, and (4) obtain a new optimal solution--until all vectors have been classified.

APPENDIX C

TABLE X

VOLUME HANDLED AND MARKETING FUNCTIONS PERFORMED BY 75 TENNESSEE
EGG HANDLING FIRMS, 1967

Firm No.	Total (Cases)	Assembled (Cases)	Transferred (Cases)	Cleaned (Cases)	Candled (Cases)	Graded (Cases)	Cartoned (Cases)	Packed (Cases)	Delivered (Cases)
1	2434		2434	2434	2434	2434		2434	2434
2	2600	2600	1300				1300	2600	2600
3	2792		2792	2792	2792	2792	2708	2792	2792
4	3536		3536	3536	3536	3536		3536	3536
5	4160		4160	4160	4160	4160	1040	4160	4160
6	4420		4420	4420	4420	4420		4420	4056
7	4628	4628	4628	4628	4628	4628	926	4628	4628
8	4680		4680		4680		468	4680	4680
9	5200		5200		520		520	5200	5200
10	5200		5200	5200	5200	5200		5200	5200
11	5304		5304	5304	5304	5304	5039	5304	5304
12	5304		5304	5304	5304	5304	4774	5304	5304
13	5460		5460	5460	5460	5460	3549	5460	5460
14	6032	6032	6032	6032	6032	6032	1206	6032	6032
15	6032		6032	6032	6032	6032	181	6032	6032
16	6240	3744	6240		6240		5928	6240	6240
17	6448		6448	6448	6448	6448	6384	6448	6448
18	6500		6500		6500		3900	6500	6500
19	7020		7020	7020	7020	7020	6669	7020	7020
20	7200		7200	7200	7200	7200	6120	7200	7200
21	7332		7332		7332		5499	7332	7332
22	7800		7800		7800	7800	6240	7800	7800
23	8008		8008	8008				8008	8008
24	9256		9256	9256	9256	9256	5554	9256	8320

TABLE X (continued)

Firm No.	Total (Cases)	Assembled (Cases)	Transferred (Cases)	Cleaned (Cases)	Candled (Cases)	Graded (Cases)	Cartoned (Cases)	Packed (Cases)	Delivered (Cases)
25	9308		9308	9308	9308	9308	9215	9308	9308
26	9360								9360
27	9880							9880	
28	10251	365	10251	10251	10251	10251	10097	10251	10251
29	10400	8840	10400	5200	5200		2600		10400
30	10660		10660	10660	10660	10660	7142	10660	10660
31	10920	10920	10920	10920	10920	10920	109	10920	10920
32	11596		11596	11596	11596	11596	11016	11596	11596
33	13000	13000	13000	13000	13000	13000	10400	13000	13000
34	13000								13000
35	13000	13000					10400		13000
36	13832		13832	13832	13832	13832	13694	13832	13832
37	14300	14300	14300	14300					5720
38	14508		14508	7254	7254	7254	4352	14508	14508
39	15184		12168	12168	12168	12168	14880	12168	15184
40	16744	16744	16744	16744	16744	16744	1674	16744	16744
41	17212		17212					17212	
42	17628		17628	17628	17628	17628	16747	17628	17628
43	18460		18460	18460	18460	18460	16614	18460	18460
44	19084		19084	19084	19084	19084		19084	19084
45	19500		19500	19500	19500	19500	19500	19500	19500
46	19812		19812	19812	19812	19812	15850	19812	19812
47	20592		20592	12792	12792	12792	17503	20592	20592
48	23816		23816	23816	23816	23816	11908	23816	23816
49	26000		26000	26000	26000	2600	19500	26000	26000
50	26000	26000	26000	26000	26000		13000	26000	26000
51	26455		26455	24455	24455	24455	26190	26455	26455
52	31304	31304	31304	31304	31304	31304	1565	31304	
53	36504		36504	36504	36504	36504	25553	36504	36504
54	37440	37440	37440	37440	37440	37440	35568	37440	37440

TABLE X (continued)

Firm No.	Total (Cases)	Assembled (Cases)	Transferred (Cases)	Cleaned (Cases)	Candled (Cases)	Graded (Cases)	Cartoned (Cases)	Packed (Cases)	Delivered (Cases)
55	38480	38480	38480	38480	38480	38480	385	38480	38480
56	40872	8175	8175	8175	8175	8175	35967	40872	40872
57	41600	41600	41600	41600	41600	41600	14144	41600	41600
58	44356	44356	44356	44356	44356	44356	13307	44356	44356
59	44824	12532	44824	44824	44824	44824	26894	44824	44824
60	46800	48877	46800	46800	46800	46800	37440	46800	46800
61	49452	49452	49452	49452	49452	49452	37089	49452	49452
62	50076	50076	50076	50076	50076	50076		50076	
63	52000		52000	52000	52000	52000	50960	52000	52000
64	58344	55432	29172	29172	29172	29172	48426	58344	58344
65	69992	37024	69992	69992	69992	69992		69992	69992
66	72800		72800	1398	1398	1398	700	72800	72800
67	104000		104000	104000	104000	104000	10400	104000	104000
68	104000		104000	104000			98880	104000	104000
69	104208	104208					10421		104208
70	178100	178100	178100	178100	178100	178100	151385	178100	178100
71	200044		200044	200044	200044	200044	180040	200044	200044
72	216372	216372	216372	216372	216372	216372	129823	216372	216372
73	249600	187200	249600	249600	249600	249600	124800	249600	249600
74	256308	256308	256308	256308	256308	256308	76892	256308	256308
75	338000	338000	338000	338000	338000	338000	202800	338000	338000

APPENDIX D

TABLE XI

VARIOUS FACTORS ASSOCIATED WITH ASSEMBLING AND DELIVERING EGGS, 75 TENNESSEE HANDLING FIRMS, 1967

Firm number	Total	Source of supply			Grade A large or better	Cases assembled per source	Cases delivered per outlet
		Own flocks	Contract flocks	Independent producers	Wholesalers		
					Percent		
1	2434	2434			77		2434
2	2600			2600	75	2600	57
3	2792	2792			66		147
4	3536	3536			65		
5	4160	4160			61		39
6	4420	4420			76		68
7	4628	4628			78	4628	33
8	4680			4445	70		68
9	5200			52	40		116
10	5200	5200			66		
11	5304	5304			75		136
12	5304	5304			74		147
13	5460	5460			59		176
14	6032	6032			74		82
15	6032	3904	2128		70		355
16	6240			3744	40	468	208
17	6448	6396		52	63		21
18	6500			6396	80	104	433
19	7020	6084		936	85		433
20	7200	7200			60		180
21	7332			7185	65	147	244
22	7800			7566	66	234	144

TABLE XI (continued)

Firm number	Total	Source of supply			Grade A large or better Percent	Cases assembled per source	Cases delivered per outlet
		Own flocks	Contract flocks	Independent producers Cases			
23	8008	8008			75		4004
24	9256	9256			66		297
25	9308	8936		372	60		423
26	9360			9360	70		267
27	9880		9880		67		
28	10251	9886		365	69	2563	270
29	10400			7800	76	982	118
30	10660	10660			76		355
31	10920	10920			66	10920	214
32	11596	11388		208	68		308
33	13000			11700	58		245
34	13000			11700	60	6500	1182
35	13000			13000	70	2600	159
36	13832	13832			76	1589	432
37	14300	4090	10210		77		272
38	14508	14508			75		140
39	15184	12168			71	3016	249
40	16744	16744			71		797
41	17212	17212			61		
42	17628	17628			66		109
43	18460	17160			76	1300	348
44	19084	19084			76		130
45	19500	3900			79	15600	
46	19812	19812			70	382	171
47	20592	12792		7800	78		327
48	23816		23816		63		361
49	26000			24700	70	1300	228

TABLE XI (continued)

Firm number	Total	Source of supply			Grade A large or better Percent	Cases assembled per source	Cases delivered per outlet
		Own flocks	Contract flocks	Independent producers Cases			
50	26000			5200	20800	6500	267
51	26455	24455		2000			575
52	31304	31304				31304	
53	36504	36504					680
54	37440	16848	20592			4160	1702
55	38480	38480				38480	1480
56	40872	8175	32697			1635	449
57	41600	18378	23222			13867	621
58	44356	13307	31049			6337	1008
59	44824	32599	12225			6266	1358
60	46800	2941	37579	4680	1600	2175	210
61	49452	42172	7280			16484	697
62	50076	5044	45032			4552	
63	52000			49400	2600		413
64	58344	5824	40278	5824	6418	2639	417
65	69992	32968	37024			7777	34996
66	72800	1400			71400		4853
67	104000			98800	5200		1209
68	104000			104000			2667
69	104208			93788	10420		4962
70	178100	32500	145600			10421	682
71	200044			200044		44525	1198
72	216372	48308	168064			2847	666
73	249600	187200		62400		37440	768
74	256308	87145		169163		23301	997
75	338000			338000		5633	875

APPENDIX E

TABLE XII

FIXED COSTS PER CASE ASSOCIATED WITH ASSEMBLING, IN-PLANT HANDLING,
AND DELIVERING, 75 TENNESSEE EGG HANDLING FIRMS, 1967

Firm No.	Interest (Cents)	Building Depreciation (Cents)	Equipment Depreciation (Cents)	Truck Depreciation (Cents)	Insurance (Cents)	Taxes (Cents)	Management (Cents)	Total Fixed Costs (Cents)
1	26.50		24.65	13.89	.41	.41		65.86
2	8.39	5.42	3.00	3.62	5.19	4.81	75.00	105.42
3	18.55	5.73	13.97	7.63	1.11	1.22	67.05	115.26
4	5.32	2.83	4.95	3.53	.17	.34	76.47	93.61
5	8.90	2.40	9.38	4.52	1.25	.62	15.00	42.07
6	7.92	1.13	9.05	4.66	.27	.27	34.12	58.42
7	6.92	2.16	3.02	5.94	.78	.26	16.85	35.93
8	8.61		8.70	10.68	10.68	1.07	36.67	76.41
9	9.62	5.80	3.85	4.81	2.89	2.89	25.60	55.40
10	7.27	1.92	5.87	4.10	.23	.46	28.00	47.84
11	6.30	1.41	6.00	4.71	.28	.41	29.41	48.53
12	4.30	.47	3.86	4.72	.28	.11	13.73	27.47
13	19.69	9.16	10.07	13.74	.59	.29	85.71	139.25
14	13.59	3.32	11.42	10.36	2.22	.33	12.07	53.32
15	2.72	1.66	4.31	5.80	.40	.11		115.00
16	6.44	2.40	3.20	6.01	.16	1.84	96.15	116.18
17	8.86	2.33	5.30	9.69	.78	.73	112.90	140.59
18	2.26		1.43	3.85		.77	72.00	80.31
19	10.09	3.56	9.05	4.99	.68	.21	15.56	44.13
20	11.46		1.46	10.42	.47	.13	15.17	39.10
21	4.92		6.44	4.27	2.18	1.37	17.02	36.20
22	4.81	2.85	2.00	2.41	7.05	3.20	21.00	43.32

TABLE XII (continued)

Firm No.	Interest (Cents)	Building Depreciation (Cents)	Equipment Depreciation (Cents)	Truck Depreciation (Cents)	Insurance (Cents)	Taxes (Cents)	Management (Cents)	Total Fixed Costs (Cents)
23	5.20	1.56	2.29	6.24	.62	.11	27.27	43.30
24	8.89	1.08	1.24	4.05	.76	.54	33.71	50.27
25	12.88	5.91	10.72	4.03	1.56	.32		35.41
26	6.41	2.67	.53	5.34	.43	.53	11.11	27.03
27	1.90	.46	.86	2.53	.08	.05		5.88
28	7.30	2.44	7.27	3.66	.70	.54	91.31	113.21
29	4.81	.65	2.55	7.21	4.81	.35	37.50	57.88
30	2.49	.47	2.16	2.35	.14	.05	34.15	41.79
31	6.78	3.20	5.31	2.29	.69	.46	19.05	37.78
32	3.21	.65	2.54	3.23	.10	.10	18.83	28.66
33	6.10	1.92	2.39	7.41	.46	.58	36.00	54.85
34	5.77	1.92	1.62	7.60	.31	.38	12.00	29.60
35	17.31	4.23	20.77	6.73	.77	.58	40.50	90.89
36	7.48	1.09	8.82	4.25	.72	.27	43.99	66.62
37	1.13	.70	.13	.92	.06	.04		2.97
38	6.07	3.45	3.17	2.59	.17	.08	8.96	24.48
39	4.15	.83	3.36	4.12	.15	.08	10.28	22.95
40	4.50	.60	5.82	2.47	.13	.08	6.21	19.80
41	.61	.15	.93	2.54	.06	.03		4.32
42	3.94	1.42	3.35	1.56	.26	.06	3.36	13.94
43	2.71	.81	2.17	2.03	.59	.34	20.28	28.93
44	7.60	1.57	3.67	5.24	1.05	.08	5.45	24.66
45	4.00	.51	4.67	2.89	1.03	.85	30.00	43.94
46	4.57	.50	3.63	5.62	.63	.05	13.12	28.13
47	4.88	.49	5.63	3.46	.73	.18	5.30	20.66
48	4.64	1.07	5.46	2.10	1.55	.29	19.65	34.77
49	1.92	.58	2.39		2.31	1.92	24.00	33.11
50	2.55	6.23	2.02	3.85	2.08	.14	8.40	25.25

TABLE XII (continued)

Firm No.	Interest (Cents)	Building Depreciation (Cents)	Equipment Depreciation (Cents)	Truck Depreciation (Cents)	Insurance (Cents)	Taxes (Cents)	Management (Cents)	Total Fixed Costs (Cents)
51	6.38	.87	5.36	7.09	1.13	.64	7.86	29.34
52	14.69	11.26	2.72	3.07	.96	.40	21.26	54.36
53	4.55	.99	5.75	1.71	1.15	.17	4.28	18.59
54	6.08	1.34	4.67	6.01	.91	.60	15.00	34.61
55	4.00	1.40	3.39	2.27	.91	.16	2.43	14.56
56	3.98	2.50	1.76	1.53	.51	.37	17.18	27.82
57	10.06	4.81	6.66	4.81	1.74	.55	4.50	33.13
58	3.03	1.07	2.56	1.69	6.76	.09	3.52	18.72
59	4.47	1.01	4.26	3.35	.59	.22	3.25	17.15
60	4.28	2.20	2.46	2.14	1.07	1.07	13.34	26.55
61	5.32	1.21	5.18	3.79	.41	1.01	2.10	19.02
62	.85	.15	1.40		1.00	.20	6.23	9.83
63	5.19		5.00	1.92	2.10	.58	14.40	29.19
64	1.81		1.23	3.00	1.03	1.47	17.16	25.70
65	2.69	.50	2.96	1.79	1.71	.71	4.46	14.82
66	3.95	1.72	1.99	3.09	.41	.25	4.29	15.69
67	3.68	1.70	2.60	1.08	3.46	.48	16.00	29.00
68	1.56	.48	.96	.48		.05	4.00	7.13
69	3.84	2.58	.29	2.80	.48	.38	8.24	18.60
70	5.62	3.06	5.11		2.18	1.04	28.07	45.08
71	4.37	1.50	4.75	1.25	.95	.20	6.24	19.26
72	1.92		2.21	2.04	.14	.15	6.01	12.47
73	4.50	1.50	3.61	2.98	1.73		15.00	29.32
74	4.48	2.34	2.41	2.34	1.21	.78	6.82	20.38
75	3.47	1.78	2.63	.96	.71	.35	7.38	17.28

APPENDIX F

TABLE XIII

CASES HANDLED AND ASSOCIATED OPERATING COSTS PER CASE
FOR 75 TENNESSEE EGG HANDLING FIRMS, 1967

Firm No.	Volume (Cases)	Packaging (¢/Case)	Truck Operations (¢/Case)	Utilities (¢/Case)	Telephone (¢/Case)	Advertising (¢/Case)	Labor (¢/Case)	Misc. (¢/Case)	Total Operating Cost (¢/Case)
1	2434		10.27	2.47	.41		106.82	3.74	123.71
2	2600	60.00	68.00	3.46	1.38	9.23	116.00	3.69	261.77
3	2792	87189	11.93	3.98	.43		121.06	1.72	227.01
4	3536		2.94	2.72	.68		20.59	1.73	28.65
5	4160	26.37	11.25	5.77	2.89	.48	45.00	1.35	93.08
6	4420	4.07	12.35	2.72	1.36	.57	47.06	3.60	71.72
7	4628	20.16	6.31	2.60	.35		29.78	2.48	61.67
8	4680	16.83	16.11	10.26	2.57	2.57	99.23	13.04	160.60
9	5200	9.00	29.00	2.31	.58	1.23	25.19	4.39	71.69
10	5200		10.00	4.62	.17	.38	48.31	1.42	78.41
11	5304	86.60	24.51	.68	1.02	1.89	102.94	5.17	222.80
12	5304	79.51	18.44	1.81	1.70		102.21	1.81	205.47
13	5460	69.01	28.57	2.20	1.65	.92	53.57	3.68	159.60
14	6032	42.19	22.07	2.59	1.79	1.66	135.26	3.96	209.52
15	6032	34.58	13.36	2.39	.75		72.41	3.28	126.77
16	6240	93.00	12.87	1.92	2.12		63.17	.58	173.66
17	6448	90.79	44.78	1.94	2.09		50.81	11.38	201.78
18	6500	54.77	23.20	5.54	4.62		44.80	31.29	164.22
19	7020	96.91	35.64	2.57	2.57	2.85	77.78	9.19	227.49
20	7200	80.29	2.82	3.33	.33		85.22	22.00	194.00
21	7332	77.05	21.85	2.45	4.09		45.39	18.86	169.70
22	7800	80.57	13.50	7.69	.46	.26	114.81	12.83	230.12

TABLE XIII (continued)

Firm No.	Volume (Cases)	Packaging (¢/Case)	Truck Operations (¢/Case)	Utilities (¢/Case)	Telephone (¢/Case)	Advertising (¢/Case)	Labor (¢/Case)	Misc. (¢/Case)	Total Operating Cost (¢/Case)
23	8008	.31	16.23	2.25	1.69	1.87	33.77	5.24	61.36
24	9256	65.61	17.46	4.21	1.17	1.08	92.70	6.68	188.90
25	9308	80.43	21.51	2.09	1.45	4.03	94.97	2.15	206.63
26	9360	10.68	6.67	2.14	.64	.53	83.33	4.49	108.48
27	9880		1.32	.61	.12		7.37	.30	9.72
28	10251	82.50	15.78	1.45	.26		74.06	1.65	175.71
29	10400	17.60	49.00	4.61	1.73		73.00	9.50	155.43
30	10660	90.30	7.81	2.63	.42		46.83	2.48	150.46
31	10920	10.06	15.24	2.31	1.03	.46	69.05	1.84	99.97
32	11596	82.94	19.06	1.73	1.40		90.14	2.06	197.32
33	13000		31.39	2.31	1.54		48.00	9.38	92.62
34	13000	105.23	21.60	1.01	.92	.04	49.92	4.27	183.00
35	13000	82.06	13.12	2.58	2.31	.14	116.10	14.23	230.41
36	13832	81.99	9.40	1.74	.78		29.48	5.17	128.69
37	14300	1.05	6.55	.84	.32		16.91	1.46	27.11
38	14508	28.03	5.38	2.03	.33		39.79	2.55	78.10
39	15184	88.64	5.48	2.37	.71		44.52	1.98	143.70
40	16744	20.70	4.50	1.76	.36	.30	33.00	3.45	63.37
41	17212	.23	1.16	1.81	.07		12.69	.38	16.35
42	17628	75.79	8.85	1.63	.11	.11	64.90	1.27	152.66
43	18460	81.62	8.40	2.46	1.76	.71	66.06	5.43	166.44
44	19084	15.72	5.81	3.02	1.18	.79	39.01	2.87	68.38
45	19500	98.76	20.00	4.31	1.27	.77	56.07	5.60	187.78
46	19812	79.70	19.74	1.76	.30		47.24	3.28	152.03
47	20592	84.44	20.20	2.91	1.75	.97	50.06	6.02	166.35
48	23816	61.79	13.10	1.51	.50	2.94	97.38	5.81	183.05
49	26000	66.07	30.00	3.46	.46	.38	69.28	5.89	175.55
50	26000	46.92	42.00	1.11	.97	.08	58.24	4.00	153.32

TABLE XIII (continued)

Firm No.	Truck			Utilities (¢/Case)	Telephone (¢/Case)	Adver- tising (¢/Case)	Labor (¢/Case)	Misc. (¢/Case)	Total Operating Cost (¢/Case)
	Volume (Cases)	Packaging (¢/Case)	Operations (¢/Case)						
51	26455	83.97	21.95	3.16	2.84	3.11	53.56	5.28	173.87
52	31304	41.27	6.65	1.61	4.60	1.69	61.70	2.36	119.86
53	36504	82.80	6.62	1.58	.59	.14	32.37	4.92	129.03
54	37440	25.75	32.64	4.49	1.44	1.87	146.94	9.29	222.43
55	38480	1.16	8.16	1.36	.70		35.68	1.20	48.26
56	40872	75.34	11.45	1.76	1.03	.18	42.04	3.91	135.70
57	41600	39.35	20.50	2.42	2.60	.36	72.31	6.73	144.28
58	44356	34.00	15.42	2.71	.27	2.25	62.48	4.40	121.53
59	44824	76.31	11.90	8.03	.53		44.09	3.93	144.79
60	46800	90.97	10.28	4.61	3.33	.11	77.22	6.08	192.60
61	49452	73.57	16.04	1.94	.24		48.90	3.91	145.59
62	50076	17.97	30.98	.60	.24	.06	31.82	3.95	85.63
63	52000	103.97	9.62	4.62	4.05	1.47	117.00	9.35	250.07
64	58344	79.42	12.21	.98	1.16	.86	82.53	7.09	184.25
65	69992	20.00	10.01	1.29	.17	.03	32.24	3.69	67.43
66	72800	68.87	6.29	2.14	.41		12.05	1.94	91.70
67	104000	82.96	9.00	1.73	2.31		35.20	3.81	135.01
68	104000	85.50	2.92	.58	.11	.11	47.60	3.12	139.94
69	104208	10.00	10.33	1.61	1.55	.19	26.72	.49	50.90
70	178100	66.81	16.27	1.30	1.72	3.88	76.56	4.25	170.79
71	200044	105.99	6.92	1.80	3.00	.20	37.48	3.96	159.35
72	216372	82.85	23.24	2.77	.16	.05	58.23	7.91	175.20
73	249600	66.50	21.25	2.60	1.11	2.40	48.38	5.57	147.80
74	256308	76.60	16.43	1.13	1.08	2.46	37.92	3.09	38.70
75	338000	53.00	27.46	1.60	.71	3.55	40.03	3.20	29.55

APPENDIX G

TABLE XIV

COST OF ASSEMBLING, IN-PLANT HANDLING, AND DELIVERING,
75 TENNESSEE EGG HANDLING FIRMS, 1967

Firm No.	Assembly Cost Per Dozen	In-Plant Handling Cost Per Dozen	Delivery Cost Per Dozen	Total Handling Cost Per Dozen	Type of Organization
			Cents		
1		4.95	1.37	6.32	P
2	.86	7.19	4.19	12.24	D
3		8.52	2.89	11.41	P
4		4.08		4.08	P
5		3.48	1.03	4.51	P
6		3.34	1.00	4.34	P
7	.35	2.13	.77	3.25	P
8		5.87	2.03	7.90	D
9		2.54	1.69	4.24	D
10		3.76		3.76	P
11		6.11	2.93	9.04	P
12		5.15	2.61	7.76	P
13		6.64	3.32	9.96	P
14		5.76	1.56	4.72	P
15	1.42	3.53	1.20	8.76	P-C
16	1.60	5.44	2.70	9.66	D
17		5.83	5.60	11.41	P
18		6.13	2.02	8.15	D
19		6.95	2.10	9.05	P
20		5.96	1.81	7.77	P
21		4.66	2.20	6.86	D
22		7.86	1.25	9.11	D
23		1.83	1.66	3.49	P
24		5.92	2.05	7.97	P
25		5.73	2.34	8.07	P
26		2.78	1.73	4.51	D
27		.52		.52	P
28	4.10	5.23	3.29	9.63	P
29	1.29	3.99	1.87	7.11	D
30		4.93	1.48	6.41	P

TABLE XIV (continued)

Firm No.	Assembly Cost Per Dozen	In-Plant Handling Cost Per Dozen	Delivery Cost Per Dozen	Total Handling Cost Per Dozen	Type of Organization
----- Cents -----					
31	.81	2.97	.81	4.59	P
32		5.31	2.22	7.53	P
33	.83	5.33	.83	7.09	D
34		2.29	2.63	4.92	D
35	.39	8.96	1.35	10.71	D
36	.33	5.12	1.39	6.51	D
37		.76	.56	1.00	P
38		1.90	1.72	3.42	D-P-C
39		4.72	.83	5.55	P
40		2.32	.45	2.77	P
41		.69		.69	P
42		4.77	.78	5.55	P
43		5.41	1.10	6.51	P
44		2.10	1.00	3.10	P
45		6.33	1.39	7.72	D
46		4.45	1.55	6.00	P
47		4.97	1.26	6.23	P
48		5.79	1.47	7.26	D-C
49		5.11	1.85	6.96	D
50	.72	4.78	1.45	5.95	D
51		5.44	1.33	6.77	P
52	.63	5.18		5.81	P
53		4.29	.63	4.92	P
54	.66	4.46	3.44	8.57	P-C
55	.42	1.45	.22	2.09	P
56	1.01	3.76	.76	5.45	P-C
57	.87	4.08	.96	5.91	P-C
58	.35	3.44	.88	4.67	D-C-P
59	.53	4.13	.73	5.40	P-C
60	.56	6.23	.52	7.30	D-C-P
61	.35	3.54	.35	5.49	P-C
62	1.00	2.18		3.18	P-C
63		7.42	1.88	9.31	D
64	.63	5.68	.68	7.00	P-C
65	.50	1.96	.28	2.74	P-C
66		3.05	.53	3.58	D
67		4.81	.30	4.90	D
68		4.80	.66	5.46	D
69	.47	1.34	.60	2.31	D
70	.43	6.01	.76	7.20	D-C-P

TABLE XIV (continued)

Firm No.	Assembly Cost Per Dozen	In-Plant Handling Cost Per Dozen	Delivery Cost Per Dozen	Total Handling Cost Per Dozen	Type of Organization
	Cents				
71		5.24	.71	5.95	D
72	.52	4.40	1.33	6.26	P-C
73	.38	4.20	1.32	5.90	D-P
74	.59	4.16	.55	5.30	D-C-P
75	.51	3.64	.74	4.89	D-C

P = producer D = dealer, C = contractor

APPENDIX H

TABLE XV

RATED CAPACITY OF IN-PLANT EGG HANDLING EQUIPMENT, AVERAGE OUTPUT
ACTUALLY ACHIEVED AND PERCENTAGE OF PLANT CAPACITY UTILIZED,
75 TENNESSEE EGG HANDLING FIRMS, 1967

Firm No.	Rated Capacity Cases/Hour	Average Output Cases/Hour	Percent Plant Capacity Utilized
1	10.0	3.3	33.3
2	5.0	3.3	66.6
3	6.0	2.4	40.7
4	10.0	2.6	26.0
5	10.0	4.4	44.0
6	20.0	8.5	42.5
7	6.0	5.9	98.8
8	7.0	3.3	47.6
9	7.0	6.3	82.9
10	15.0	7.1	47.6
11	20.0	8.5	42.5
12	15.0	6.4	42.5
13	15.0	7.0	46.7
14	7.0	5.3	75.3
15	10.0	8.3	82.9
16	18.0	6.0	33.3
17	22.0	8.7	31.3
18	15.0	6.3	41.7
19	12.0	5.4	45.0
20	20.0	6.9	34.6
21	18.0	5.9	32.6
22	8.0	7.5	93.8
23	6.0	5.9	98.7
24	10.0	3.9	39.0
25	20.0	9.9	99.7
26	6.0	6.0	100.0
27	30.0	13.6	45.2
28	12.0	5.5	45.6
29	15.0	12.5	83.3
30	15.0	7.3	48.8

TABLE XV (continued)

Firm No.	Rated Capacity Cases/Hour	Average Output Cases/Hour	Percent Plant Capacity Utilized
31	10.0	4.4	44.0
32	14.0	6.4	45.5
33	10.0	6.3	63.0
34	20.0	12.5	62.5
35	32.0	16.7	50.1
36	36.0	19.0	73.1
37	20.0	19.6	98.2
38	12.0	11.2	93.0
39	15.0	13.9	92.7
40	20.0	15.3	76.7
41	8.0	7.9	98.5
42	12.0	8.5	70.7
43	18.0	8.9	49.3
44	20.0	17.5	87.4
45	20.0	10.4	52.1
46	18.0	15.2	84.7
47	20.0	14.1	70.7
48	18.0	15.3	84.8
49	20.0	12.5	62.5
50	10.0	16.7	167.0
51	21.0	18.2	86.5
52	20.0	13.1	65.5
53	35.0	29.3	83.6
54	22.0	16.0	72.7
55	27.0	25.0	91.4
56	18.0	19.7	109.2
57	33.0	22.9	69.3
58	25.0	21.3	85.3
59	35.0	25.4	72.4
60	30.0	22.5	75.0
61	40.0	27.2	67.9
62	32.0	30.1	94.0
63	30.0	25.0	83.3
64	30.0	26.7	89.0
65	35.0	33.7	96.1
66	50.0	50.0	100.0
67	60.0	50.0	83.3
68	60.0	50.0	83.3
69	50.0	44.5	89.1
70	72.0	56.2	78.0

TABLE XV (continued)

Firm No.	Rated Capacity Cases/Hour	Average Output Cases/Hour	Percent Plant Capacity Utilized
71	60.0	48.1	80.2
72	76.0	52.0	68.4
73	60.0	53.3	88.9
74	72.0	59.0	81.5
75	90.0	81.3	90.3

APPENDIX I

TABLE XVI

COST OF INPUTS USED FOR ASSEMBLING, IN-PLANT HANDLING, AND DELIVERING,
75 TENNESSEE EGG HANDLING FIRMS, 1967

Firm No.	Investment in Plant and Equipment		Investment in Capital* Cost		Investment in Plant and Equipment		Labor Wage		Management Wage		Cost of Cartons
	(Dollars)	(Dollars)	Per Case Handled in 1967 (Cents)	Per Dollar Invested (Cents)	(Dollars)	(Dollars)	Per Hour (Dollars)	Per Hour (Dollars)	(Dollars)	Cents/each	
1	10,200	4.190	58.59	13.98	12,900	1.56	2.00	2.00	2.00	3.00	
2	3,602	1.395	35.33	25.33	4,352	1.81	2.50	2.50	2.50	3.00	
3	7,850	2.811	46.71	16.62	10,350	1.00	2.00	2.00	2.00	2.99	
4	2,750	.777	8.74	24.12	3,750	1.00	2.00	2.00	2.00	3.00	
5	5,900	1.418	32.56	21.99	7,400	1.00	2.00	2.00	2.00	3.00	
6	5,000	1.131	27.32	24.16	7,000	2.00	3.00	3.00	3.00	2.99	
7	3,400	.734	18.57	25.30	6,400	1.00	3.00	3.00	3.00	2.99	
8	4,065	.868	54.93	63.28	8,065	1.42	3.00	3.00	3.00	2.61	
9	8,000	1.538	32.27	20.39	10,000	1.40	1.60	1.60	1.60	3.00	
10	5,050	.971	21.95	22.61	7,550	1.15	2.00	2.00	2.00	2.95	
11	4,675	.881	21.39	24.28	6,675	1.88	2.22	2.22	2.22	2.77	
12	2,550	.480	14.35	29.90	4,550	1.12	2.00	2.00	2.00	2.99	
13	4,600	.824	47.61	57.79	21,500	1.25	2.00	2.00	2.00	2.90	
14	10,890	1.805	38.55	21.36	16,390	1.23	2.00	2.00	2.00	3.10	
15	4,600	.762	12.92	16.96	8,200	1.71	3.00	3.00	3.00	3.10	
16	5,000	.801	29.44	36.75	8,000	1.90	2.88	2.88	2.88	2.90	
17	6,420	.995	53.32	53.59	11,420	1.75	2.00	2.00	2.00	3.00	
18	830	.127	23.81	187.43	2,830	1.40	2.00	2.00	2.00	3.00	
19	11,350	1.616	50.72	31.39	14,150	1.06	3.00	3.00	3.00	3.35	
20	10,500	1,458	36.03	24.71	16,500	1.48	3.00	3.00	3.00	2.99	
21	4,720	.643	34.28	53.31	7,220	1.00	2.00	2.00	2.00	3.00	
22	6,000	.769	34.30	44.60	7,500	1.59	2.25	2.25	2.25	3.33	

TABLE XVI (continued)

Firm. No.	Investment in Plant and Equipment (Dollars)	Investment in Plant and Equipment per Case Handled in 1967 (Dollars)	Capital* Cost Per Case Handled in 1967 (Cents)	Capital Cost in 1967 Per Dollar Invested (Cents)	Investment in Plant Equipment and Trucks (Dollars)	Labor Wage Per Hour (Dollars)	Management Wage Per Hour (Dollars)	Cost of Cartons Cents/each
23	4,325	.540	20.41	37.80	8,325	1.00	3.00	
24	13,450	1.453	20.04	13.79	16,450	1.50	2.00	3.00
25	20,975	2.253	39.41	17.49	23,975	1.52	2.00	2.65
26	8,000	.854	13.66	16.00	12,000	1.67	2.00	
27	1,750	.177	5.73	32.37	3,750	1.00	1.90	
28	12,450	1.214	29.45	24.26	14,950	1.33	3.00	2.75
29	4,000	.384	21.99	57.27	10,000	1.34	3.00	2.25
30	3,300	.309	10.18	32.94	5,300	1.00	2.00	3.00
31	9,800	.897	21.84	24.35	14,800	1.51	2.00	3.00
32	4,440	.382	19.11	50.03	7,440	1.47	3.00	2.65
33	8,150	.626	19.56	31.25	15,850	1.33	3.00	
34	7,100	.546	26.16	47.91	15,000	1.60	3.00	4.00
35	38,000	2.923	53.72	18.38	45,000	1.57	2.25	2.65
36	15,200	1.098	22.36	20.36	20,700	1.40	3.00	2.66
37	2,200	.153	5.76	37.65	3,250	1.50	3.00	
38	14,600	1.006	17.84	17.73	17,600	1.48	2.00	3.00
39	7,600	.500	13.61	27.22	12,600	1.31	3.00	3.00
40	11,750	.701	16.93	24.08	15,050	1.03	2.00	3.00
41	2,100	.122	4.04	33.11	2,100	1.00	1.00	
42	10,900	.618	12.03	19.47	13,900	1.10	2.28	2.50
43	7,000	.379	16.23	42.83	10,000	1.40	3.00	2.93
44	13,000	.681	21.03	30.88	29,000	1.20	2.00	
45	11,100	.569	22.23	39.07	15,600	1.10	2.50	2.95
46	9,200	.464	14.73	31.75	18,100	1.29	2.00	2.90
47	13,585	.659	22.58	34.26	20,085	1.12	3.00	3.00
48	18,100	.759	20.84	27.46	22,100	1.54	2.00	3.00
49	9,200	.353	18.92	53.60	9,200	1.56	3.00	2.52

TABLE XVI (continued)

Firm No.	Investment in Plant and Equipment (Dollars)	Investment in Plant and Equipment per Case Handled in 1967 (Dollars)	Capital Cost Per Case Handled in 1967 (Cents)	Capital Cost in 1967 Per Dollar Invested (Cents)	Investment in Plant and Trucks (Dollars)	Labor Wage Per Hour (Dollars)	Management Wage Per Hour (Dollars)	Cost of Cartons Cents/each
50	5,235	.201	19.08	94.93	13,235	1.44	3.00	3.00
51	18,785	.710	25.67	36.15	33,785	1.22	2.00	2.70
52	80,000	2.555	38.60	15.11	92,000	1.32	2.00	2.92
53	28,200	.772	19.69	25.51	33,200	1.27	3.00	3.00
54	27,500	.734	28.82	39.26	45,500	1.86	3.00	.87
55	23,800	.618	13.12	21.23	30,800	1.15	3.00	3.00
56	27,570	.674	15.81	23.46	32,570	1.37	3.00	2.49
57	67,700	1.627	35.57	21.86	83,700	1.87	3.00	3.00
58	20,850	.470	20.89	44.45	26,850	1.42	3.00	3.00
59	28,100	.626	23.04	36.81	40,100	1.30	2.00	3.00
60	32,100	.685	25.09	36.63	40,100	1.65	3.00	2.90
61	37,600	.760	19.22	25.29	62,600	1.22	2.00	3.00
62	8,500	.169	8.39	49.64	8,500	1.17	3.00	
63	46,000	.884	30.89	34.94	54,000	1.55	3.00	3.00
64	7,160	.122	14.77	121.07	21,160	1.45	3.85	2.63
65	27,700	.395	13.72	34.73	37,700	1.33	3.00	
66	39,500	.542	12.80	23.62	57,500	2.25	3.00	2.85
67	57,464	.648	19.77	30.51	76,464	1.60	4.00	2.63
68	20,000	.192	6.46	33.65	24,000	1.40	2.00	2.85
69	56,700	.544	11.21	20.61	80,000	1.70	5.00	3.00
70	200,000	1.122	23.28	20.75	200,000	1.78	7.88	2.62
71	155,000	.744	20.53	25.59	175,000	1.72	3.00	3.00
72	47,800	.220	15.26	69.36	83,160	2.21	3.50	2.60
73	165,000	.661	20.62	31.20	224,500	1.39	4.00	3.10
74	181,700	.708	16.52	23.33	229,700	1.53	4.00	2.60
75	208,700	.617	14.45	29.55	234,700	1.68	4.00	2.50

APPENDIX J

TABLE XVII

LABOR EFFICIENCY IN ASSEMBLING, IN-PLANT HANDLING, AND DELIVERING EGGS,
75 TENNESSEE EGG HANDLING FIRMS, 1967

Firm No.	Assembling (Cases/hr.)	Transferring (Cases/hr.)	Candling (Cases/hr.)	Cartoning (Cases/hr.)	Packing (Cases/hr.)	Delivering (Cases/hr.)
1		6.69	6.68		3.34	1.17
2	1.25			2.08	3.33	2.50
3		4.88	4.87	2.44	2.55	2.98
4		9.71	9.70		2.62	
5		10.00	9.99	5.00	5.00	6.66
6		17.00	16.99	17.00	8.50	19.50
7	26.67	53.33	26.67	26.67	53.33	7.62
8		6.66	6.65	3.00	8.18	3.64
9		2.00	1.99	2.00	6.25	8.33
10		14.28	14.27		3.57	
11		17.00	16.99	8.08	8.50	5.10
12		12.76	12.75	5.75	6.38	2.27
13		14.00	13.99	4.55	7.00	3.50
14	3.74	5.27	5.26	3.48	5.27	9.67
15		8.29		4.60	8.29	7.25
16		16.00	15.99	7.60	12.00	4.29
17	7.20	20.66	20.65	10.23	10.23	1.77
18		12.50	12.49	3.75	8.33	4.17
19		10.80	10.79	5.12	5.40	5.63
20		12.04	12.03	5.88	7.69	7.29
21		17.62	17.61	6.33	8.81	3.53
22		7.50	7.49	6.00	7.50	6.52
23		5.92			8.29	7.25
24		8.90	8.89	4.27	3.96	5.33

TABLE XVII (continued)

Firm No.	Assembling (Cases/hr.)	Transferring (Cases/hr.)	Candling (Cases/hr.)	Cartoning (Cases/hr.)	Packing (Cases/hr.)	Delivering (Cases/hr.)
25		9.94	9.93	9.83	9.94	4.48
26					6.00	4.00
27					13.57	
28	98.50	10.94	10.93	5.39	5.47	3.72
29	11.33	12.50	12.49	5.00	12.50	6.25
30		14.64	14.63	4.89	7.32	5.86
31	10.50	8.94	8.93	2.10	4.38	10.50
32		12.74	12.73	6.06	6.37	6.84
33	20.83			10.00	12.50	15.63
34						3.13
35	16.66			13.33		6.20
36		19.00	18.99	9.39	19.00	10.64
37	39.28				22.92	11.00
38		11.16	11.15	3.35	11.16	5.60
39		27.80	27.79	13.62	13.90	9.13
40		15.33	15.32	5.37	8.94	18.94
41					7.88	
42		8.48	8.47	8.05	8.48	8.48
43		17.75	17.74	8.88	8.88	7.03
44		17.48	17.47		8.74	7.71
45		10.42	10.41	10.42	10.42	7.50
46		15.24	15.23	12.19	15.24	9.53
47		14.14	8.79	7.47	14.14	5.46
48		15.27	15.26	3.92	15.27	6.11
49		12.50	12.49	12.50	12.50	6.25
50	16.67	16.67	16.66	8.33	16.67	13.16
51		18.18	18.17	9.00	12.12	10.18

TABLE XVII (continued)

Firm No.	Assembling (Cases/hr.)	Transferring (Cases/hr.)	Candling (Cases/hr.)	Cartoning (Cases/hr.)	Packing (Cases/hr.)	Delivering (Cases/hr.)
51		18.18	18.17	9.00	12.12	10.18
52	10.95	17.20	17.19	5.00	5.79	
53		29.25	29.24	6.83	29.25	16.06
54	16.00	16.00	15.99	5.33	16.00	3.20
55	26.43	24.67	24.66	5.70	8.41	61.67
56	8.72	14.27	14.26	17.30	9.83	10.92
57	17.78	22.86	22.85	3.89	12.31	13.33
58	21.33	21.33	21.32	6.40	14.22	10.66
59	30.13	25.35	25.34	25.25	8.45	21.55
60	18.00	22.50	22.49	18.00	11.25	18.00
61	21.13	27.17	27.16	6.97	27.17	10.57
62	9.20	30.09	30.08		10.14	
63		55.00	12.50	24.50	8.33	3.33
64	11.84	26.71	6.68	11.09	6.68	12.47
65	17.80	33.65	33.64		8.41	33.65
66		13.50	13.49	4.50	50.00	35.00
67		50.00	25.00	23.75	25.00	16.67
68		50.00	4.17	4.17	25.00	25.00
69	22.27			4.45	4.45	14.84
70	31.71	28.07	14.04	49.34	14.04	11.73
71		48.09	24.04	43.28	32.06	13.74
72	34.68	52.01	52.00	52.01	14.86	17.34
73	26.67	53.33	26.67	26.67	53.33	7.62
74	19.56	58.68	58.67	58.68	19.56	19.56
75	24.07	40.63	27.08	90.00	11.60	14.44

VITA

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