# EFFICIENT ORGANIZATION OF THE LIVESTOCK-MEAT MARKETING SYSTEM IN EASTERN MACEDONIA, GREECE

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Vernon L. Sorenson
Major professor

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ABSTRACT

EFFICIENT ORGANIZATION OF THE LIVESTOCK-MEAT MARKETING SYSTEM IN EASTERN MACEDONIA, GREECE

By

Christos Theocharis Kamenidis

The significant rise in per capita income of the Greek people coupled with remarkable growth of foreign tourism in Greece has led to a substantial increase of total meat consumption in the country. In order to reduce meat imports, and therefore the foreign exchange outflow, the Government has taken a series of measures, such as higher output prices and input subsidies, more credit to producers with very low interest rates, etc. As a result of this policy, some larger producers have entered the livestock industry while most of the existing livestock producers have expanded their operations. Thus, livestock production is expected to increase appreciably by 1980.

On the other hand, existing slaughterhouses are relatively many, small and technologically out of date. Their buildings are generally old and poorly equipped. They still employ crude methods of livestock slaughtering. They do not process livestock by-products because their small volumes make it unprofitable.

The aforementioned factors may necessitate the establishment of new slaughter plants and systems. If new investment occurs, then

the main questions which might be raised include: What should be the optimum number, size, and location of new slaughter plants in E. Macedonia, so that the aggregate cost of livestock assembly, processing and meat distribution be minimized and thus the efficiency of the livestock-meat marketing system be improved?

To undertake the empirical analysis, a linear programming transhipment model was employed. The computer program used was the APEX-I.

The basic data needed for this computer analysis were: (1) Regional livestock supplies; (2) Regional meat consumption; (3) Livestock assembly cost per unit of product between all the supply regions and all the plant locations; (4) Livestock slaughtering unit cost by plant sizes and by levels of capacity utilization; and (5) Meat distribution cost per unit of product between all the plant locations and all the consumption centers.

Six alternative solution models were constructed and tested in order to find out what might be the impact of changing the corresponding variable--characterizing each model--upon the optimal solution of the basic model. The characteristics of the basic model are: (1) 1972 livestock supplies; (2) 50 percent capacity utilization of trucks engaged in livestock assembly; (3) full capacity utilization of slaughtering plants; (4) use of modern technology in livestock slaughtering; and (5) 20 supply regions, 21 consumption centers and 10 potential plant sites. Model II differs from the basic one in assuming full capacity utilization of the trucks engaged in livestock assembly. Model III assumes 14 supply regions, 15 consumption regions and 8 potential

plant sites. Model IV assumes 1980 livestock supplies; Model V assumes 90 percent plant capacity utilization; and Model VI assumes continuation of the currently existing livestock slaughtering system.

The empirical analysis has shown that whenever a modern livestock slaughtering system was assumed--as is the case in all models except model VI--the optimum solution ended up with either two plants (models: Basic, II, III and optimal solution of model IV) or three plants (second optimal solution of model IV and optimal solution of model V). When the optimum number of plants is two, then the optimum plant locations are either Serres and Kavala (when 1972 livestock supplies are assumed) or Serres and Drama (when 1980 supplies are assumed). When the optimum number of plants is three, then the optimum plant locations are Serres, Kavala and Drama.

The major questions which arise next are: (1) Should new slaughtering plants using modern technologies by established in E. Macedonia, Greece, or should the current system continue? (2) If modern slaughtering technology is to be introduced, should two or three plants be built? The trade-offs (advantages and disadvantages) of the alternative solutions will determine which course of action should be adopted.

If two or three new slaughtering plants using a modern technology were established, then some probable advantages over the old system of 21 slaughterhouses would be: (1) concentration of larger amounts of livestock by-products at the plant locations, which in turn may make their processing profitable; (2) increased efficiency of the livestock-meat marketing system; (3) improvement in meat quality;

(4) economies of size in the veterinary inspection of slaughtered animals. Some probable disadvantages of the proposed new slaughtering system over the existing one would be: (1) reduction in the employment of slaughterers as a result of substitution of capital for labor; (2) loss of revenues for the communities whose slaughterhouses will be closed; (3) problems of disposing larger amounts of waste.

If three plants (i.e., one in each province of E. Macedonia) were established rather than two, a more equitable pattern of regional economic development would result. However, a system of three plants would have a higher total cost than one of two plants, given the same total output and input price structure.

Given these benefits and costs for all the alternative solutions, it is the task of policy makers to make the final decision.

# EFFICIENT ORGANIZATION OF THE LIVESTOCK-MEAT MARKETING SYSTEM IN EASTERN MACEDONIA, GREECE

By

Christos Theocharis Kamenidis

A DISSERTATION

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This doctoral dissertation is dedicated
to my parents, Theocharis and Irene
and to my wife, Katherine.

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# RESEARCH OBJECTIVES AND BACKGROUND ECONOMIC INFORMATION

## Introduction

Greece has accomplished a notably rapid economic growth and development over the period of 1958 to 1972. Gross National Product (GNP) at constant (1958) prices--used here as a measure of economic growth--has increased from 94.8 billion drachmae[1] in 1958 to 262.1 billion drachmae in 1972 (Table I-1). This GNP rise reflects an annual growth rate of real output by about eight percent on the average.

The remarkable expansion in GNP coupled with a very low population growth--less than 0.5 percent annually on the average (Table I-1)--has contributed to a substantial increase in per capita income of Greeks. From 329 dollars in 1958 (current prices), per capita income of Greeks--measured here in terms of Net National Income (NNI)--has increased to 1,129 dollars in 1972 (Table I-1). This income does not differ much from that in constant prices, since inflation--measured in terms of Consumer Price Index (CPI)--was insignificant. For the entire period of 1958-1972 it has averaged at a level of approximately 2.5 percent annually (Table I-1).

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[1]Thirty Greek drachmae equal to 1 USA dollar.

Table I-1. Population, GNP, CPI, per capita income, foreign tourism, imports-exports and balance of trade, Greece, 1958-1972

| YEAR | POPULATION ('000 PEOPLE) | POPULATION % GROWTH | GNP IN BILLION DRACHMAE (1958 PRICES) | PER CAPITA INCOME (NNI) IN DOLLARS (CURRENT PRICES) | CONSUMER PRICE INDEX (CPI) GENERAL (JUNE 1958=100) | FOREIGN TOURISM ('000 VISITORS) | IMPORTS | EXPORTS | BALANCE OF TRADE |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BILLION DRACHMAE | | |
| 1958 | 8,173 | 0.95 | 94.8 | 329 | 100.0 | 277 | 16.9 | 6.9 | - 10.0 |
| 1959 | 8,258 | 1.04 | 98.4 | 337 | 100.7 | 340 | 17.0 | 6.1 | - 10.9 |
| 1960 | 8,327 | 0.84 | 102.9 | 357 | 102.3 | 399 | 21.1 | 6.1 | - 15.0 |
| 1961 | 8,398 | 0.85 | 114.4 | 401 | 104.1 | 494 | 21.4 | 6.7 | - 14.7 |
| 1962 | 8,448 | 0.60 | 118.6 | 420 | 103.8 | 598 | 21.0 | 7.5 | - 13.5 |
| 1963 | 8,480 | 0.37 | 128.0 | 462 | 106.9 | 741 | 24.1 | 8.7 | - 15.4 |
| 1964 | 8,510 | 0.36 | 139.9 | 514 | 107.8 | 757 | 26.6 | 9.3 | - 17.3 |
| 1965 | 8,550 | 0.47 | 152.1 | 576 | 111.0 | 976 | 34.0 | 9.8 | - 24.2 |
| 1966 | 8,614 | 0.74 | 162.3 | 625 | 116.6 | 1,132 | 36.7 | 12.2 | - 24.5 |
| 1967 | 8,716 | 1.19 | 173.3 | 667 | 118.6 | 996 | 35.6 | 14.9 | - 20.7 |
| 1968 | 8,741 | 0.28 | 185.6 | 715 | 119.0 | 1,018 | 41.8 | 14.0 | - 27.8 |
| 1969 | 8,773 | 0.36 | 202.6 | 796 | 121.9 | 1,306 | 47.8 | 16.6 | - 31.2 |
| 1970 | 8,793 | 0.23 | 219.5 | 882 | 125.8 | 1,609 | 58.8 | 19.3 | - 39.5 |
| 1971 | 8,852 | 0.67 | 237.7 | 990 | 129.8 | 2,258 | 62.9 | 19.0 | - 43.0 |
| 1972 | 8,950 | 0.53 | 262.1 | 1,129 | 135.5 | 2,732 | 70.4 | 26.1 | - 44.3 |

SOURCES: (1) For population, CPI, foreign tourism and imports-exports-balance of trade the source is: National Statistical Service of Greece, Statistical Yearbook of Greece 1972, Athens, Greece 1973, pp. 25, 342, 297 and 245 respectively.

(2) For GNP and per capita income the source is: Ministry of Planning and Governmental Policy, Provisional National Accounts of Greece 1972, Athens, Greece, March 1973, pp. 52-53 and 15-16.

The substantial increase in per capita income of Greeks was the main factor for the significant increase in their per capita meat consumption. From 21 kilograms in 1958, it increased to 52.4 kilograms in 1972 (Table I-2), an annual average increase of about seven percent. The relatively slow rise in retail meat prices from their especially low levels at the beginning of the study period is another significant factor for the rise in meat consumption. Urbanization, improved transportation and communication systems and more widespread education at a secondary and university school levels also have had an appreciable impact upon the increase in per capita meat consumption of Greeks.

Concurrently with the increase in per capita meat consumption, there has been a change in the food basket (Table I-2). Beginning in the 1970's Greeks have been substituting beef for lamb. Thus, while in 1958 lamb (including mutton and goat meat) represented more than half of per capita total meat consumption, by 1962 it represented less than one-third of it. Over the same period, consumption of beef increased by 266 percent, poultry by 331 percent, pork by 183 percent and lamb by only 55 percent.

The substantial increase in per capita meat consumption of Greeks along with the sizable growth of foreign tourism--from 277 thousands in 1958 to 2.7 million in 1972 (Table I-1)--gave a significant boost to the total meat consumption in the country, From 173 thousand tons[2] in 1958, it increased to 466 thousand tons in 1972 (Table I-2), an aggregate increase of more than one and a half times over the period.

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[2]By "tons" is meant "metric tons" throughout this analysis.

Table I-2. Per capita meat consumption in kilograms, and total meat consumption, production and imports in thousand metric tons, Greece, 1958-1972.

| YEAR | PER CAPITA MEAT CONSUMPTION IN KILOGRAMS | | | | TOTAL MEAT CONSUMPTION IN THOUSAND METRIC TONS (1) | TOTAL MEAT PRODUCTION IN THOUSAND METRIC TONS | | | | TOTAL MEAT IMPORTS IN THOUSAND METRIC TONS |
|---|---|---|---|---|---|---|---|---|---|---|
| | BEEF & VEAL | LAMB, MUTTON, GOAT MEAT | PORK | ALL KINDS OF MEAT (1) | | BEEF & VEAL | LAMB MUTTON GOAT MEAT | PORK | ALL KINDS OF MEAT (1) | |
| 1958 | 4.32 | 11.18 | 2.9 | 20.95 | 172.7 | 24.5 | 77.2 | 24.7 | 145.7 | 27 |
| 1959 | 4.42 | 11.38 | 3.0 | 21.59 | 183.7 | 26.9 | 79.7 | 27.2 | 153.7 | 30 |
| 1960 | 5.03 | 11.88 | 3.0 | 22.91 | 194.8 | 28.9 | 81.7 | 27.7 | 158.8 | 36 |
| 1961 | 6.46 | 12.85 | 3.1 | 25.61 | 199.0 | 41.4 | 67.0 | 37.8 | 148.0 | 51 |
| 1962 | 7.57 | 12.45 | 3.4 | 26.95 | 215.6 | 38.3 | 73.6 | 40.1 | 168.6 | 47 |
| 1963 | 9.30 | 12.81 | 3.7 | 31.12 | 240.9 | 46.8 | 73.9 | 39.0 | 177.9 | 63 |
| 1964 | 8.85 | 13.92 | 3.8 | 32.39 | 251.7 | 53.4 | 76.5 | 39.0 | 190.7 | 61 |
| 1965 | 10.50 | 15.46 | 4.3 | 38.50 | 310.9 | 62.0 | 79.0 | 46.7 | 214.9 | 96 |
| 1966 | 10.77 | 15.21 | 4.4 | 38.57 | 337.8 | 72.9 | 82.1 | 51.4 | 241.8 | 96 |
| 1967 | 12.95 | 14.56 | 4.4 | 41.44 | 355.5 | 75.8 | 84.4 | 46.1 | 252.5 | 103 |
| 1968 | 14.68 | 14.84 | 4.7 | 43.53 | 371.0 | 84.2 | 84.4 | 39.8 | 253.0 | 118 |
| 1969 | 15.52 | 14.59 | 4.8 | 44.53 | 393.4 | 85.9 | 89.8 | 44.8 | 278.4 | 115 |
| 1970 | 17.99 | 14.90 | 5.9 | 47.20 | 429.9 | 89.7 | 90.9 | 52.1 | 303.9 | 126 |
| 1971 | 15.10 | 17.67 | 7.1 | 50.17 | 462.5 | 86.8 | 96.1 | 63.2 | 334.5 | 128 |
| 1972 | 15.83 | 17.38 | 8.2 | 52.40 | 469.0 | 91.1 | 99.0 | 73.3 | 359.5 | 106 |

(1) Including poultry

SOURCES:
1. National Statistical Service of Greece, Statistical Yearbook of Greece; 1966, p. 173; and 1972, p. 180. Also unpublished data have been provided to the author through his personal correspondence with the statistical service.
2. Center of Planning and Economic Research (KEPE), Developments in the Livestock Sector, Athens, Greece, 1972, pp. 92-93.
3. "Express" newspaper, Agricultural Economy 1974, Special Edition, April 1974, pp. 14-15.

The above sources have provided the basic data, some of which have been further processed by the author.

However, while all the factors affecting the total meat consumption in Greece were enhancing ones, to the contrary, the main determinants of meat production were by and large preventive ones. Small farm size (9 acres on the average reflecting a limited farm area and a large number of farmers) was one of the most severe obstacles for a substantial expansion of livestock production in Greece. Price uncertainties faced by farmers, occasional controversial governmental meat price and import policies, poor farm management, low rainfall, mountainous and relatively unfertile soil, and a comparatively inefficient livestock and meat marketing system were also important reasons for the underdevelopment of the Greek livestock and meat industry. As a result of these, and probably other factors, meat production remained substantially behind meat consumption. In 1972 total meat production was 359.5 thousand tons as compared to 145.7 thousand tons in 1958 (Table I-2). This same table shows the trends in the production of each kind of meat over the study period 1958-1972.

The gap created between meat consumption and meat production in Greece led to large quantities of meat imports every year. As a consequence of these, substantial amounts of foreign exchange left the country, worsening thus even more the permanently deficit balance of trade (Table I-1). In 1972, meat imports reached the level of 106 thousand tons, while in 1958 they were only 27 thousand tons (Table I-2). The corresponding outflow of foreign exchange amounted to 4.4 billion drachmae (145 million dollars) for the year of 1972. More than 85 percent of the imported meat was beef and lamb.

This significant outflow of foreign exchange (which is so much needed for the economic development of the country) coupled with difficulties and uncertainties with which the country is presently faced in getting adequate meat supplies at reasonable prices--as a result of world wide meat shortages--induced the Greek government to adopt more favorable meat production policies in order to encourage the development of the livestock and meat industry in the country.

The outcome of the governmental incentives (higher output prices, heavy input subsidies, loans in large amounts and at a very low interest rate, etc.) is that many people from diverse professions have entered into the livestock industry, establishing primarily commercial types of livestock operations.

## The Research Problem

The entry of relatively many larger producers into the livestock industry is expected to substantially increase the livestock population, and therefore the number of slaughterings in Greece. This will probably lead to increased demand for slaughtering facilities and services.

On the other hand, the existing slaughterhouses in the country are generally small, out of date, and may not be optimally located. They still utilize crude methods of slaughtering which may adversely affect the quality of meat. Many of the slaughterhouses do not meet even the basic sanitary standards. Thus, the government in its long-run plans to establish modern slaughter plants may not take into account the existence of the present slaughterhouses.

Taken as given, this prospect of significantly increasing the domestic livestock production and the possibility of replacing the existing slaughter system in the near or far future, the questions which sooner or later might be raised by the various policy makers of the country could be these:

1. How many livestock slaughtering plants should be built in total in order to slaughter the anticipated higher volume of livestock production?
2. How large should the plants be so that economies of size can be achieved, and thus the costs of slaughtering be minimized?
3. Where should those slaughtering plants be located, so that the aggregate costs of (a) assembling the live animals from the production points to the plant locations, (b) slaughtering them in the slaughterhouses, and (c) transporting the carcass meat from the plant locations to consumption centers be minimized?

## The Analysis Objectives

The main objective of this analysis is the determination of of the optimum number, size and location of new modern livestock slaughtering plants in E. Macedonia, Greece. The purpose of this is to improve the efficiency of the livestock meat marketing in the area. In other words, to perform all the marketing functions involved from the livestock production to meat consumption with the minimum possible costs.

Marketing is not just a movement of goods from producers to consumers; it is the total system of business activities which are involved from production to consumption. In this sense, marketing includes not only retailing, wholesaling and transportation of final products but it also includes assembly and processing of raw materials as well as other functions. If one of these functions does not perform efficiently, then the whole marketing system will be less productive because high interdependence exists among all components of the marketing system.

Exactly, here lies the importance of this analysis, that is to contribute to the improvement of the marketing efficiency of livestock -meat industry in the area throu improving the livestock slaughtering system along with livestock assembly and meat distribution. This improvement is expected to generate increased incentives to the industry's participants, which in turn may encourage the further expansion of the livestock production.

The specific objectives of this analysis are the following:

1. To compute the regional total livestock marketings (in meat equivalents) in Eastern Macedonia for the year 1972 and also project them to 1980.
2. To estimate the regional total meat consumption for the same year 1972.
3. To estimate the livestock assembly cost from the production regions to the slaughtering plants.
4. To estimate the meat distribution cost from the slaughtering plants to the consumption centers.

5. To estimate the slaughtering costs (both fixed and variable) by plant sizes and at various levels of plant capacity utilization.
6. To determine the optimum number, size and location of slaughtering plants under 1972 livestock slaughterings and meat consumption patterns.
7. To appraise the appropriate adjustments which may be needed in the optimum number, size and location of the slaughtering plants as the following variables change: (a) livestock assembly cost, (b) livestock supplies, (c) number of regions, (d) the degree of plant capacity utilization, and (e) the slaughtering system.

## The Area of Study

Eastern Macedonia (the shaded area of the following map of Greece, Figure I-1) has been chosen to be the area of this study. There are both economic and technical reasons for this choice. Technically, it was relatively easier to collect the required detailed livestock production data in Eastern Macedonia as compared to other regions of Greece. Economically, this area is one of the most productive agricultural regions of the country, especially from the standpoint of cattle production. In it are concentrated 17.6 percent of Greece's cattle production, 4.9 percent of sheep-goat production and 5.6 percent of hog production, according to 1971 statistical data.[3]

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[3]National Statistical Service of Greece, Agricultural Statistics of Greece 1971, Athens, Greece 1973, pp. 92-93.


Figure I-1. Map of Greece

Eastern Macedonia consists of three provinces, Serres, Kavala and Drama. The total area covered by these provinces of Eastern Macedonia accounts for 9,526 square kilometers which represents 7.3 percent of the total area of Greece. Its population amounts to 416 thousands or 4.6 percent of total Greek population.[4]

The province of Serres, in particular, is considered as the most progressive and productive agricultural area of Greece. It ranks first among all the 52 provinces of the country in cattle production, fifth in population and sixth in area. In 1971, it produced 9.2 percent of Greece's total cattle production. Its population amounts to 203 thousand people and the area which occupies accounts for 3,968 square kilometers.[5] A large portion of its land consists of plains, most of which is irrigated.

## The Sources of the Data

Both primary and secondary data were used in this study.

The data on livestock slaughterings by each village were obtained from the provincial offices of the Ministry of Agriculture, located in the capitals of the three provinces, Serres, Kavala and Drama, of Eastern Macedonia.

The data on livestock assembly and meat distribution cost were obtained through two different types of questionnaires constructed by the author for this specific purpose. One type of questionnaire

[4]National Statistical Service of Greece, Statistical Yearbook of Greece 1972, Athens, Greece, 1973, p. 36.

[5]Ibid.

was directed strictly to truckers engaged in either livestock assembly and/or meat distribution (Appendix A-1). The other type of questionnaire was directed to any marketing firm (e.g., local dealers, meat wholesalers, butchers, etc.) involved in one or another way in either livestock assembly or meat distribution (Appendix A-2). One reason for constructing these two types of questionnaires was to have a cross-examination on the data obtained. The other reason was to obtain the corresponding information regarding the different participants of the livestock-meat industry. The interviews were conducted by assistants of the Department of Agricultural Economics, University of Thessaloniki, Greece in June of this year, 1974.

The data on slaughtering costs were taken from a special FAO study[6] referring to the marketing of livestock and meat in Greece. The largest part of this study-report is an economic-engineering analysis of livestock slaughterhouses. It refers to a modern technology of livestock slaughtering applied in western European countries. Input prices refer to Greece.

The income data were obtained from a 1973 publication of National Accounts of the Ministry of Planning and Governmental Policy.[7]

The rest of the data were obtained from the National Statistical Service of Greece, either from its existing publications or from its files of unpublished data by the request of the author. These sources appear in the bibliography section.

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[6]E. Bockenhoff and N. E. Wernberg, "Marketing of Livestock and Meat in Greece," FAO, No. TF-7, Rome, Italy, 1967.

[7]Ministry of Planning and Governmental Policy, "Provisional National Accounts of Greece 1972," Athens, Greece, March 1973, pp. 15-16 and 52-53.

## Summary

The significant increase of per capita income of Greeks accompanied by remarkable growth of foreign tourism were the main factors for the substantial increase of total meat consumption in Greece. The Greek government to match livestock production to meat consumption in order to reduce meat imports and therefore the foreign exchange outflow, gave attractive incentives to livestock producers. These were loans at low interest rates, input subsidies, substantial meat price increases, etc. As a result of these incentives, relatively larger producers entered into the livestock industry while most of the existing livestock producers expanded their production. Thus, total livestock production is anticipated to be increased appreciably by 1980. According to extension agronomists of the provincial offices of the Ministry of Agriculture in Serres, Kavala and Drama, livestock production in Eastern Macedonia is projected to 1977 to be about 50 percent greater than that of 1972.

It is obvious that the anticipated increase in livestock production along with the currently existing obsolescence, at least from the standpoint of technology, in the present slaughterhouses of Eastern Macedonia will demand more and more modern marketing facilities (slaughterhouses, etc.). If this will be the case, then the main questions which will be raised sooner or later might be: what should be (a) the number, (b) size, and (c) location of new slaughter plants--so that the aggregate cost of livestock assembly and processing and meat distribution be minimized? This analysis seeks to answer these same questions.

Eastern Macedonia has been chosen as the area of this study out of the entire country of Greece because, on the one hand, it is a very important livestock production area of the country, and on the other hand, it was relatively easier to collect the required data on livestock slaughterings, livestock assembly and meat distribution in this area instead of for the whole country.

# CHAPTER II

# THE PRESENT LIVESTOCK AND MEAT MARKETING SYSTEM IN E. MACEDONIA, GREECE

## Introduction

This chapter is primarily aimed at describing the currently existing livestock slaughtering system in E. Macedonia, Greece. The purpose is to obtain a better understanding of the research problem and facilitate the recommendation phase of the analysis. However, because of the high interdependence which exists among all the marketing functions in the entire production and distribution system, information will be provided on these too. This will help in diagnosing probable bottlenecks which may exist at any stage of the system and which possibly affect the performance of livestock processing.

The main sources of this information are:

a. formal interviews of butchers and truckers engaged in either livestock assembly and/or meat distribution. Questionnaires, specifically constructed for this purpose, have been used in conducting the corresponding interviews;

b. informal interviews of various participants of the industry (meat wholesalers, butchers, slaughterers, acting menagers of slaughterhouses, etc.) conducted by the author;

c. provincial offices of the Ministry of Agriculture and Commerce in the three provinces (Serres, Kavala and Drama) of E. Macedonia;

d. the special FAO study-report[8] on marketing of livestock and meat in Greece.

The information provided probably does not give a full picture of the presently existing situation in the livestock-meat industry in E. Macedonia. However, for the purpose of this study it is felt that this information is sufficient. Of course the need for a detailed diagnostic study of the entire livestock production and meat distribution system is recognized.

## Marketing Channels for Livestock and Meat

Marketing channels simply are paths through which farm products move from the time they leave the farm or ranch until they reach their destination.[9] In other words, marketing channels include any individuals, firms, or institutions which are involved in the process of moving goods from producers to consumers. Many agencies which perform or assist in performing some marketing functions are not classed as marketing channels, simply because they neither take title to goods nor negotiate purchases or sales.[10] The trucking companies, the advertising agencies, the banks, etc. cannot be characterized as marketing channels for the very same reasons. They are simply facilitating marketing organizations. The key element in defining a marketing channel is the passage of title or control over goods and services, not their physical movements.[11]

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[8] Ibid.

[9] W. F. Williams and T. T. Stout, "Economics of the Livestock-Meat Industry," the MacMillan Company, New York, 1964, p. 153.

[10] C. F. Phillips and J. J. Duncan, "Marketing: Principles and Methods," sixth edition, Richard E. Irwin, Inc., Homewood, Illinois, 1968, p. 46.

[11] J. B. Matthews, Jr., et. al., "Marketing: An Introductory Analysis," McGraw-Hill Book Company, New York, 1964, p. 262.

On the basis of these definitions, a chart (Figure II-1) was drawn to present graphically the currently existing marketing channels for livestock and meat in E. Macedonia, Greece. As this chart shows, live animals move either to other farmers for fattening or reproduction, or to some marketing firm for slaughtering. In the latter case, live animals are usually forwarded to slaughterhouses for slaughtering by one of the following routes:

a. producers--butchers;

b. producers--commission men--butchers;

c. producers--local dealers--butchers;

d. producers--commission men--meat semi-wholesalers;

e. producers--local dealers--meat semi-wholesalers;

f. producers--commission men--meat wholesalers;

g. producers--commission men--local dealers--meat wholesalers;

h. producers--commission men--meat processors;

i. producers--local dealers--meat processors;

j. producers--commission men--local dealers;

k. importers of live animals

The volume of livestock moving through each of these channels in E. Macedonia or Greece as a whole is not known. The need for special research in this area is obvious. However, from the information gathered through the author's informal interviews with various marketing participants of the livestock-meat industry, it seems that route (a) prevails in villages or small towns while route (g) prevails in cities and large towns.

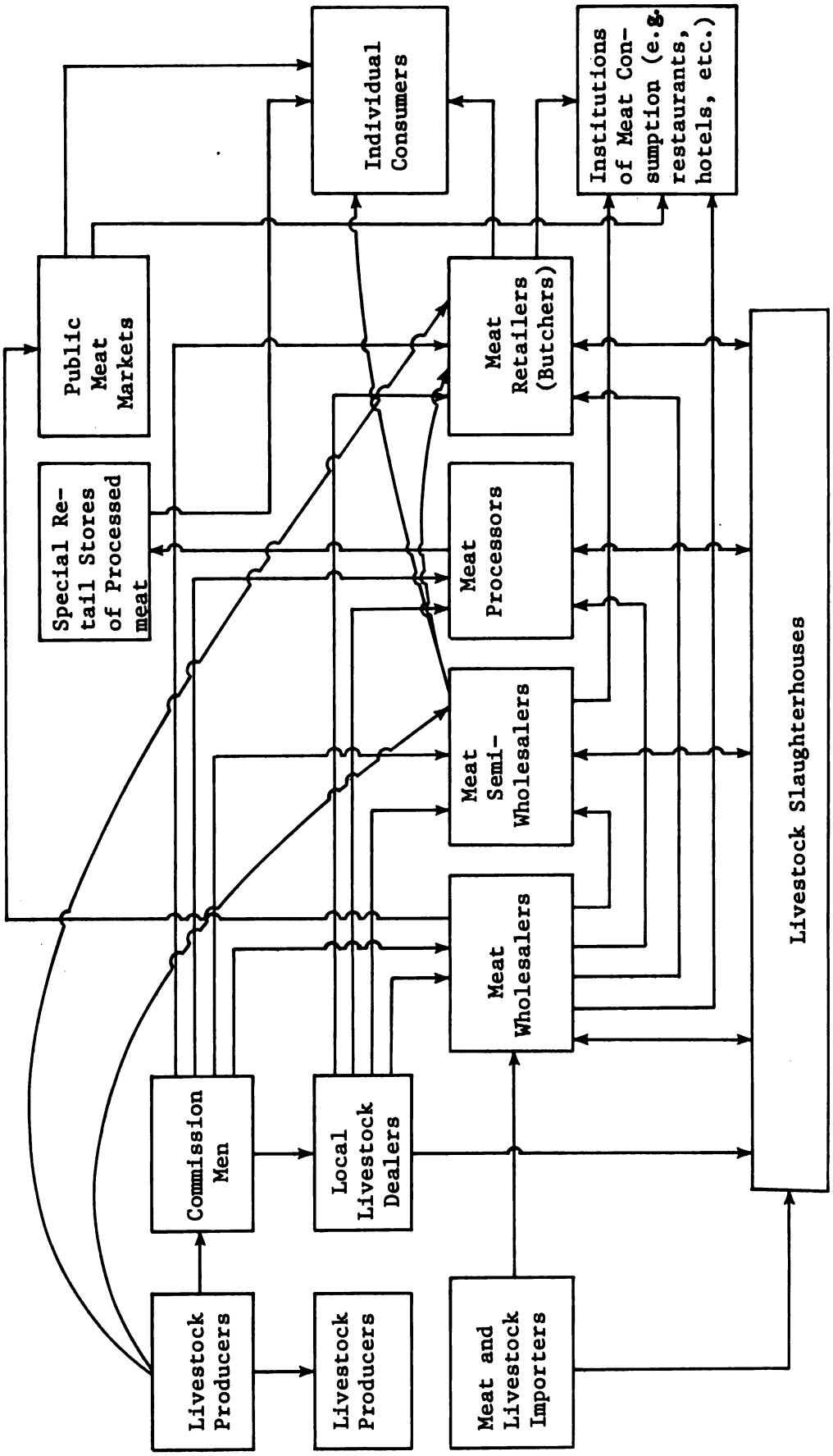


Figure II-1. Marketing channels for livestock and meat, E. Macedonia, Greece, 1974.

After the live animals have been slaughtered, carcass meat moves to its final destination (individual consumers or institutions of meat consumption) through one of the following ways:

a. butchers--consumers;

b. semi-wholesalers--consumers;

c. semi-wholesalers--butchers--consumers;

d. meat wholesalers--butchers--consumers;

e. meat wholesalers--public meat markets--consumers;

f. meat wholesalers--meat semi-wholesalers--butchers--consumers.

Again neither in this case is there any research information with regard to the volume of carcass meat moving through these channels. However, from the unsystematic information available, it seems that route (a) prevails in villages and small towns while routes (d), (e), and (f) prevail in cities and large towns.

The nature and the role of marketing channels for both livestock and meat are described in brief in the immediately following sections.

Commission men or "animal traders," as they are called in Greece, are usually successful farmers (leaders) in each community. They are working for someone's account, e.g. butchers', wholesalers', etc. They usually collect the necessary information regarding the availability of animals for sale, etc. and sometimes negotiate the price with farmers. They are authorized to offer either the final price or a minimum price. In the latter case, whoever does the assembly of live animals offers the final price after he has visited the place of transaction and inspected the animals. Commission men

receive commission fees for the job which they perform. These vary for the different livestock species. In the provinces of E. Macedonia, the currently held commission fees are: for cattle, 100 drachmae per head; for hogs, 50 drachmae per head; and for lambs, 5 drachmae per head.[12]

Local livestock dealers are specialized marketing firms who both buy and sell live animals. They buy either directly from farmers, or usually through their commission men. They generally work for meat wholesalers of big cities and sometimes for semi-wholesalers, butchers, and meat processors. They supply them with either carcass meat (frequently) or with live animals (rarely). In the first case they take care of slaughtering while in the second case the latter (i.e. meat wholesalers, etc.) do.

Meat wholesalers buy large amounts of meat, store it in their warehouses and then sell it to the various marketing firms, such as butchers, semi-wholesalers, public meat markets and meat processors. They also provide meat to some large meat consumption institutions, such as hospitals, taverns and restaurants. They usually buy from either local dealers (meat or live animals) and commission men or from meat importers (imported meat). When they buy live animals, either themselves or usually their personnel take care of slaughtering.

Meat semi-wholesalers are between butchers and wholesalers in the marketing system. They buy either from meat wholesalers (big

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[12]Data provided by three interviewed commission men in Serres and Drama.

cities) or farmers, commission men and local dealers (towns or villages) and sell simultaneously to both, butchers and meat consumption institutions (hospitals, restaurants, hotels, etc.) as well as to individual consumers.

Butchers, are specialized meat retailers. They sell directly to individual consumers and rarely to institutions. The latter applies to towns and villages where wholesalers do not exist. They buy from either meat wholesalers or semi-wholesalers (as usually happens in cities), or from commission men and local dealers or directly from farmers (as usually happens in towns and villages).

Public meat markets are city or large town areas in which many meat retailers are concentrated. Meat displays outside of their store, non-permanent customers and comparatively lower prices than butchers are their common characteristics. They base their profits on volume of sales rather than on sale price. The competition among them is very keen. They buy meat from meat wholesalers and sell to both individual consumers and institutions (e.g. restaurants, etc.)

Meat processors buy meat and process it to the various meat products, such as sausage, salami, etc. They buy either from meat wholesalers or from commission men and livestock local dealers. They sell directly to the grocery stores or to sausage stores, specialized small retail stores, which sell only sausages, salami and other ready-to-eat meat products.

Importers are specialized in either live animal imports or fresh and/or frozen meat imports. They sell directly to meat wholesalers. When they import live animals for meat, they take them to the nearest Greek slaughterhouse, slaughter them and sell the carcass meat to meat wholesalers.

## Livestock Production

"Because the marketing process starts with the product as it is offered at the farm, the conditions surrounding this product and its production are important in understanding many of the problems and costs of agricultural marketing."[13] This implies that the production and marketing of livestock products must be synchronized; otherwise inefficiencies shall be generated in the entire livestock production and meat marketing system. For example, when the livestock production is scattered over a relatively large area and the volume of production is small, the livestock assembly function becomes very difficult and highly costly.

Aspects of livestock production which are of great importance to the livestock and meat marketing system seem to be the number, size, mix and location of livestock production units. The reason is that they significantly affect the efficiency of the livestock assembly function, which in turn affects the efficiency of livestock slaughtering and so one. Thus the efficiency of the total marketing system is affected. For example, when livestock production is undertaken by many small, mixed and widely scattered production units, no economies of size can be realized in livestock assembly, slaughtering, and meat distribution. In this way the total marketing cost per unit of product will be comparatively high. This means that the marketing system will essentially perform inefficiently in the sense of producing a certain output with a relatively high cost.

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[13] R. L. Kohls, "Marketing of Agricultural Products," third edition, the MacMillan Company, New York, 1967, p. 76.

Table II-1, referring to the country as a whole but seeming to apply to the specific area of E. Macedonia as well, indicates that livestock production of any specie (cattle, sheep, goats and hogs) is undertaken by a relatively large number of small producers. As this table shows, this is especially true for the cattle subsector. About 80 percent of cattle producers raise only one to four animals each and the total number of cattle they raise represents almost half of the area's total cattle production. More than 92 percent of total cattle production is undertaken by 99 percent of all producers, each of whom raise 1 to 19 cattle.

In the hog subsector, 85 percent of all hog producers feed only one to four hogs and the total number of hogs they feed represents 30 percent of the area's total hog production. Half of the hog production is undertaken by only one percent of the total number of hog producers, each of whom feeds more than 50 hogs. In the sheep-lamb subsector, 53 percent of all sheep-lamb producers raise one to nine animals each and the total number of animals they raise accounts for about six percent of the area's total sheep-lamb production. More than 73 percent of total sheep-lamb production is undertaken by 20 percent of producers who raise 50 animals or more each. In the goat subsector, almost 90 percent of goat producers raise one to nine animals each and the total number of animals they raise represents 20 percent of the area's total goat production. Approximately 65 percent of the total goat production in the area is undertaken by only 3.5 percent of all goat producers who raise more than 50 animals each.

Table II-1. Livestock farm sizes, Greece, 1971.[1]

| 1. Size Distribution of Cattle Holdings | | | | | | |
|---|---|---|---|---|---|---|
| | Cattle farm size (number of cattle per holding) | | | | | |
| Holdings and animals | 1 - 4 | 5 - 9 | 10-19 | 20-29 | 30-49 | 50 & Over |
| No. of holdings | 192,720 | 39,400 | 9,100 | 1,220 | 620 | 240 |
| No. of cattle[2] | 413,500 | 244,920 | 113,240 | 22,000 | 28,120 | 14,500 |
| **2. Size Distribution of Sheep Holdings** | | | | | | |
| | Sheep farm size (number of sheep per holding) | | | | | |
| Holdings and animals | 1 - 9 | 10-19 | 20-49 | 50-99 | 100-199 | 200 & Over |
| No. of sheep holdings | 139,360 | 29,060 | 43,340 | 31,900 | 17,940 | 3,900 |
| No. of sheep[2] | 435,800 | 371,180 | 1,333,920 | 2,062,460 | 2,244,180 | 1,035,120 |
| **3. Size Distribution of Goat Holdings** | | | | | | |
| | Goat farm size (number of goats per holding) | | | | | |
| Holdings and animals | 1 - 9 | 10-19 | 20-49 | 50-99 | 100-199 | 200 & Over |
| No. of goat holdings | 367,580 | 17,960 | 13,160 | 9,200 | 7,500 | 3,760 |
| No. of goats[2] | 893,100 | 221,200 | 379,780 | 602,180 | 968,120 | 179,400 |
| **4. Size Distribution of hog holdings** | | | | | | |
| | Hog farm size (number of hogs per holding) | | | | | |
| Holdings and animals | 1 - 4 | 5 - 9 | 10-19 | 20-29 | 30-49 | 50 & Over |
| No. of hog holdings | 120,520 | 8,300 | 7,120 | 1,840 | 1,620 | 1,520 |
| No. of hogs[2] | 170,840 | 53,600 | 90,400 | 40,240 | 57,660 | 164,380 |

(1) Sample of five percent of total farms.

(2) Number of animals represents inventories in the end of 1971.

SOURCE: National Statistical Service of Greece, Statistical Yearbook of Greece, 1972, Athens, Greece, 1973, pp. 173-174.

The generally small size of livestock operations can be explained by the fact that livestock production usually is not undertaken as a principal business activity by farmers, but rather as a supplementary activity aimed at improving their incomes. Almost one-fourth of all farm families in Greece, in addition to cultivating various crops, raise one to ten livestock to make fuller utilization of their labor force, or to more profitably utilize crop products (e.g., corn, alfalfa, etc.) produced on their farms.

Another characteristic of livestock production in E. Macedonia, which is disadvantageous to livestock and meat marketing system, is the fact that livestock producers of any species are not concentrated in one or few areas, but rather are scattered all over the villages and towns of each province. Without exception, all the 286 communities of E. Macedonia feed livestock. However, the volume of production differs from community to community depending on the area of its arable land, pasture land, etc. An idea of the regional livestock production in the area of E. Macedonia is given in Table IV-1 of Chapter IV. As that table shows, the most dense livestock producing regions in E. Macedonia are in the following order: Serres, Iraklia, Chryssoupolis, Drama, Nigrita, Nea Zichni and Doxaton.

Both characteristics of livestock production in E. Macedonia (i.e., small size and the scattering of livestock operations) along with the hilly and mountainous land pose problems to efficiently (i.e., least cost) organizing the livestock and meat marketing system.

## Livestock Assembly

Livestock assembly is undertaken primarily by butchers and secondly by local dealers. The former are working on behalf of themselves while the latter are working to supply meat wholesalers. The first type of assembly is common in small cities, towns and villages, while the second is in the big cities of Athens, Thessaloniki and some others.

Livestock assembly seems to be undertaken on a rather uncoordinated basis. This is especially true in the case of butchers in villages or small towns. Whenever a butcher needs meat to supply his customers, he visits farmers of his village or surrounding villages, buys the required animals, slaughters them in the local slaughterhouse, and then sells the meat. It is very rare for cooperation to take place among the butchers in obtaining meat supplies. The situation is somewhat different in the case of local dealers. They try to satisfy a substantially greater meat demand of their meat wholesalers. For this reason, they usually undertake the livestock assembly as long as they find and are able to purchase the required, generally large number of live animals.

The gathering of the necessary market information--regarding the quantity, quality, kind and price of the live animals--for either category of livestock assemblers is done by commission men. Their nature and role has been described in section two of this chapter.

Because of the individualistic type of livestock assembly organization and operation, a small volume of animals is usually assembled each time. For this reason, whoever undertakes the assembly

function seeks the employment of small trucks in order to avoid relatively higher transportation expenses. Out of 77 reported cases of livestock assembly undertaken by the interviewed 30 butchers in E. Macedonia, it was found that the following frequency of truck utilization occurred: (a) in 57.2 percent of the cases, trucks of 2 and 2.5 tons were used in livestock assembly; (b) in 14.2 percent of the cases, trucks of 1 and 1.5 tons were used; (c) in 16.9 percent of the cases, tricycles or trucks of 1/4 through 1/2 tons were used; (d) in 7.8 percent of the cases, trucks of 4 tons were used; and (e) in 3.9 percent of the cases, trucks of over 6 tons were used.

The general trend in the size of trucks used in livestock assembly was that, the greater the distance between slaughterhouses and production points, the greater the size of the employed trucks was. This is something which was expected, since in longer distances, the chances of acquiring larger volumes of live animals are better. Indeed, the interviews indicated that the large size trucks of over four tons were utilized in distances greater than 100 kilometers on the average, and their average capacity utilization was 94 percent.

In general, the degree of capacity utilization of all kinds of trucks which were used in the livestock assembly was relatively low. In 23.4 percent of the 77 reported cases of assembling live animals, it was found that the degree of truck capacity utilization ranged between 15 and 25 percent. In 24.7 percent of all cases, the degree of truck capacity utilization ranged between 26 and 50 percent. In 16.8 percent of the cases, trucks were used between 51 and 75 percent.

of their capacity. In 31.2 percent of all cases, the capacity utilization of the employed trucks ranged between 76 and 100 percent. In 3.9 percent of all cases, trucks were used in over capacity.

Out of 30 interviewed butchers, 29 of them had used rented trucks, for assembling the required livestock. Only one of them has had his own trucks.

Exactly one-half of the interviewed butchers preferred to have their own trucks. The main reason cited for this was convenience, i.e., to do the job when they liked. The remaining one-half of them do not like to have their own trucks, because they expect the operating and maintenance costs of trucks to be comparatively very high for their generally small volume of business handled.

Out of the total number of interviewed butchers, 53.3 percent of them answered that they go to buy livestock for slaughtering four times a month, 30 percent of them make six to eight trips a month, and the remaining 16.7 percent go more than 12 times a month.

The cost rates of livestock assembly varies with distance and size and type of truck. Livestock assembly cost rates in E. Macedonia are shown in Table IV-3 of Chapter IV. These rates refer to a full capacity utilization of the corresponding trucks. The interviews revealed that the load does not play much role in the determination of the transportation rates. The major factor underlying the livestock assembly cost rates is distance. Another is the size of the truck. The larger the truck, the higher the rate for the same distance. The type of road construction (asphalt, gravel, etc.), topography (hilly

or mountainous areas), kind of animals transported, etc. also play some, but not an important, role in the determination of transportation rates by truckers.

## Livestock Slaughtering

The FAO report[14] describes the existing situation of livestock slaughterhouses in Greece as follows:

> All slaughterhouses are rather poorly equipped. Buildings are generally old and frequently without outside walls so that dust and vermin cannot be kept off. Usually stables and slaughter rooms are not separated. Floors are of concrete and the waste water drains into an open channel in the middle of the slaughterhouse from where it runs, untreated, into brooks and rivers. Mechanical equipment is generally inadequate, e.g., there are no overhead rail systems for the internal movement of carcasses and no machines for dehairing pigs. Only in few cases are there tanks for scalding pigs. There are also no working tables; the dehairing of pigs and the cleansing of the intestines is done on the floor. Scales are mostly obsolete and cold storage rooms are generally lacking. In most slaughterhouses, there are not even separate rooms for storing meat so carcasses remain in the killing room until transported.

While seven years have passed since this report was first published, the situation in the slaughterhouses is still essentially the same. Of course, some new slaughterhouses have been built between 1967 and today, but they are very few and outside of the study area. In general, the improvement programs have been implemented very slowly.

Currently in the three provinces of E. Macedonia there are 21 slaughterhouses which are distributed as follows: Serres, 10; Kavala, 5; and Drama, 6. However, these are only the main slaughterhouses; in Greece they are called "slaughterhouses of wide meat consumption", in the sense that they can provide carcass meat all over the nation. The smaller slaughterhouses, the "slaughterhouses of

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[14] Ibid.

local meat consumption," as they are called, serve the meat requirements of the local communities. Besides a small building, they are not equipped at all. These slaughterhouses are usually located in towns or large villages. There are 18 such slaughterhouses in E. Macedonia, the majority of them in the province of Kavala.[15]

The ownership of slaughterhouses belongs to the corresponding communities where they are located and for which they are a good source of income. None of them are private or cooperative. The expenses for their construction and equipment are undertaken by both the national government and the community authorities contributing about equally.

The operation of the slaughterhouses is undertaken by and large by the owning municipalities. Very rarely are they leased to private companies or individuals. Out of the 21 slaughterhouses of E. Macedonia, only two are currently leased to individuals. These are the slaughterhouses of Neos Skopos and Nigrita, both in the province of Serres.

The capacity of slaughterhouses cannot be defined precisely and therefore it cannot be measured accurately under the existing system of slaughtering. It depends almost entirely on the number of slaughterers working in a specified slaughterhouse. It also depends on their skills; the more skillful they are the larger number of animals they can slaughter and skin. Thus, the size of a slaughterhouse

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[15]Veterinary offices of the Ministry of Agriculture in Serres, Kavala and Drama.

in Greece cannot be described objectively unless the number of slaughterers working in it is incorporated.

Essentially, there is no management in the regular meaning of the term in the slaughterhouses of E. Macedonia. There is usually only one person working in the municipal building and he is transferred to the slaughterhouse to take care of it when it operates. He may well be called acting manager. His responsibilities include opening the slaughterhouse on operating days, cleaning it after the operation, and collecting the slaughtering fees. His educational level is low, usually not beyond elementary school.

Slaughterhouses do not operate every day. They are usually open three days a week, i.e., Monday, Wednesday and Friday and then for only a few hours a day, typically from 8:00 to 10:00 a.m. These two factors (days and hours of operation) indicate that the currently existing slaughterhouses in E. Macedonia are not fully utilized.

Whoever owns slaughtered animals pays slaughtering fees, "rights of slaughtering" as they are called in Greece. These are charges imposed by the municipalities to the users of their slaughterhouses. Slaughtering fees in the province of Serres are: 30 drachmae per head of cattle, 25 drachmae per head of hogs, 10 drachmae per head of sheep-goats and 5 drachmae per head of lambs or goat-kids. The corresponding figures for Drama and Kavala are 70, 50, 7.5 and 5 drachmae per head respectively.[16] The usual total values of these animals are currently averaged at the levels of about 12,000 drachmae

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[16]Data provided by the acting managers of the main slaughterhouses in each province of Serres, Kavala and Drama.

for cattle, 3,000 drachmae for hogs, 800 drachmae for sheep-goats, and 500 drachmae for lambs and goat kids.

Slaughtering (killing and skinning) of animals is done by specialized workers, the slaughterers. Methods used are generally crude. Cattle are killed by pistol using specially treated arrows. The other animals, hogs, sheep and goats are killed by knife. Skinning is usually done on the floor, unless the slaughterhouse is equipped with an internal rail system on the ceiling. In such a case, the killed animal is hung for skinning.

Slaughterers typically work independently of the slaughterhouse in the sense that they are not employees of the slaughterhouse. They have their own union through which they are notified to go for work. They are paid directly by the owners of the slaughtered animals such as butchers, meat wholesalers or local dealers. Their payment is scheduled according to the livestock species. For the area of E. Macedonia, they are:[17]

| | | |
|---|---|---|
| 1. | Cattle | 160 drachmae |
| 2. | Hogs | 90 drachmae |
| 3. | Sheep and goats | 25 drachmae |
| 4. | Lambs | 20 drachmae |

These prices reflect the cost of slaughterers' labor used in both the killing and skinning the slaughtered animals at the slaughterhouse. While, there is not complete uniformity in the payment of slaughterers among all the areas, the differences are small.

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[17]Data provided by the presidents of slaughterers unions in each province of Serres, Kavala and Drama.

Much of the animal byproducts (such as blood, etc.) is thrown away during the slaughtering process. The relatively small volume of slaughtering makes it unprofitable to process these by-products in each slaughterhouse. Inspection of the slaughtered animals by veterinary doctors takes place both before and after the slaughtering.

The annual volume of slaughterings in the main slaughterhouses of E. Macedonia are shown in Table II-2. As the table shows only three out of the 21 slaughterhouses have processed more than two thousand tons of meat annually. Another three slaughterhouses processed between one and two thousand tons of meat. The remaining 16 slaughterhouses processed less than one thousand tons of meat. Of these, three slaughterhouses processed less than 100 tons of meat in 1972.

There are typical seasonal fluctuations in livestock slaughtering, varying for the different species, as Table II-3 indicates. This table gives the monthly livestock slaughterings by species and in total for the entire province of Serres, i.e., for its ten slaughterhouses altogether. As the table shows, the peak of cattle slaughterings takes place in the months of June and October. For sheep, lamb and goats it takes place in August and September, and for hogs in November and December. This seasonality is generally related to either demand for the corresponding kinds of meat or to the availability of fodder during the months in question. The first case usually applies to lamb and pork subsectors while the second to the cattle subsector.

Table II-2. Slaughterhouses currently existing in E. Macedonia, Greece, with the corresponding volume of slaughterings by livestock species, 1972.

| Location of Slaughterhouses | Number of Head of Slaughtered Animals | | | Carcass Meat Weight in Tons of Slaughtered Animals | | | |
|---|---|---|---|---|---|---|---|
| | Cattle | Sheep-Goats | Hogs | Beef | Lamb Mutton Goat Meat | Pork | Total Carcass Meat |
| 1. Serres | 7,636 | 30,062 | 5,718 | 1,380 | 351 | 457 | 2,188 |
| 2. Iraklia | 4,783 | 46,808 | 5,135 | 1,079 | 613 | 411 | 2,103 |
| 3. Mavrothalassa | 409 | 1,925 | 236 | 85 | 21 | 12 | 118 |
| 4. Nea Zichni | 633 | 3,628 | 410 | 96 | 43 | 25 | 164 |
| 5. Neos Skopos | 7,287 | 6,811 | 3,359 | 1,592 | 82 | 235 | 1,909 |
| 6. Nigrita | 3,938 | 13,836 | 1,901 | 857 | 138 | 95 | 1,090 |
| 7. Proti | 1,163 | 7,539 | 786 | 166 | 90 | 37 | 293 |
| 8. Rodopolis | 565 | 2,533 | 1,148 | 102 | 33 | 64 | 199 |
| 9. Sidirokastron | 2,194 | 220,058 | 1,500 | 450 | 3,081 | 89 | 3,620 |
| 10. Strymonikon | 322 | 4,986 | 578 | 53 | 70 | 41 | 164 |
| I. Province of Serres | 28,930 | 338,186 | 20,771 | 5,860 | 4,522 | 1,466 | 11,848 |
| 11. Kavala | 3,976 | 25,476 | 2,241 | 618 | 242 | 133 | 993 |
| 12. Chryssoupolis | 3,085 | 16,986 | 3,581 | 1,238 | 186 | 215 | 1,639 |
| 13. Eleftheroupolis | 1,226 | 4,950 | 1,057 | 171 | 46 | 85 | 302 |
| 14. Podochorion | 194 | 5,870 | 148 | 18 | 49 | 7 | 74 |
| 15. Moustheni | 147 | 2,136 | 155 | 13 | 21 | 8 | 42 |
| II. Province of Kavala | 8,628 | 55,418 | 7,182 | 2,058 | 544 | 448 | 3,050 |
| 16. Drama | 4,207 | 16,464 | 1,440 | 603 | 179 | 72 | 854 |
| 17. Prossotsani | 1,189 | 10,589 | 1,173 | 177 | 118 | 82 | 377 |
| 18. Kato Nevrokopi | 317 | 281 | 90 | 37 | 4 | 6 | 47 |
| 19. Nikiforos | 495 | 4,784 | 119 | 61 | 43 | 6 | 110 |
| 20. Kalampaki | 3,152 | 3.458 | 667 | 691 | 45 | 47 | 783 |
| 21. Doxaton | 1,187 | 5,975 | 1,610 | 198 | 61 | 84 | 343 |
| III. Province of Drama | 10,547 | 41,551 | 5,099 | 1,767 | 450 | 297 | 2,514 |
| IV. Eastern Macedonia | 48,105 | 317,027 | 33,052 | 9,685 | 4,086 | 2,211 | 17,402 |

Sources: The Veterinary Offices of the Ministry of Agriculture in each of the three provinces of Serres, Kavala, and Drama.

Table II-3. Monthly livestock slaughterings in metric tons of carcass meat in all the slaughterhouses of the province of Serres, E. Macedonia, Greece, 1972.

| Months | Beef | | Lamb, Mutton, Goat Meat | | Pork | | All Kinds of Meat | |
|---|---|---|---|---|---|---|---|---|
| | Tons | Percent | Tons | Percent | Tons | Percent | Tons | Percent |
| 1. January | 430 | 7.3 | 66 | 1.3 | 151 | 10.3 | 647 | 5.4 |
| 2. February | 410 | 7.0 | 55 | 1.2 | 89 | 6.1 | 554 | 4.7 |
| 3. March | 420 | 7.2 | 32 | 0.7 | 91 | 6.2 | 543 | 4.6 |
| 4. April | 311 | 5.3 | 388 | 8.6 | 68 | 4.6 | 767 | 6.5 |
| 5. May | 126 | 2.1 | 98 | 2.2 | 69 | 4.7 | 293 | 2.5 |
| 6. June | 938 | 16.0 | 436 | 9.7 | 93 | 6.3 | 1,467 | 12.4 |
| 7. July | 420 | 7.2 | 559 | 12.4 | 135 | 9.2 | 1,114 | 9.4 |
| 8. August | 517 | 8.8 | 903 | 20.0 | 136 | 9.3 | 1,556 | 13.1 |
| 9. September | 655 | 11.2 | 815 | 18.0 | 140 | 9.6 | 1,610 | 13.6 |
| 10. October | 803 | 13.7 | 618 | 13.7 | 132 | 9.0 | 1,553 | 13.1 |
| 11. November | 520 | 8.9 | 145 | 3.2 | 152 | 10.4 | 817 | 6.9 |
| 12. December | 310 | 5.3 | 407 | 9.0 | 210 | 14.3 | 927 | 7.8 |
| TOTAL | 5,860 | 100.0 | 4,522 | 100.0 | 1,466 | 100.0 | 11,848 | 100.0 |

SOURCE: The Veterinary Office of the Ministry of Agriculture in the Province of Serres.

## Meat Transportation and Distribution

Meat transportation refers to shipments of carcass meat from the slaughterhouses to representative points (e.g. warehouses of meat wholesalers) of consuming centers. Meat distribution refers to shipments of carcass meat within the city, that is, from a central point (e.g., a warehouse of a meat wholesaler) to the individual meat retailing shops. In this analysis meat distribution cost is ignored and the term is interchangeably used with that of "meat transportation cost."

Meat transportation takes place with trucks equipped with refrigeration facilities when the distance is relatively long, or with common trucks or tricycles when the distance is relatively short. The most commonly used refrigerated trucks in the area of E. Macedonia are of sizes 2, 2.5, 5, 6, 10 and 12 tons.

Meat transportation cost rates in E. Macedonia are shown in Table IV-6 of Chapter IV. As that Table shows they vary in direct proportion to distances travelled. The volume shipped or the size of truck does not seem to play any important role in fixing the transportation cost rates.

Truckers are generally small in number and size in both E. Macedonia and the country as a whole. The main reason for this is the relatively small annual volume of their business. In the city of Serres there are 18 truckers; in Kavala, 12; and in Drama 11.[18] Out of ten interviewed truckers, two of them had 5 trucks each, three had

[18]Data provided by the provincial offices of the Ministry of Commerce in Serres, Kavala and Drama.

four trucks, two had three trucks, and three had two trucks. These truckers were selected for interview because all of them were involved in either live animals or meat transportation or in both. Almost all truckers in a city or a province constitute a Union. Through this they establish uniform transportation rates for the entire area in which their activity is extended.

## Meat Wholesaling

Meat wholesaling seems to be the most underdeveloped area of the meat marketing system in E. Macedonia and the country as a whole. Both individuals and governmental authorities, by a vast majority, consider it as an unproductive marketing function. They consider wholesalers along with local dealers or commission men as "parasites" on farmers.

This unfavorable belief, the so-called "antimiddleman bias," created against meat wholesalers, and middlemen in general, led the governments to ignore them any time new public programs were formulated for the development of the livestock and meat industry in the country.

Meat wholesalers operate under fixed marketing margins of six percent. This means to get the meat wholesaling price, on the farm price of meat (which is also determined by the government) should be added an amount equivalent to six percent of farm price. This meat wholesaling margin policy does not uniformly apply all over the country. In many provinces in which wholesaling was considered by the government as abandoned by meat retailing, wholesaling was not authorized at all.

The outcome of this governmental policy was that meat wholesalers from, say, Athens or Thessaloniki going to such provinces and buying its meat supplies were unwilling to sell meat (obviously at no profit, since no wholesaling margin was authorized there) to the retailers of that province. The consequence of this was that even in the most favorable lamb producing areas, customers could not find lamb to consume. After strong protests by both local meat retailers and consumers, the government made an effort to alleviate this situation somewhat. A new rule was established so every wholesaler buying meat supplies from a province was obliged to sell to that local market at least 25 percent of the total volume of his meat purchases. The chain reaction of meat wholesalers to that new governmental rule was twofold: (1) either they were unwilling to go to such provinces to get meat supplies with the consequence that many animals in those areas could not be sold locally, or (2) if some of them still were continuing to go to those areas to get meat supplies, both the livestock slaughtering and carcass meat transportation was undertaken secretly at night. The result of their behavior was that: (a) neither a good picture of livestock slaughterings during that period can be given, since these slaughterings were not recorded, (b) nor were the slaughtered animals examined sanitarily.

Meat wholesalers do not handle large volumes of meat, simply because the market area which they serve is relatively small. Thus, in Serres there are four wholesalers, three in Kavala and none in Drama.[19] Each runs his business almost alone. They get their meat

[19]Data provided by the provincial offices of the Ministry of Commerce in Serres, Kavala and Drama.

supplies through local dealers. They buy in cash from farmers and sell in short term (weekly) credit to meat retailers. The relatively large wholesalers are generally specialized, i.e., they are engaged in either beef wholesaling, lamb wholesaling, or frozen meat wholesaling, etc. This obviously makes the meat marketing system more inefficient since it forces meat retailers to deal with more than one wholesaler, and thus spend more time in getting their meat supplies.

Marketing functions offered by meat wholesalers to either butchers or farmers seem to be very poor, if they ever exist. Besides meat storage and short-term credit to butchers, it seems that meat wholesalers do not provide at all or sufficiently the following marketing functions:

1. No grading function is offered to either livestock producers when they or their representatives buy animals from them, or to meat retailers when they sell meat to them, usually in whole, half or quarter carcasses. The absence of meat grading makes it necessary for butchers to visit them for personal inspection of meat purchased.
2. No transportation is provided by wholesalers to meat retailers, leaving them responsible for the meat shipments to their shops.
3. No outlook information is provided to either farmers or butchers concerning both meat supplies and prices in the near future. Information cutbacks (if not misinformation) many times are considered critical for a profitable operation, not only in meat wholesaling, but in many other businesses in Greece.

## Meat Retailing

Meat retailing in Greece is almost entirely undertaken by specialized sellers, the butchers. Public meat markets do operate in the cities, but their volume of sales seems to be small compared to that of butcher shops.

Butcher shops are many in number and small in size. In the city of Serres with a population of 41 thousand people there are 57 butcher shops. In Kavala with a population of 47 thousand people there are 65 butcher shops and in Drama with a population of 31 thousand people there are 28 butcher shops.[20]

Informal interviews with butchers in Serres and Drama indicated that the weekly volume of meat sales of a representative butcher shop averages about 100 kilograms of beef, 150 kilograms of lamb, sheep and goat meat, 30 kilograms of pork, and 80 kilograms of chicken.

Entry into meat retailing industry is easy. Whoever wants to operate a butcher shop submits an application to the local police station and gets a license for it. From a competitive point of view, it does not seem to present any barriers, since neither big butcher exist nor heavy capital investments are required. Meat advertisement by the meat retail stores is absent.

Buying habits of Greek consumers seem to be much different than those of Americans. They buy more often (1 to 3 times a week), and much less (1 to 2 kilograms) each time. This buying behavior of Greek consumers is probably the outcome of many factors, such as the greater amount of time available to Greek housewives (since a small

[20]Data provided by the provincial offices of the Ministry of Commerce in Serres, Kavala and Drama.

portion of them work), their desires to buy fresh meat, the proximity of butcher shops so that it is not a problem for them to go often for shopping, etc.

Meat retailing is almost entirely a personal operation. The highest volume of its sales is based upon the personal relations of the butcher and his customers. Approximately 80 percent of his clientele is a permanent one. The trust which the butcher creates to his customers via his good service is the most important element for keeping such a high percentage of permanent clientele.

Almost all meat retailers run their business in small stores. An average size of 15 square meters (i.e., 3 x 5 meters) is very common. Despite the small size of the butcher shop, rent is relatively high. Depending upon its proximity to the center of the city, the rent ranges from 25 to 100 dollars a month. Total monthly variable cost (including rent) averages about 120 to 250 dollars a month.

The butcher shops are generally poorly equipped. However, refrigerators and freezers along with a scale and meat grinder exist in all the shops. Usually the scale is not automatic in the small towns or villages, while the electronic scales--widely used in the U.S.A.--are not being used yet in Greece. Special butcher knives are used to cut the meat in a primitive way into smaller parts. An axe or saw are also in existence for cutting the bones, which almost always accompany the meat selling. Boneless meat is seldom, if ever, sold by meat retailers. A large and round piece of wood upon which the meat is cut is another tool of the Greek butcher.

No display of meat cuts on a ready selling basis takes place in meat retailing in Greece as it does in other European countries and in the U.S.A. That is, there are no meat cuts packed, priced and displayed in an open refrigerator so that the customer can look them over and select the cut of his choice. Probably reasons for not having such a system in Greece may be the limited space in the butcher shops, the cost of an open refrigerator, the small volume of sales, etc.

Butcher shops in more than 90 percent of the cases are operated by the butchers themselves. No other personnel helps with the operation simply because nobody else is needed. The butcher himself can very well manage all the transactions taking place during the day. Unusual peaks beyond his capacity are rare simply because the number of customers corresponding to each butcher is substantially limited. For most of the eight working hours a day the butcher is sitting in the store without any transactions. It is obvious that tremendous excess capacity in meat retailing in Greece takes place.

The retail price of meat (as well as price at the wholesale and farm level) is set by the government and more specifically by the Ministry of Commerce through fixing the retail meat marketing margins. What actually happens is that the government sets the meat farm prices and then on the basis of fixed marketing margins determines the retail meat prices. That is, both wholesale and retail meat marketing margins (expressed in money terms) are added on the farm prices to obtain the retail meat prices.

The government sets retail prices for two kinds of meat cuts, legs and ribs. However, the price differential between the two cuts is not large. What is important in the Greek meat pricing system is not the grade as it is the age of the dressed animal, e.g. veal versus beef, etc.

No meat grading system based on meat cuts (such as T-bone, sirloin, etc.) exists now in Greece, as it does in the U.S.A. and other European countries. This means that no price differentiation takes place in the meat market according to the quality of carcasses. This, in turn, essentially means "personal discrimination" because different customers pay almost the same prices for different grades of meat. This actually takes place currently in meat retailing in Greece. Butchers faced with such a situation (absence of meat grading and presence of governmental fixed retail prices) usually sell the good quality meat to their best customers (relatives, wealthy people who buy more often and in larger quantities). This, in essence, is at the expense of lower income customers, who even though pay the same price, actually acquire a much lower quality of meat. In other words, poor customers essentially subsidize the rich customers in the meat consumption in Greece.

Retailers obtain their meat supplies either through wholesalers (as it commonly happens in the cities) or directly through farmers as happens in villages, towns and small cities.

Retailers in getting their meat supplies from wholesalers spend considerable time in personal meat inspections in order to buy good quality meat and thus better satisfy their customers. Butchers

also spend time to find a transportation mode to ship the purchased meat to their stores. Given the fact that meat wholesalers are usually specialized in beef wholesalers, frozen meat wholesalers, etc., meat retailers in transacting with all of them separately spend considerable time. All these activities of meat retailers, which by and large could be eliminated in a well organized meat marketing system, seem working at the expense of successfully managing the meat retailing business.

## Livestock and Meat Price and Trade Policies

The major objective of governmental policies regarding the livestock and meat subsector of the Greek economy is to stimulate livestock production in order to achieve the following three principal targets.[21]

a. to minimize meat imports in order to reduce the outflow of foreign exchange, badly needed for the industrialization process of the country.
b. to provide sufficient incomes to livestock producers, and
c. to supply sufficient amounts of relatively low cost meat to all the consumers throughout the country.

The main policy instruments, which the government employed from time to time to accomplish its targets were:[22]

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[21] OECD, "Agricultural Policy in Greece," Paris, France, 1973, pp. 36-40.

[22] Ibid.

a. price policies for livestock and meat.

b. trade (especially import) policies for livestock and meat.

Until 1964, the government relied on a tariff barrier of 15 to 28 percent on imported livestock and meat, to protect domestic production. Yet the rate was not sufficiently high to balance the difference in price levels between domestic and world markets. As a result prices for imported meat were considerably lower than domestic meat prices. Consumer demand for lower priced imported meat understandably rose and thus demand for, and therefore, prices of domestic meat did not increase sufficiently to cover increased production costs.[23]

Since foreign trade protection policy had not satisfactorily worked, the government at the beginning of 1964 introduced the system of minimum farm prices, varying for the different kinds of meat.

As soon as producer prices threaten to fall below the minimum price, issuance of import licenses is reduced or stopped in order to reduce total meat supplies and thus keep prices above the minimum levels.

During the period of 1970-73, supply of meat was small and demand high, pushing the meat prices up. The government trying to control the rising cost of living, introduced maximum prices for meat at all levels, farm, wholesale and retail, which from time to time were raised to not discourage the domestic livestock production.

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[23]E. Bockenhoff and N. E. Wernberg, "Marketing of Livestock and Meat in Greece," FAO, No. TF-7, Rome, Italy, 1967, p. 39.

During this year 1974, the government also introduced minimum intervention prices for pork, in order to prevent prices from falling below a minimum level. This policy was mainly aimed at not allowing the discouragement of hog producers from the currently existing demand crisis for pork. Such a possible discouragement may lead hog producers to reduce or to give up production with the probable consequences of another nationwide meat supply crisis.

In addition to the product price policies, a program of direct or indirect subsidies is also in existence. Subsidies in the form of premium for cattle with a liveweight of more than 250 kilograms were the first introduced in 1963. In 1966, this minimum liveweight was increased to 300 kilograms. In 1970, this program was abolished.

Since 1971, a generous investment program on livestock production was introduced in order to encourage the entry of larger producers into the livestock industry to develop it relatively faster. Heavy subsidies on inputs (buildings, equipment, etc.), large amounts of loans with a very low interest rate and increased meat prices were employed.

## Summary

The basic characteristics of the present livestock slaughtering system and other marketing functions of the livestock--meat industry in E. Macedonia were presented in this chapter. The purpose was to give an idea of how the entire livestock production and meat

marketing system performs. This may help in better understanding the research problem and in facilitating the decision making process.

Livestock production in E. Macedonia is undertaken by many small farmers. The density of production in each region is primarily affected by the acreage of both arable and pasture land and secondly by other factors, such as rainfall, farming traditions, etc. The production density affects the performance of livestock assembly, processing, and the meat distribution system. Their costs affect, in turn, the optimal number, size and location of slaughter plants.

Livestock assembly is basically performed by butchers and local dealers. The former are found more often in villages and small towns while the latter in cities and large towns. Butchers assemble live animals always for themselves while local dealers by and large for meat wholesalers. Livestock assembly cost rates vary primarily with the distance that the animals are shipped and secondly with the size or the type of trucks used as transporters.

Livestock slaughtering in E. Macedonia takes place in the existing 21 "slaughterhouses of wide meat consumption." Of them, 10 are located in the province of Serres, 5 in Kavala and 6 in Drama. The annual volume of slaughterings per plant is generally small. Sixteen out of 21 slaughterhouses slaughter live animals accounting for less than 1,000 tons of carcass meat equivalents. They usually operate three days a week, and only a few hours each day. All plants are owned and operated by the municipalities in which they are located. The owners of slaughtered animals pay both slaughtering fees to local administration for the right of using the facility and

wages to slaughterers for slaughtering (killing and skinning) the animals. The buildings, machinery and equipment of most existing slaughterhouses are out of date. The slaughtering system is a crude one. Cattle are killed by pistols using specially treated arrows while sheep, goats and hogs are killed by knife. The skinning is usually done on the floor. No processing of animal by-products takes place, because their small volume in each slaughterhouse makes it unprofitable.

The transportation of carcass meat from slaughterhouses to consumption centers is accomplished with either common or refrigerated trucks. The former are used within short distances of less than 30 kilometers while the latter are used for longer distances. Meat transportation cost rates per ton are basically related to distance.

Meat wholesaling is essentially underdeveloped. Only seven meat wholesalers exist currently in E. Macedonia, of whom four are in Serres, three in Kavala and none in Drama. Their primary function is to sell meat to butchers, semi-wholesalers and big consumption institutions (hospitals, restaurants, etc.). No grading service is offered to either livestock producers or meat retailers. Also, neither transportation nor outlook information is provided to either participant of the livestock-meat industry.

Meat retailing is undertaken by specialized retailers--the butchers. It is also performed by meat semi-wholesalers. Butchers are relatively numerous and their annual volume of sales is small. They generally operate on a personal basis, in the sense that they

have a large number of permanent customers. The meat they sell is neither graded nor pre-packaged, and they apply almost uniform prices to all meat cuts.

Meat prices are fixed at the farm level and regulated at the wholesale and retail level through regulating the marketing margins. Governmental trade policies are exercised by controlling the volume of meat imports. The purpose of both price and trade policies is basically twofold: a) to provide sufficient income to livestock producers and b) to assure consumers of a regular flow of meat at a reasonable price.

# CHAPTER III

# THEORETICAL CONSIDERATIONS AND METHODOLOGICAL PROCEDURES

## Introduction

The economic theory (model) underlying the problem under investigation along with the mathematical and computer models utilized in the analysis are presented in this chapter. Also, the analytical procedure which was followed is described in brief. Furthermore, the simplifying assumptions which were made and the variations of the basic solution model which were considered during the analysis are presented.

## The Economic Model

The cost minimization model underlies any plant location analysis. The reason for this is that such analyses aim toward the determination of an optimum location for a processing plant in a certain area, so that the totality of specified costs incurred can be minimized. Such costs are principally considered the following: (a) the cost of assembling the raw material from its sources to the sites where the plants are located; (b) the cost of processing the material in the plants in question; and (c) the cost of distributing the finished product from the plant locations to its final destinations.

The nature of the current problem is the determination of the optimum number, size and location of slaughtering plants in the area of E. Macedonia. In analyzing this problem, the focus was put almost entirely on minimizing the aggregate costs of assembling the live animals from the production regions to the slaughtering plants, processing them in the plants and distributing the carcass meat from the slaughtering plants to the consumption centers.

Figure III-1, whose horizontal axis represents the number of plants and vertical axis the total costs, shows graphically how the optimum number of plants in the minimum cost (optimum) solution is achieved. In this graph, one curve gives the total transportation cost (TTC), i.e., the combined costs of livestock assembly and meat distribution; another curve gives the total processing costs (TPC). The transportation cost curve is downward sloping to the right, indicating that as the number of slaughtering plants increases, the total transportation costs decrease. This is so because, on the one hand, live animals are shipped relatively short distances in order to be slaughtered, and, on the other hand, carcass meat is also transported relatively short distances from slaughtering plants to consumption centers. To the contrary, the total processing cost curve is upward sloping to the right. This means that as the number of slaughtering plants decreases, total processing costs decline too, for the simple reason that economies of size are expected to be realized in processing. From the combination of the transportation and processing cost curves, the total cost (TC) curve is obtained. The importance of this curve is that its lowest point gives the optimum solution, i.e.,

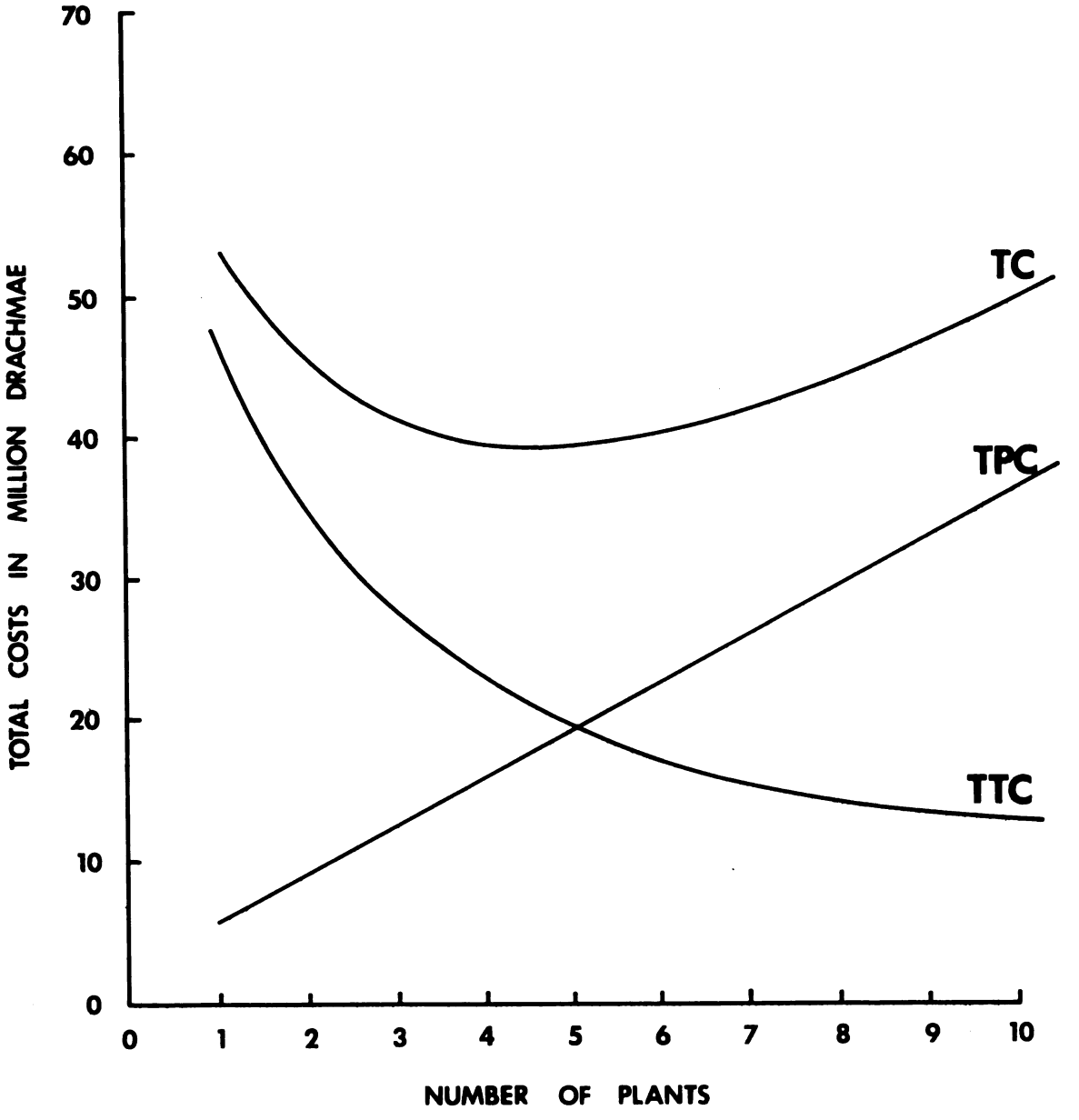


Figure III-1. Determination of the optimum number of plants on the basis of the total (processing and transportation) costs. (Hypothetical data)

the optimum number of slaughtering plants with which the minimum aggregate cost is achieved.

## The Mathematical Model

The mathematical model used in this analysis was developed by King and Logan.[24] It has the following form:

$$\text{Minimize: } Z = \Sigma_i\Sigma_j A_{ij}L_{ij} + \Sigma_j C_j E_j + \Sigma_j\Sigma_k T_{jk}M_{jk}$$

Subject to:

(a) production balance: $\Sigma_i L_{ij} \leq S_i$

(b) consumption balance: $\Sigma_j M_{jk} \geq D_k$

(c) processing balance: $\Sigma_i L_{ij} = E_j = \Sigma_k M_{jk}$

(d) $L_{ij}, E_j, M_{jk} \geq 0$

Where:

$i$ = supply regions; $i = 1,...20$

$j$ = potential slaughtering plants; $j = 1,...10$

$k$ = consumption centers; $k = 1,...21$

$L_{ij}$ = live animals (expressed in meat equivalents in tons), shipped from the supply region i to the slaughtering plant j.

$E_j$ = live animals (expressed in meat equivalents in tons), processed in the slaughtering plant j.

$M_{jk}$ = carcass meat in tons, shipped from the slaughtering plant j to the consumption center k.

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[24] King, Gordon A., and S. H. Logan, "Optimum Location, Number and Size of Processing Plants with Raw Product and Final Product Shipments," Journal of Farm Economics, Vol. 46, No. 1 (February, 1964), 94-108.

$A_{ij}$ = livestock assembly cost in drachmae per ton of meat equivalents, from the supply region i to the slaughterhouse j.

$C_j$ = processing cost in drachmae per ton of meat equivalents of the livestock processed at the slaughter plant j.

$T_{jk}$ = meat transportation cost in drachmae per ton of carcass meat from the slaughter plant j to the consumption center k.

$S_i$ = total supply of livestock slaughterings (expressed in terms of meat equivalents) in tons from the supply region i.

$D_k$ = total meat demand in tons in the consumption center k.

## The Computer Model

The computer model used in this analysis is the "transhipment model." This is a special kind of transportation linear programming model. It is called so because this model studies simultaneously the shipment of a product from its origins to marketing facilities (e.g., processing plants, warehouses, etc.) and the transhipment of the product from these facilities to final destinations. For this reason, the matrix of the transhipment model is accordingly constructed in order to take into consideration all activities involved.

In this study of optimum number, size, and location of processing (slaughtering) plants, the matrix has been divided into three distinct parts, with regard to activities (columns). These are the following:

1. The part referring to the livestock assembly from the production points to the slaughterhouses. The number of activities

(columns) of this part is equal to the number of supply points times the number of processing plants.

2. The part referring to the livestock slaughtering at all the potential slaughterhouses. The number of activities in this part is exactly equal to the number of all potential slaughtering plants.
3. The part referring to the distribution of carcass meat from the slaughterhouses to the consumption points. The number of activities of this part is equal to the number of slaughterhouses times the number of consumption points.

The matrix size for this problem is 81 rows by 420 columns. Of these 420 columns, the first 200 columns represent the potential shipment of live animals from each of the 20 supply points to each of the 10 potential slaughtering plants.

The next columns, i.e., from column 201 to column 210, represent the number of all potential slaughtering plants. These activities reflect the total number of live animals slaughtered and processed in each of these 10 potential plants.

The last 210 columns, i.e., from column 211 to column 420, represent the shipment of carcass meat from each of the 10 potential plants to each of the 21 existing consumption points.

As far as the rows are concerned, the first 20 rows represent the supply of live animals from each of the 20 supply points. The next 10 rows, 21-30, represent "livestock equilibrium" in the processing plants, i.e., what is received from the production points is equal to what is processed in the plants. The next 10 rows, 31-40,

represent the "meat equilibrium," i.e., what is shipped to consumption points is equal to what is processed in the plants. The following 21 rows, 41-61, represent the meat in-shipments to the existing 21 consumption points. The remained 20 rows, 62-81, represent the plant capacities of the potential 10 plants given in a range of maximum and minimum volume which can be processed in each of these plants.

Table III-1 gives an idea as to how the matrix used in this analysis looks. This matrix was basically constructed by Professor Stephen Harsh of Michigan State University and modified by the author to present more neatly the inflow and outflow of the product.

As it is seen in this matrix format (based upon hypothetical data), there are 3 supply regions, A, B and C, 2 processing plants, F and H, and 3 consumption regions, X, Y and Z. These made up a matrix size of 14 rows (3 + 4 + 3 + 4) by 14 columns (3 X 2 + 2 + 3 X 3).

A brief explanation of this matrix format might be worthwhile, since it could give some insights as to how this computer model works. The explanation will follow the matrix structure by rows.

Row 1 shows that the supply region A can ship its total amount of less than or equal to 500 units (as shown in the column of constraints) to both potential plants F and H, as figures of 1 indicate in columns 1 and 2. However, as to what quantity will be shipped from the supply region A to the potential processing plants F and H will depend first on the livestock assembly cost from A to F and H (which in turn, will primarily depend on the corresponding distance) and secondly on the unitary processing cost in each of these two plants. The quantities of raw material shipped out from region A to

Table III-1. Matrix format of the transhipment model under the linear programming formulation.

| Locations | | 1 F | 2 H | 3 F | 4 H | 5 F | 6 H | 7 F | 8 H | 9 X | 10 Y | 11 Z | 12 X | 13 Y | 14 Z | Constraints |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Supply Regions | 1. A | 1 | 1 | | | | | | | | | | | | | ≤ 500 Quantities |
| | 2. B | | | 1 | 1 | | | | | | | | | | | ≤ 300 Supplied |
| | 3. C | | | | | 1 | 1 | | | | | | | | | ≤ 200 |
| Processing Plants | 4. F | 1 | | 1 | | 1 | | -1 | | | | | | | | = 0 Livestock |
| | 5. H | | 1 | | 1 | | 1 | | -1 | | | | | | | = 0 Equilibrium |
| | 6. F | | | | | | | -1 | | 1 | 1 | 1 | | | | = 0 Meat |
| | 7. H | | | | | | | | -1 | | | | 1 | 1 | 1 | = 0 Equilibrium |
| Consumption Centers | 8. X | | | | | | | | | 1 | | | 1 | | | ≥ 350 Quantities |
| | 9. Y | | | | | | | | | | 1 | | | 1 | | ≥ 400 Demanded |
| | 10. Z | | | | | | | | | | | 1 | | | 1 | ≥ 250 |
| Processing Plants | 11. F | | | | | | | 1 | | | | | | | | ≥ 400 |
| | 12. | | | | | | | 1 | | | | | | | | ≤ 700 Plant |
| | 13. H | | | | | | | | 1 | | | | | | | ≥ 300 Capacities |
| | 14. | | | | | | | | 1 | | | | | | | ≤ 600 |
| Unit Cost | | -10 | -15 | -15 | -25 | -20 | -30 | -70 | -85 | - 8 | -20 | - 5 | -12 | -10 | -15 | |
| | | Livestock Assembly Cost | | | | | | Processing Cost | | Meat Transportation Cost | | | | | | |

plants F and H simultaneously appear in rows 4 and 5 under the same columns 1 and 2. Similar explanation can be given for the supply regions B and C. The intersection of rows 4 and 5 with the columns 7 and 8, respectively, give the total amount of raw material processed in each of these plants. These amounts should be equal to the sum of the corresponding quantities shipped to these plants from each of the existing supply regions and thus a zero balance livestock equilibrium appears in the column of constraints with regard to the processing plants.

Columns 9, 10 and 11 under the row 6 show the amounts of finished product (carcass meat) which can be shipped from the slaughtering plant F to each of all existing consumption points X, Y and Z. As to what quantity of meat will be shipped from F to X, Y and Z will depend on the meat transportation cost between them and that in turn will primarily depend on the corresponding distance.

Rows 8, 9 and 10 under the same columns 9, 10 and 11 show the carcass meat outshipment from plant F to consumption points S, Y and Z as simultaneously being in-shipments to these consumption points. Similar explanation can be given for columns 12, 13 and 14 for rows 7 (as out-shipments) and 8, 9 and 10 (as in-shipments). The quantities of carcass meat which should be shipped to each of these consumption regions should be greater than or equal to the quantities appearing in the column of constraints for the corresponding rows 8, 9 and 10.

The intersection of columns 7 and 8 with the rows 6 and 7, respectively, give the total amount of carcass meat shipped out from

each of the plants F and H. These amounts should be equal to the sum of the corresponding quantities shipped to each of the consumption regions and thus a zero balance meat equilibrium appears in the column of constraints with regard to the processing plants.

Rows 11 and 12 give the plant capacity of plant F and rows 13 and 14 give the plant capacity of plant H in a range of greater than or equal to and less than or equal to a given plant capacity as shown in the column of constraints. Columns 7 and 8 give the amounts of raw materials processed in each plant, respectively.

The last row, which is not numbered, gives the unitary costs of assembly, processing, and distribution. The assembly and distribution cost is given as the cost of transporting one unit of the product for the distance involved. For example, the assembly cost 10 appearing in column 1 means that to assemble one unit of live animals (here 1 ton of carcass meat equivalents) from the supply region A to the processing plant F will cost 10 monetary units. The processing costs under the columns 7 and 8 are given as the costs of processing one unit of live animals (here 1 ton of carcass meat equivalent).

The unitary cost figures bear a negative sign in front of them. This is so, because this cost minimization problem is solved in the computer as maximization problem. It is obvious that to maximize the negative cost function is the same thing as to minimize the positive cost function.

The most significant information given by the computer output is the following:

1. The quantities shipped from supply points to processing plants;
2. The quantities processed in each plant;
3. The quantities shipped from processing plants to consumption centers;
4. The aggregate cost of assembly, processing and distribution of the optimal solution;
5. The marginal cost of livestock slaughtering in each plant. That is, how much the total cost of slaughtering in a certain plant will change when the volume of livestock slaughtering in that plant will increase by one unit.

With regard to computer analysis, it has been done in the computer center of Michigan State University. Because of the relatively large size of the matrix (81 rows by 420 columns), the APEX-I[25] copyright computer program has been utilized in this analysis.

## The Analytical Procedure

To generate the appropriate form of data which were required in the determination of optimum number, size and location of livestock slaughtering plants in E. Macedonia, Greece, the following stepwise procedure was employed.

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[25]Control Data Corporation, "APEX-I Reference Manual," Control Data Corporation, Minneapolis, Minnesota, 1974.

a. Location and Volume of Livestock Slaughterings. The first step is the designation of livestock supply areas and the estimation of livestock slaughterings in each area. The latter is described in Chapter IV.

The designation of supply areas in E. Macedonia has been done for each province separately. The basis for the demarkation was the existence of natural barriers, such as rivers, mountains, concentration of villages, etc. The province of Serres was divided into 8 areas, that of Kavala into 5 areas, and the province of Drama into 6 areas. Thus, the entire area of E. Macedonia was subdivided into 19 smaller regions, as they are shown in the following map (Figure III-2).

The supply of slaughterings in each of these regions was represented by one point, since the transhipment model which is used in this analysis is a point-trading model. Generally, each region has been represented by its central locality. However, for regions in which cities or large towns were included, they were selected as representative points, whether or not they were centers of the regions. The rationale for this is that these cities or towns are usually centers of sizable livestock production in addition to being major centers of meat consumption.

Besides these 19 supply regions of livestock slaughterings in E. Macedonia, another supply point was added to represent the livestock and meat imports into the area. The village of Promachon, which lies in the borders of Greece and

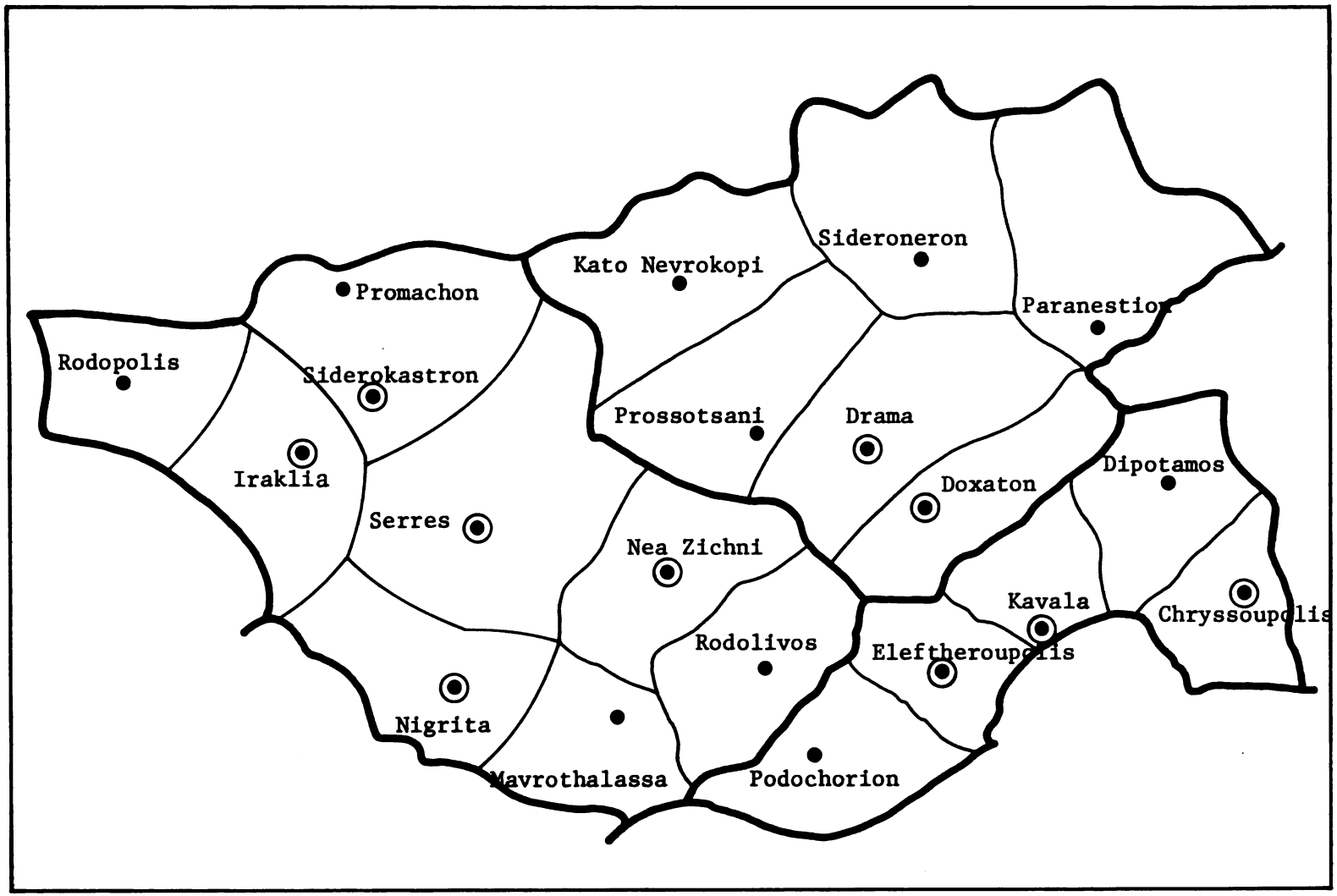


Figure III-2. Map of E. Macedonia, Greece.

Bulgaria was selected. This point was selected because all the imports of both live animals and meat into Greece from Yugoslavia, Rumania and Bulgaria pass through this village.

b. Location and Volume of Meat Consumption. The second step of this analysis is the designation of the meat consumption regions and the estimation of the meat consumption volume in each of these regions. The latter is described in Chapter IV. This designation is exactly the same as that of the livestock slaughtering supply regions, as far as the mainland of E. Macedonia is concerned. In the whole area of E. Macedonia, 19 meat consumption regions were selected, each of which coincides with the 19 livestock supply regions. The representative production points of these regions were also used as the representative consumption points of the same regions.

Beside these 19 meat consumption centers of E. Macedonia, two additional consumption centers were used to represent the regions to which the surplus meat shall be exported. The two largest cities of Greece, Athens and Thessaloniki, were selected as such consumption centers. These cities were selected to be the meat exporting points of E. Macedonia, simply because according to 1972 data,[26] more than 95 percent of the total meat exports from E. Macedonia go to those two cities.

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[26]Provincial Veterinary Offices of the Ministry of Agriculture in Serres, Kavala and Drama.

c. Designation of the Potential Slaughtering Plant Sites. The third procedural step of this analysis is the designation of the potential plant sites. The significance of this step is to estimate the distances between them and all the production and consumption regions. Then, on the basis of these distances, both livestock assembly cost and meat distribution cost per unit of product can be estimated.

The major factor taken into consideration in selecting the potential plant sites was the concentration of livestock production. In regions in which a high density of livestock production exists, the representative points of these regions were selected as candidate plant sites. Another factor which was also important in the selection of the potential plant sites is the proximity of these plants to the existing big consumption centers. Other factors, such as adequate labor supply, abundance of water supply, availability of electricity, access to highways, are also important elements in any plant location analysis. However, in this case these factors were not critical ones because all the regions of the study area seem to meet almost equally well these requirements.

On the basis of the above considerations, the following 10 locations were selected as potential plant sites: Sidirokastron, Iraklia, Serres, Nigrita, Nea Zichni, Eleftheroupolis, Kavala, Chrysoupolis, Doxaton, and Drama. These plant sites are shown in the map (Figure III-2) with a symbol of a circle around a dot. Of these plants, the first five

belong to the province of Serres, the next three in the province of Kavala and the last two in the province of Drama.

After these plant sites have been selected, the next task is to estimate the road distances between them and all the production and consumption points. The distance estimation has been done on the basis of road distance data provided by the Technical Offices of each province. On the basis of these distance data, the distance matrix has been constructed (Appendix Table A-3).

d. Livestock Assembly Cost. The fourth step in this analysis is the estimation of the livestock assembly cost, that is, the cost of shipping live animals from the production points to slaughterhouses. This cost along with the meat distribution cost has been estimated on the basis of data received through questionnaires from trucking companies. Out of 41 truckers in E. Macedonia, 12 have been selected for interview. The criterion of their selection was their heavy involvement in either livestock assembly and/or meat transportation. Their names and the nature of their business was provided by the offices of their unions in the corresponding provinces. The number distribution originally was five for Serres, four for Kavala and three for Drama. Of them, two were not met because they were out of town the day of interview. So, finally ten truckers were interviewed, of whom four are located in Serres and three in both Kavala and Drama. The estimation of livestock assembly cost is presented in the next Chapter IV.

e. Livestock Slaughtering Cost. The fifth procedural step in this analysis is the estimation of processing costs, that is, the in-plant unitary cost of livestock slaughtering. This has been done for different sizes of plants and for different levels of capacity utilization, as it is described in Chapter IV.

f. Meat Distribution Cost. The sixth step in this analysis is the estimation of meat distribution cost, that is, the cost of shipping the carcass meat of slaughtered animals from the slaughterhouses to major representative points (e.g., warehouses of meat wholesalers) of the consumption centers. As to how these cost data have been obtained, it has already been described above, in section (d). The estimation of meat distribution cost is presented in the following Chapter IV.

g. Number, Size, and Location of Slaughtering Plants. The final procedural step in this analysis is the determination of the optimum number, size, and location of slaughter plants. To find this the following procedure was employed:

1. The total number of livestock to be slaughtered (expressed in meat equivalents) in E. Macedonia was divided by the total number (ten) of the potential slaughter plants. Thus, the volume of slaughterings which corresponds to each plant was determined.

2. Plant capacities were determined within a range of zero and 15,500 tons of meat equivalent. The latter figure represents the volume which the largest plant can process annually when it operates at 100 percent of its capacity.

3. Then, the unit cost of processing which corresponds to this volume of slaughterings was calculated. This was the same for all the potential plants in the first run, since it was assumed that in the first run each plant processes one-tenth of the total volume of slaughterings.

4. On the basis of these data, the first run was undertaken in the computer. The output of this run gave the different flows (volumes) of livestock slaughterings which are going to be processed in each plant. These volumes depend on the aggregate cost of livestock assembly and meat distribution.

5. The appropriate unit processing costs were calculated for the corresponding new volumes of slaughterings for each plant.

6. The program with the new processing cost data was run again in the computer and the second output was obtained. This iterative procedure was continued until the total cost (assembly, processing and distribution) did not decline any more.

7. If no further reduction of total costs was achieved in more than two plants, then the plant with the smallest volume was eliminated and the program was run again with the remained number of plants. This was done for different combinations of plant locations of the above number of plants in order to find the optimum (minimum cost) solution.

This trial and error optimization process does not absolutely guarantee global optimum solution, because of economies of scale problem associated with linear programming.

The optimum number of slaughtering plants is given by that number of plants when the minimum cost solution was achieved.

The optimum size of slaughtering plants is determined by the corresponding volume of livestock slaughterings processed in each plant of the optimal solution.

Finally, the optimum location of slaughtering plants is given by the corresponding location of the plants under which the optimal solution was obtained.

## Alternative Solution Models

Six alternative solution models--differing among themselves by some variable or variables--were examined in this analysis in order to evaluate the potential impact which they might have upon the optimum number, size and location of the slaughtering plants.

These models are the following:

1. Basic Model. In this model were considered: (a) 1972 supplies of livestock (cattle, sheep-goats, and hogs) slaughterings; (b) 50 percent capacity utilization of trucks engaged in livestock assembly; (c) 100 percent capacity utilization of trucks engaged in meat distribution; (d) 100 percent capacity utilization of slaughtering plants; (e) use of modern technology in livestock slaughtering; and (f) 20 supply regions, 21 consumption centers and 10 potential slaughter plants.
2. Model II. This model differs from the basic one by only the livestock assembly cost. That is, in this model it is assumed that trucks engaged in livestock assembly are utilized at full capacity instead of 50 percent of their capacity as it was assumed in the basic model.
3. Model III. This model differs from the basic one by the number of production and consumption regions and slaughtering plants. Specifically, in this model the study area of E. Macedonia was divided into only 14 production regions and 15 consumption centers. In addition, only 8 potential plants were considered.

4. Model IV. This model differs from the basic one only by the volumes of the regional livestock supplies. Projected livestock slaughterings instead of those actually taken place in 1972 are considered in this model. These projections basically were made for the year 1977. However, because of their very optimistic view, they are considered as applying to the year 1980.
5. Model V. This model differs from the basic one only by the degree of plant capacity utilization. That is, in this model plants are assumed to operate at 90 percent of capacity instead of 100 percent (full capacity) as assumed in the basic and all the other models. It also refers to 1980 supplies.
6. Model VI. This model differs from the basic one only by the technology used in livestock slaughtering. In particular, in this model is assumed the continuation of the current slaughtering system under which a standard unit processing cost applies to all plants, regardless of their size and degree of capacity utilization. In other words, in this model, no economies of size are assumed in livestock slaughtering.

## Feasibility Assumptions

In a dynamic economic system in which the free enterprise doctrine applies as that of Greece, the exogenous variables which might affect a certain endogenous variable are usually numerous. Therefore, it is practically impossible--from both operational and financial standpoints--to include all the potential causal variables

in a mathematical model. Thus, certain assumptions must be made upon some of the exogenous variables, so that the analysis becomes feasible. For this reason, the assumptions made in this study are called feasibility assumptions. Some of these assumptions are the following:

1. Slaughtering cost function is assumed to be the same in all plants. This implies that all slaughter plants apply the same level of technological improvement and the prices of inputs they use are also the same. This, in effect, means that neither technologies nor inputs affect the optimum solution pattern. Only different plant sizes and capacity utilizations with their different unit processing costs affect the optimal solution.
2. Transportation (both livestock assembly and meat distribution) cost functions are also assumed to be the same in all regions, since the same trucks and under the same conditions (truck capacity utilization, etc.) are assumed to be used in all regions for the relative distances and for the corresponding operations. Only distance is assumed to affect the unit transportation cost, ceteris paribus.
3. Livestock production and meat consumption are considered to be concentrated at one central point of each production and consumption region, respectively. Of course, this may tend to overestimate or underestimate the distances for each region. However, with the large number of origins of supply, and destinations of demand these over- and underestimates may offset each other.

4. All animals supplied for slaughtering are assumed to go through the slaughterhouses. That is, slaughtering of any livestock on farm is considered as not taking place. Otherwise, their total annual volume of slaughterings will be lower and therefore the optimum solution much different.
5. The conversion of raw product (live animals) into the final product (carcass meat) is assumed to be given and constant for each livestock specie. In other words, the average weight of slaughtered animals is assumed to be uniform for each specie.
6. No price changes of the product within regions are assumed to be taking place for the period under consideration.
7. The total demand for the final product (meat) is equal to the total supply of raw product (live animals, as they are expressed in meat equivalents) in the study area.

## Summary

The transhipment model--a special kind of transportation linear programming model--has been utilized in this analysis to determine the optimum number, size and location of slaughtering plants in E. Macedonia, Greece. The basic characteristic of this model is that it takes simultaneously into consideration all the costs involved (assembly, processing and distribution) to give the solution output.

The matrix format has been originally constructed by professor Stephen Harsh of Michigan State University and modified by the author. The size of the matrix used in this analysis is of 81 rows by 420

columns. Because of its large size, the APEX-I computer program has been utilized in the analysis.

The economics underlying the research problem is the least-cost model, i.e., that of minimizing the total costs incurred in producing (processing) a certain amount of output.

To study the problem, the area under consideration has been divided into 19 supply regions which were also consumption regions. One point in each region--generally a central one--was used to represent its livestock production and meat consumption as well. A village of Serres on the border between Greece and Bulgaria was selected as the twentieth supply point to represent all livestock and meat imports in the area. The two largest cities of Greece, Athens and Thessaloniki, were selected as additional consumption centers to represent the exported surplus meat of the area to these cities.

Ten potential slaughter plants were considered to begin with in this study. Their locations coincide with the representative points of ten most densely populated livestock regions.

# CHAPTER IV

# ESTIMATION OF REGIONAL LIVESTOCK SUPPLY AND MEAT CONSUMPTION, LIVESTOCK ASSEMBLY AND PROCESSING, AND MEAT DISTRIBUTION COSTS

## Introduction

This chapter is devoted to making the required estimation of:

a. 1972 regional supplies of livestock slaughterings by species. Also to make their projections to year 1980;
b. the regional meat consumption by kinds of meat;
c. the livestock assembly cost per unit of product by different sizes of trucks and at various distances;
d. the livestock slaughtering cost by sizes of plants and by different levels of capacity utilization;
e. the meat distribution cost per unit of product and by distances that meat is shipped.

All these estimations are used as the basic information data for the computer analysis, whose results shall be presented in the next chapter.

## Estimation and Projections of Regional Livestock Supplies

The annual regional volume of livestock slaughterings was estimated by adding those of all communities included in a specified region. The statistical data on the livestock slaughterings were given both in number of head and in metric tons of carcass meat equivalents. Of these two kinds of figures the latter were used in this analysis. This was done to make possible the summation of the slaughterings of all livestock species undertaken in a region. This study refers to a multi-specie (cattle, sheep, goats and hogs) optimum slaughtering plant location, and the only common denominator which could be used to add the volumes of slaughterings of each specie is to express them in terms of meat equivalents. Table IV-1 presents the annual livestock supplies by regions. It is understandable that this transformation may not give a perfectly accurate picture regarding the estimation of total costs of all livestock assembly and slaughtering, and meat distribution. However, the overall picture of total costs does not seem to deviate much from the reality mainly because the highest portion (65 percent) of all livestock slaughterings in E. Macedonia are cattle, on the basis of which all the cost data were estimated.

The projections of livestock supplies were made by the extension agronomists of the Ministry of Agriculture in each province. They were primarily based upon the trends of livestock production. These projections were made by species and provinces in both number of head and tons of carcass meat. They originally referred to year

Table IV-1. Livestock slaughterings in number of head and in metric tons of carcass meat, E. Macedonia, Greece, 1972.

| Production Regions | Cattle | | Sheep-Goats | | Hogs | | Total Carcass Meat | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of head | Metric Tons of Carcass Meat | Number of Head | Metric Tons of Carcass Meat | Number of | Metric Tons of Carcass Meat | Tons (1972) | % | (1977) |
| 1. Rodopolis | 4,240 | 606 | 15,026 | 123 | 2,782 | 160 | 889 | 7.4 | 1,369 |
| 2. Sidirokastron | 2,644 | 443 | 17,980 | 176 | 2,554 | 153 | 772 | 6.4 | 1,184 |
| 3. Iraklia | 9,802 | 2,135 | 15,777 | 154 | 4,848 | 312 | 2,601 | 21.6 | 3,996 |
| 4. Serres | 11,202 | 2,314 | 49,525 | 518 | 13,347 | 962 | 3,794 | 31.4 | 5,809 |
| 5. Nigrita | 4,294 | 813 | 25,172 | 207 | 5,419 | 337 | 1,357 | 11.2 | 2,072 |
| 6. Mavrothalassa | 1,683 | 285 | 15,121 | 153 | 2,333 | 149 | 587 | 4.9 | 906 |
| 7. Nea Zichni | 4,101 | 754 | 24,709 | 247 | 3,423 | 244 | 1,245 | 10.3 | 1,906 |
| 8. Rodolivos | 1,979 | 405 | 24,642 | 234 | 2,308 | 187 | 826 | 6.8 | 1,258 |
| I. Province of Serres | 39,945 | 7,755 | 187,952 | 1,812 | 37,014 | 2,504 | 12,071 | 100.0 | 18,500 |
| 9. Podochorion | 853 | 106 | 15,131 | 152 | 417 | 25 | 283 | 7.3 | 402 |
| 10. Eleftheroupolis | 2,585 | 392 | 20,562 | 166 | 2,232 | 102 | 660 | 17.0 | 935 |
| 11. Kavala | 3,580 | 667 | 19,038 | 195 | 1,752 | 112 | 974 | 25.0 | 1,375 |
| 12. Chryssoupolis | 5,638 | 1,052 | 32,683 | 321 | 5,996 | 385 | 1,758 | 45.2 | 2,486 |
| 13. Dipotamos | 1,332 | 115 | 13,101 | 85 | 240 | 14 | 214 | 5.5 | 302 |
| II. Province of Kavala | 13,988 | 2,332 | 100,515 | 919 | 10,637 | 638 | 3,889 | 100.0 | 5,500 |
| 14. Doxaton | 4,601 | 888 | 12,793 | 124 | 1,630 | 121 | 1,133 | 29.7 | 1,954 |
| 15. Drama | 6,288 | 1,134 | 20,650 | 184 | 3,968 | 241 | 1,559 | 40.8 | 2,685 |
| 16. Prossotsani | 1,308 | 244 | 25,917 | 210 | 769 | 44 | 498 | 13.1 | 862 |
| 17. Kato Nevrokopi | 1,955 | 272 | 5,716 | 52 | 634 | 39 | 363 | 9.5 | 625 |
| 18. Sidironeron | 554 | 62 | 2,370 | 20 | 105 | 3 | 85 | 2.2 | 145 |
| 19. Paranestion | 906 | 96 | 7,355 | 81 | 78 | 4 | 181 | 4.7 | 309 |
| III. Province of Drama | 15,612 | 2,696 | 74,801 | 671 | 7,184 | 452 | 3,819 | 100.0 | 6,580 |
| 20. Promachon | 329 | 64 | 253,754 | 3,529 | -- | -- | 3,593 | -- | -- |
| IV. Imports | 329 | 64 | 253,754 | 3,529 | -- | -- | 3,593 | -- | -- |
| V. Total Supply | 69,874 | 12,847 | 517,022 | 6,931 | 54,835 | 3,594 | 23,372 | | 30,580 |

Sources: The basic data (slaughterings by villages or towns) have been provided by the provincial offices of the Ministry of Agriculture. Some further processing on those data has been done by the author.

1977. However, because of their very optimistic view--acknowledged also by the specialist agronomists who made the projections--they can be safely considered as applying to the year 1980. The projected livestock supplies of all species combined have as follows: (a) Serres, 18,500 tons of carcass meat; (b) Kavala, 5,500 tons and (c) Drama, 6,580 tons. For entire E. Macedonia they reach the level of 30,580 tons (Table IV-1). No livestock and meat imports are assumed to take place through any point of E. Macedonia in 1980.

The regional projections of livestock supplies were made by allocating province's projected total supplies among its regions. The allocation has been made according to the share of each region to its province's 1972 livestock supplies. That is, first it was calculated the percentage of a province's 1972 total livestock supplies produced in each region of that province. Then, these percentages were multiplied by the projected livestock production of the province in question. Thus the projections of livestock supplies for each region of E. Macedonia were obtained (Table IV-1).

## Estimation of Regional Meat Consumption

Regional meat consumption was calculated as follows:

1. The total meat consumption in each province was estimated by adding net exports (exports minus imports) onto the province's total meat production.
2. Total urban meat consumption of a province was estimated by multiplying the province's urban population (i.e., population of towns having more than 3,000 inhabitants) by the national

per capita red meat (beef, lamb and pork) consumption. The implicit assumption made here is that in towns over 3,000 inhabitants, people will consume meat, at the same level as the average Greek consumer.

3. Total urban meat consumption of each province was subtracted from its total (urban and non-urban) meat consumption. The difference represents the total meat consumption by the non-urban population of the province in question.
4. Total non-urban meat consumption in each province was divided by the total non-urban population of that province. Thus, per capita meat consumption by the non-urban population of each province was estimated.
5. Per capita non-urban meat consumption of a province was multiplied by the non-urban population of every region belonging in the province under consideration. Thus, the total non-urban meat consumption was calculated for each region.
6. Total urban and non-urban meat consumption in each region was added and thus the total regional meat consumption was estimated as shown in Table IV-2. The procedure for calculating per capita non-urban meat consumption in each province is given in Appendix Table A-3.

Provincial and regional population was divided into urban and non-urban simply because there is plenty of evidence not yet tested, indicating that per capita meat consumption of urban population is much higher than that of non-urban population. Given the

Table IV-2. Regional meat consumption in metric tons, E. Macedonia, Greece, 1972.

| Consumption Centers | Population | | | Meat Consumption in Metric Tons, 1972 | | |
|---|---|---|---|---|---|---|
| | Total Population | Urban* Population | Non-Urban Population | Urban | Urban | Total |
| 1. Rodopolis | 11,774 | -- | 11,774 | -- | 378 | 378 |
| 2. Sidirokastron | 18,139 | 10,040 | 8,099 | 416 | 260 | 676 |
| 3. Iraklia | 26,355 | 4,021 | 22,334 | 166 | 715 | 881 |
| 4. Serres | 79,914 | 41,091 | 38,823 | 1,701 | 1,243 | 2,944 |
| 5. Nigrita | 24,184 | 7,301 | 16,883 | 302 | 541 | 843 |
| 6. Mavrothalassa | 9,512 | -- | 9,512 | -- | 305 | 305 |
| 7. Nea Zichni | 16,869 | 3,118 | 13,751 | 129 | 441 | 570 |
| 8. Rodolivos | 16,151 | 3,164 | 12,987 | 131 | 416 | 547 |
| I. Province of Serres | 202,898 | 68,735 | 134,163 | 2,845 | 4,299 | 7,144 |
| 9. Podochorion | 6,461 | -- | 6,461 | -- | 198 | 198 |
| 10. Eleftheroupolis | 21,622 | 6,090 | 15,532 | 252 | 477 | 729 |
| 11. Kavala | 59,230 | 46,887 | 12,343 | 1,941 | 379 | 2,320 |
| 12. Chryssoupolis | 17,979 | 5,785 | 12,194 | 240 | 374 | 614 |
| 13. Dipotamos | 2,985 | -- | 2,985 | -- | 91 | 91 |
| II. Province of Kavala | 108,277 | 58,762 | 49,515 | 2,433 | 1,519 | 3,952 |
| 14. Doxaton | 17,960 | 3,440 | 14,520 | 142 | 395 | 537 |
| 15. Drama | 48,047 | 30,627 | 17,420 | 1,268 | 474 | 1,742 |
| 16. Prossotsani | 13,201 | 3,775 | 9,426 | 156 | 256 | 412 |
| 17. Kato Nevrokopi | 8,225 | -- | 8,225 | -- | 223 | 223 |
| 18. Sidironeron | 2,321 | -- | 2,321 | -- | 63 | 63 |
| 19. Paranestion | 1,255 | -- | 1,255 | -- | 34 | 34 |
| III. Province of Drama | 91,009 | 37,842 | 53,167 | 1,566 | 1,445 | 3,011 |
| 20. Thessaloniki | 556,769 | | | | | 1,853 |
| 21. Athens | 2,540,251 | | | | | 7,412 |
| IV. Exports | | | | | | 9,265 |
| V. Total Consumption | | | | | | 23,372 |

* Urban population is considered here the population of towns of over 3,000 people.

Sources: (1) National Statistical Service of Greece, Population of Greece, Athens, Greece, 1972, pp. 53-55, 92-93 and 157-160 for the data on population. (2) Provincial Offices of the Ministry of Agriculture for the basic data on meat consumption. Further processing of those data has been done by the author.

fact that the volume of meat consumption in each region is an important element in the optimal location of processing plants, this procedure was considered appropriate.

To estimate the quantities of meat shipped to Athens and Thessaloniki, the surplus meat of E. Macedonia was allocated between them in a ratio of four to one, respectively. That is, 80 percent of exported meat was considered as going to Athens and 20 percent as going to Thessaloniki. This allocation structure has been based upon the 1972 proportions of E. Macedonia's red meat exports to these two cities.[27] The exported quantities of meat to these cities are much less of their total meat consumption.

## Estimation of Livestock Assembly Cost

To estimate the livestock assembly cost--the cost of shipping live animals from the supply regions to the slaughterhouses, a small-scale survey was conducted in June, 1974. During this survey, cost data were obtained on meat distribution as well. The questionnaires constructed by the author for these special purposes and used in this survey are given in the Appendices A-1 and A-2.

Ten truckers, engaged in both livestock assembly and meat distribution, were interviewed. The information they provided with regard to livestock assembly refers to: (a) the sizes and types of trucks most commonly used in livestock transportation at various distances; (b) the transportation cost they charge per full load of live

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[27]Data provided by the veterinary offices of the Ministry of Agriculture in Serres, Kavala and Drama.

animals shipped at various distances with different sizes and types of trucks; (c) the degree of capacity utilization of trucks engaged in livestock assembly; (d) the truck capacity in terms of number of head of live animals of each specie.

On the basis of these data, the average livestock assembly cost per full truck load was calculated (Table IV-3). To find the assembly cost per head of cattle or any other specie, assembly cost per full truck load was divided by the number of cattle or other animals which each size of truck can transport (Table IV-3).

In order to estimate the livestock assembly cost in terms of meat equivalents, the assembly cost per head of cattle was multiplied by five, since one head of cattle yields an average carcass weight of about 200 kilograms of meat, or one-fifth of a metric ton. Thus, the livestock assembly cost per ton of meat equivalents is determined at 100 percent of truck capacity utilization (Table IV-4).

To compute the livestock assembly cost in terms of meat equivalents at 50 percent of truck capacity utilization, the assembly cost (in terms of meat equivalent) at full (100 percent) truck capacity utilization was multiplied by two, since to transport a specified volume of live animals, trucks of certain size utilized at 50 percent of their capacity have to make twice as many trips as the same truck when it is utilized at full capacity (Table IV-4).

In this analysis, the assembly cost rates of two ton trucks has been used, since this was the most commonly used truck in the study area, as indicated by truckers and butchers interviewed. Furthermore, the cost rates of two ton trucks at 50 percent of capacity

Table IV-3. Livestock assembly cost rates in terms of number of head, E. Macedonia, Greece, June 1974.

| Range of Distances in Kilometers | Cost of Livestock Assembly in Drachmae per full Truck Load | | | | Cost of Livestock Assembly in Drachmae per Head of Cattle (1) | | | |
|---|---|---|---|---|---|---|---|---|
| | Trucks of 1/4 to 1/2 tons | Trucks of 1 to 1 1/2 tons | Trucks of 2 to 2 1/2 tons | Trucks of 4 tons | Trucks of 1/4 to 1/2 tons | Trucks of 1 to 1 1/2 tons | Trucks of 2 to 2 1/2 tons | Trucks of 4 tons |
| 0 - 10 | 150 | 170 | 190 | 200 | 75 | 43 | 32 | 25 |
| 11 - 20 | 200 | 220 | 250 | 270 | 100 | 55 | 42 | 34 |
| 21 - 30 | 250 | 270 | 270 | 320 | 125 | 68 | 45 | 40 |
| 31 - 40 | 350 | 380 | 380 | 400 | 175 | 95 | 63 | 50 |
| 41 - 50 | 380 | 400 | 400 | 450 | 190 | 100 | 67 | 56 |
| 51 - 100 | 420 | 500 | 500 | 650 | 210 | 125 | 83 | 81 |
| 101 - 150 | 700 | 700 | 700 | 900 | 350 | 175 | 117 | 113 |
| 151 - 200 | 750 | 800 | 800 | 1,000 | 375 | 200 | 133 | 125 |

Source: Interviewed truckers in the three provinces, Serres, Kavala, Drama of E. Macedonia, Greece, in June 1974.

(1) To find the assembly cost per head of cattle, the assembly cost per full truck load was divided by the number of cattle which each size of truck can transport. These data are as follows according to the interviewed truckers:

| Truck Size | Capacity of Trucks in Terms of Live Animals |
|---|---|
| 1. Trucks of 1/4 to 1/2 tons | 2 cattle, or 25 lambs, or 8 hogs |
| 2. Trucks of 1 to 1 1/2 tons | 4 cattle, or 35 lambs, or 12 hogs |
| 3. Trucks of 2 to 2 1/2 tons | 6 cattle, or 40 lambs, or 14 hogs |
| 4. Trucks of 4 tons | 8 cattle, or 55 lambs, or 18 hogs |

Table IV-4. Livestock assembly cost rates, in terms of meat equivalents, E. Macedonia, Greece, June 1974.

| Distance Ranges in Kilometers | Cost of Livestock Assembly (Expressed in Meat Equivalents) Under Full Capacity Utilization of Trucks, in Drachmae per Ton (1) | | | | Livestock Assembly Cost (Expressed in Terms (2) of Meat Equivalents) in Drachmae per Ton of Meat, Under 50 Percent of Truck Capacity Util. | | | |
|---|---|---|---|---|---|---|---|---|
| | Trucks of 1/4 to 1/2 tons | Trucks of 1 to 1 1/2 tons | Trucks of 2 to 2 1/2 tons | Trucks of 4 tons | Trucks of 1/4 to 1/2 tons | Trucks of 1 to 1 1/2 tons | Trucks of 2 to 2 1/2 tons | Trucks of 4 tons |
| 0 - 10 | 375 | 215 | 160 | 125 | 750 | 430 | 320 | 250 |
| 11 - 20 | 500 | 275 | 210 | 170 | 1,000 | 550 | 420 | 340 |
| 21 - 30 | 625 | 340 | 225 | 200 | 1,250 | 680 | 450 | 400 |
| 31 - 40 | 875 | 475 | 315 | 250 | 1,750 | 950 | 630 | 500 |
| 41 - 50 | 950 | 500 | 335 | 280 | 1,900 | 1,000 | 670 | 560 |
| 51 - 100 | 1,050 | 625 | 415 | 405 | 2,100 | 1,250 | 830 | 810 |
| 101 - 150 | 1,750 | 875 | 585 | 565 | 3,500 | 1,750 | 1,170 | 1,130 |
| 151 - 200 | 1,875 | 1,000 | 665 | 625 | 3,750 | 2,000 | 1,330 | 1,250 |

Source: Table IV-3.

(1) To find the livestock assembly cost in terms of meat equivalents, the assembly cost per head of cattle (Table IV-3) was multiplied by 5, since 1 cattle yields an average weight of carcass meat of about 200 kilograms, or one-fifth of a metric ton.

(2) To find the livestock assembly cost in terms of meat equivalents, at 50 percent of truck capacity utilization, the assembly cost at full capacity was multiplied by two, since to transport the same volume, the truck has to make double trips when it is used at 50 percent of its capacity than when it is used at full capacity.

utilization was used in the basic solution model, since the interviewed marketing firms have indicated that this is the most common case in livestock assembly in the area of E. Macedonia.

## Estimation of the Livestock Processing Cost

To estimate the total cost--and through them the unit cost--of livestock slaughtering for different plant sizes, input-output requirements must first be determined and then cost rates on them must be applied. In this analysis, the slaughtering cost data were basically obtained from the FAO study.[28] However, some adjustments have been made on these data in order to incorporate in them the inflation which took place since 1966 when the FAO study was conducted, and also the input price differentials whenever they exist among the various regions for some inputs.

From the 17 different plants of various locations (provinces) analyzed by the aforementioned FAO study, only 7 plants with distinctly different sizes were selected in this analysis. These are the plants of Tripolis, Ioannina, Lamia, Didymotichon, Komotini, Kavala-Drama, and Trikala-Karditsa. These plants were labeled with the letters A, B, C, D, E, F, and G, respectively.

The process of reestimating the slaughtering cost in the above mentioned 7 plants under conditions of E. Macedonia at 1974 price levels is shown in Table IV-5. However, for a better understanding of this table, a brief explanation on the costing follows.

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[28] Ibid.

Table IV-5. Cost of livestock slaughtering by sizes of plants and at full capacity utilization, E. Macedonia, Greece.

| Cost Items | Slaughtering Plants | | | | | | |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G |
| 1. Plant capacity (in tons of carcass meat per day) | 11 | 16 | 20 | 28 | 32 | 38 | 62 |
| 2. Plant capacity (in tons of carcass meat annually) | 2,750 | 4,000 | 5,000 | 7,000 | 8,000 | 9,500 | 15,500 |
| 3. Area of the slaughterhouse buildings (in sq. meters) | 1,290 | 1,300 | 1,800 | 2,150 | 2,380 | 2,530 | 2,885 |
| 4. Costs of the slaughterhouse buildings in thousand drachmae (1966 prices) | 7,888 | 7,950 | 11,007 | 13,147 | 14,554 | 15,470 | 17,642 |
| 5. Costs of equipment in thousand drachmae (1966 prices) | 1,910 | 1,960 | 2,500 | 3,280 | 3,680 | 3,870 | 4,440 |
| 6. Costs of buildings and equipment in thousand drachmae (1966 prices) | 9,798 | 9,910 | 13,507 | 16,427 | 18,234 | 19,340 | 22,082 |
| 7. Costs of buildings and equipment in thousand drachmae (1974 prices | 15,158 | 15,330 | 20,895 | 25,413 | 28,208 | 29,919 | 34,160 |
| 8. Area of land used by the slaughter-house (in square kilometers) | 9 | 11 | 12 | 15 | 17 | 18 | 20 |
| 9. Value of land used by the slaughterhouse in thousand drachmae (1974 prices) | 270 | 330 | 360 | 450 | 510 | 540 | 600 |
| 10. Total costs of buildings, equipment and land in thousand drachmae (1974 prices) | 15,428 | 15,660 | 21,255 | 25,863 | 28,718 | 30,459 | 34,760 |
| 11. Annual costs of buildings, equipment and land in thousand drachmae (1974 prices) | 1,929 | 1,958 | 2,657 | 3,233 | 3,590 | 3,807 | 4,345 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 12. Wages of the labor used in plant operation in thousand drachmae (1966 prices) | 880 | 1,240 | 1,960 | 2,240 | 2,640 | 2,640 | 3,240 |
| 13. Wages of the labor used in plant operation in thousand drachmae (1974 prices) | 1,361 | 1,918 | 3,032 | 3,465 | 4,084 | 4,084 | 5,012 |
| 14. Cost of oil used in operation in thousand drachmae (1966 prices) | 28.5 | 65 | 120 | 200 | 215 | 244 | 400 |
| 15. Cost of oil used in operation in thousand drachmae (1974 prices) | 98 | 223 | 412 | 687 | 738 | 838 | 1,373 |
| 16. Costs of electricity and water utilized in thousand drachmae (1966 prices) | 147 | 339 | 360 | 612 | 646 | 732 | 1,200 |
| 17. Costs of electricity and water utilized in thousand drachmae (1974 prices) | 227 | 524 | 557 | 947 | 999 | 1,132 | 1,856 |
| 18. Administration expenses (wages) in thousand drachmae (1966 prices) | 400 | 550 | 600 | 850 | 850 | 1,000 | 1,250 |
| 19. Administration expenses (wages) in thousand drachmae (1974 prices) | 619 | 851 | 928 | 1,315 | 1,315 | 1,547 | 1,934 |
| 20. Maintenance and process supplies expenses in thousand drachmae (1966 prices) | 158 | 199 | 300 | 346 | 386 | 410 | 510 |
| 21. Maintenance and process supplies expenses in thousand drachmae (1974 prices) | 244 | 308 | 464 | 535 | 597 | 634 | 789 |
| 22. Total fixed costs of slaughterhouse operation in thousand drachmae (1974 prices) | 2,670 | 2,963 | 3,817 | 4,816 | 5,204 | 5,671 | 6,674 |
| 23. Total variable costs of slaughterhouse operation in thousand drachmae (1974 prices) | 2,055 | 2,964 | 3,433 | 4,319 | 4,926 | 5,814 | 8,202 |
| 24. Total costs of slaughterhouse operation in thousand drachmae (1974 prices) | 4,725 | 5,927 | 7,250 | 9,135 | 10,130 | 11,485 | 14,875 |
| 25. Unit (ton of carcass meat) cost of slaughterhouse operation in drachmae (1974 prices) | 1,718 | 1,482 | 1,450 | 1,305 | 1,266 | 1,209 | 960 |

Source: FAO, "Marketing of Livestock and Meat in Greece," Rome, 1967, Table 25. The basic data obtained from this source have been further processed by the author in order to make the appropriate adjustments.

1. The total costs of buildings in the Kavala-Drama plant (as it was calculated by the FAO study) was divided by the area covered by the buildings of this plant in order to find the costs of buildings per square meter. This cost then has been applied to all seven plants in order to take into consideration the regional input price differentials, since this Kavala-Drama plant belongs in the area of E. Macedonia.

2. The unit cost of buildings per square meter has been multiplied by the area in square meters which the buildings of each of these slaughter plants cover. Thus, the value of buildings of all seven plants under conditions of E. Macedonia but at 1966 price level have been calculated.

3. These costs of buildings and equipment (as given originally in the FAO study since they are mostly imported items) were summed up. Their sum then was multiplied by 154.7, because inflation has risen by 54.7 percent on the average from 1966 to 1974. Thus, the 1974 prices of buildings and equipment were estimated.

4. The value of the land covered by each slaughter plant was calculated by multiplying their corresponding total land area in stremmata (1,000 square kilometers) by 30,000 drachmae--the average price of a stremma in these areas--according to 1974 land cost data.[29]

5. The sum of costs of buildings, equipment and land at 1974 prices was multiplied by 12.5 to estimate the annual costs (interest

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[29]Data provided by the extension agronomists of the Ministry of Agriculture in Serres, Kavala and Drama.

of the money invested on buildings, equipment and land, depreciation for buildings and equipment and taxes for land). This 12.5 percentage for calculating these annual costs has been used by the authors of the FAO study and this percentage has been adopted in this analysis, because it seems to be a fairly realistic one under the present economic situation in Greece.

6. The costs of all but oil items (e.g., electricity, water) were adjusted to 1974 price level from that of 1966, by multiplying their 1966 costs by 154.7 in order to incorporate in them the inflation of 54.7 percent which took place on the average from 1966 to 1974.

7. To adjust oil's 1966 cost to 1974 prices, its 1966 cost was multiplied by 343.3, since the price of oil has increased by 243.3 percent in Greece from 1966 to 1974.

8. To calculate the annual total fixed costs (TFC) of a slaughter plant, the following cost items were added: (a) annual costs of buildings, equipment and land; (b) all the administrative expenses; and (c) one-half of maintenance and other (office supplies, etc.) expenses.

9. To calculate the annual total variable costs (TVC) of a slaughter plant, the following cost items were added: (a) the cost of labor; (b) the cost of oil, water, electricity; and (c) one-half of the maintenance and other (office supplies, telephone, etc.) expenses.

10. To estimate the livestock slaughtering cost per unit (actually per ton of carcass meat equivalents), the total costs (TC), i.e., the

sum of total fixed and variable costs, were divided by the annual volume of livestock slaughterings (expressed in terms of meat equivalents) of the corresponding plant size.

To indicate whether or not economies of size are in existence in these 7 slaughterhouses of different sizes, their short-run (SR) costs were calculated (Appendix Table A-5) and the corresponding SR cost curves are graphically presented in Figure IV-1. In each cost curve, the numbers 1, 2, 3 and 4 represent 80, 90, 100 and 110 percent of plant capacity utilization respectively. Capital letters A, B, C, D, E, F and G reflect the sizes of plants equivalent to 2,750, 4,000, 5,000, 7,000, 8,000, 9,500 and 15,500 metric tons of carcass meat respectively.

These SR slaughtering cost curves were constructed on the basis of the following calculations:

1. The volumes of livestock slaughterings (always expressed in terms of meat equivalents in this analysis) were calculated for four different levels (80, 90, 100 and 110 percent) of plant capacity utilization.
2. The total variable costs for these different levels of plant capacity utilization were calculated by multiplying the percentages of plant capacity utilization by the total variable cost of the plant in question.
3. This new TVC was added to the unchanged TFC and a new TC of processing for the corresponding volume of livestock slaughterings was calculated.

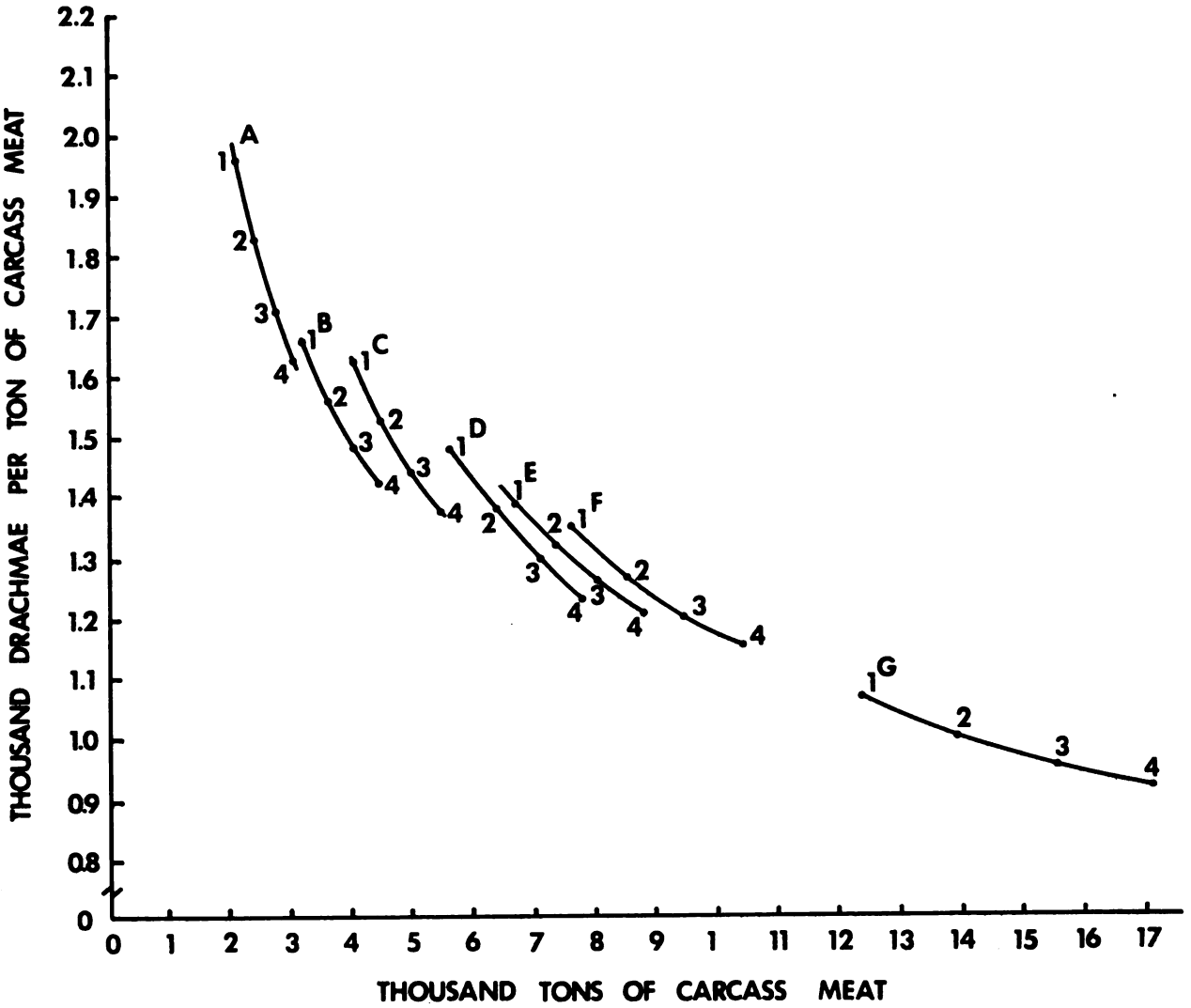


Figure IV-1: Short-run cost curves of seven different size livestock slaughtering plants, E. Macedonia, Greece, 1974.

4. This new total slaughtering cost was divided by the corresponding volume of livestock slaughterings and thus, the unit cost of processing for the respective level of plant capacity utilization was calculated.
5. On the basis of unit processing cost (presented on the vertical axis) and the corresponding volume of livestock slaughterings (presented on the horizontal axis) the SR cost curves of Figure IV-1 were constructed.

## Estimation of Meat Distribution Cost

The basic data required for estimating the meat distribution cost--the cost of shipping carcass meat from slaughterhouses to consumption centers--were obtained through the same survey used for obtaining the livestock assembly cost data. Details as to how this survey was conducted have been given already in section four of this chapter.

The information provided by the interviewed truckers with regard to meat transportation cost refers to: (a) the sizes and types of trucks most commonly used in meat transportation at various distances; (b) the transportation cost they charge per ton of carcass meat for different distances; (c) the degree of capacity utilization of trucks engaged in meat transportation, etc.

On the basis of these data, the average unit meat transportation cost was calculated. The unit cost is given in drachmae per ton of carcass meat shipped at different distances and with the corresponding sizes of trucks, utilized at full capacity. (Table IV-6).

Table IV-6. Meat transportation cost rates in drachmae per metric ton of carcass meat, E. Macedonia, Greece, June 1974.

| Distance Ranges in Kilometers | Meat Transportation Cost Rates in Drachmae per Ton of Carcass Meat Under Full Truck Capacity Utilization | Size of Truck Most Commonly Used for the Corresponding Distances in Meat Transportation |
|---|---|---|
| 1 - 30 | 300 | 2.5 or 6 tons |
| 31 - 60 | 350 | |
| 61 - 100 | 400 | |
| 101 - 150 | 500 | 6, 10, or 12 tons |
| 151 - 200 | 600 | |
| 201 - 300 | 800 | |
| 301 - 400 | 1,000 | 10 or 12 tons |
| 401 - 500 | 1,200 | |
| 501 - 600 | 1,400 | |
| 601 - 700 | 1,600 | |

Source: Questionnaires having the interviews with ten truckers in E. Macedonia, Greece, in June 1974.

As this table shows, the longer the distance, the bigger trucks are utilized in meat transportation, since the chances of shipping large amounts of carcass meat are greater.

As the interviewed truckers have indicated, the trucks which are used for shipping carcass meat to distances beyond 30 kilometers should be equipped with a refrigerating system. Within the distance of one to 30 kilometers any type of non-refrigerated truck can be used. In relatively short distances of one to ten kilometers--a usual distance between a slaughterhouse location and the nearest large consuming center--the most commonly used truck is the tricycle of 1/2 ton capacity or any other small non-refrigerated truck.

## Summary

In this chapter, the regional livestock production and meat consumption, the unit livestock assembly and processing cost, and the unit meat transportation costs were estimated.

These estimates are very important because they are the basic data for the computer analysis. Specifically, the regional livestock supply and meat consumption (along with plant sizes) constitute the "constraints" column of the computer matrix while unit livestock assembly and processing and meat distribution costs constitute its "unit cost" row.

Regional livestock slaughtering supplies were estimated on the basis of 1972 slaughterings of each community which belongs in the region under consideration. That is, the livestock slaughterings (expressed in tons of carcass meat) of all communities belonging in

a certain region were added up and thus gave the region's livestock supplies for the year 1972. The projections of livestock supplies for each region were made by allocating each province's livestock projections to every region belonging in that province in accordance with the region's share to its province 1972 supplies.

Regional meat consumption was estimated as follows: each region's urban population was multiplied by the national per capita meat consumption to give the total meat consumption of the urban population of the region in question. On this was added the total meat consumption by the non-urban population of the region. The latter was estimated by subtracting the total net meat exports from the total meat production of the province in which the region in question belongs. From this difference the province's total urban meat consumption was subtracted to arrive at the total non-urban meat consumption. This, then was divided by its total non-urban population to obtain per capita meat consumption of the non-urban population of the province in question. Then, this was multiplied by the total non-urban population of each region belonging in the province in question to obtain the total regional non-urban meat consumption.

Livestock assembly and meat distribution costs per unit of product have been estimated on the basis of cost data provided by ten interviewed truckers of the area engaged in these activities. These unit costs are averages of the cost data of all interviewed truckers and refer to both shipping distances and sizes of trucks employed.

The unit livestock processing cost was estimated for different sizes of plants and different levels of their capacity utilization. The basic livestock, processing cost data were taken from the FAO report. Only the appropriate adjustments were made on them to incorporate both the inflation taken place since the study was conducted and also the local prices of the inputs (labor, land, etc.) used.

# CHAPTER V

# NUMBER, SIZE AND LOCATION OF LIVESTOCK SLAUGHTERING PLANTS

## Introduction

This chapter contains the empirical results of the computer analysis undertaken on the basis of the data generated in the previous chapter. These results refer to:

a. the optimum number, size and location of the slaughtering plants;
b. the optimum flow of live animals from the supply regions to the slaughtering plants;
c. the optimum flow of carcass meat from the slaughtering plants to the consumption centers; and
d. the minimum aggregate costs of livestock assembly, processing and meat distribution.

A set of two tables summarize the results of the optimum solution in each model. The first table gives the optimum flow of live animals from the supply regions to the slaughterhouses, as well as the total livestock volume supplied by each region. The second table gives the optimum flow of carcass meat from the slaughterhouses to the consumption centers, as well as the total meat volume consumed

in each consumption center (region). Both tables give the optimum number, size and location of the slaughtering plants.

A brief elaboration of the findings is added, accompanied by the relevant graphs whenever it is felt necessary. Furthermore, a comparative analysis of these findings for all the alternative solution models will follow in order to facilitate the decision-making process.

## The Basic Solution Model

As it has already been described in the previous chapter, this model is characterized by: (1) 1972 livestock supplies; (2) 50 percent capacity utilization of trucks engaged in livestock assembly; (3) 100 percent capacity utilization of trucks engaged in meat distribution; (4) 100 percent capacity utilization of slaughtering plants; (5) use of modern technology in livestock slaughtering; and (6) 20 supply regions, 21 consumption centers and 10 potential slaughtering plants.

The optimum (minimum cost) solution of this model was obtained for two plants, those located in Serres and Kavala. The plant sizes are 15,500 tons of carcass meat for Serres and 8,000 tons for Kavala. The first plant is used at full capacity, while the second one is used at about 97 percent of its capacity. As mentioned in Chapter III, no plant is allowed to be utilized above its full capacity.

The procedure for determining the optimum number of plants was described in the previous chapter. This is a stepwise procedure.

It starts from all the potential plants and ends up with the optimum number. Indeed, the computer analysis has shown that as the number of ten potential plants was reduced--and therefore the volume processed in each of the remained plants was increased--total costs (processing plus transportation) were continuously declining. When the number of plants was reduced to four, the solution was stabilized. That is, total costs did not automatically decline further since neither the number of plants declined nor the volume of livestock processed by each plant changed in the next computer run. At first glance, one might think that this was the optimal solution. However, when the number of plants was reduced to three--by eliminating the plant with the smallest processing volume--total costs continued declining. They continued to do so until the number of plants became two. The analysis did not proceed further to one plant, since the biggest plant (15,500 tons of carcass meat) under consideration in this study cannot process all the livestock supplies equivalent to 23,372 tons of carcass meat. In addition, looking at Figure IV-1 (p. 89) it is clearly seen that the long-run slaughtering cost curve (the envelop curve of the short-run cost curves--which does not appear in the graph) has almost flattened beyond the level of 15,500 metric tons of carcass meat equivalents. This means that no significant economies in slaughtering would be expected to be realized with a plant of size, say, 24,000 metric tons of carcass meat equivalents, so that to be capable of processing all the supplied livestock in the area which amounts to 23,372 metric tons of carcass meat equivalents. In contrast, total transportation cost (livestock assembly plus meat

distribution) is expected to substantially increase with one slaughter plant, since both livestock and meat must be transported in relatively longer distances. In other words, with only one slaughtering plant in E. Macedonia, total transportation cost is expected to increase more than slaughtering cost is expected to decrease and thus total costs would be greater as compared to two slaughtering plant system. Given the fact that total costs were lower under two plants than under any larger number of plants, the optimum number of livestock slaughter plants is two in the area of E. Macedonia under the specified conditions of this analysis.

The optimum size of plants is simultaneously determined with the optimum number of plants. This is given by the volume which each plant is going to process according to the computer analysis. If this volume does not coincide exactly with the size of any one of the seven plant models considered in this study (p. 88), then the size of the plant model which approximates the most to the estimated volume of livestock to be processed by a certain plant specifies its optimum size. Thus, for the plant of Serres the optimum plant size is 15,500 tons of carcass meat, since the optimum solution has determined this amount to be processed by this plant. For the plant of Kavala the optimum plant size is 8,000 tons of carcass meat since the remained volume of 7,872 tons which was estimated to be processed by the plant of Kavala approximates the most to the model plant size of 8,000 tons of carcass meat.

To find the optimum location of the two (optimum number) plants, various combinations of two plant sites were investigated.

However, these combinations were restricted to most reasonable ones, i.e., to those locations in which either livestock production in the first place or meat consumption in the second place or both are in high density.

The following three combinations of two plant sites were examined:

a. Serres - Kavala, yielding a total cost of 51.38 million drachmae;
b. Serres - Drama, yielding a total cost of 51.59 million drachmae; and
c. Serres - Doxaton, yielding a total cost of 51.92 million drachmae.

As it is seen above, the combination of Serres - Kavala plants gave the minimum aggregate costs of livestock assembly and processing, and meat distribution. This implies that the optimum location of plants under the specified conditions of this basic solution model is Serres and Kavala.

This optimum solution reveals that economies of size exist in livestock processing, since as the number of plants was reduced--and therefore the size of plants was increased--total costs of processing and transportation were declined. It is interesting also that the plants have a tendency to be located in those regions in which either livestock production or meat consumption or both are high. It is noticeable that the biggest plant of the optimal solution is located in the region of Serres which ranks first in both

livestock production and meat consumption and is centrally located. However, the other optimum plant location is Kavala despite that it is not centrally located and its region ranks eighth in the volume of livestock supply, but which ranks second in the volume of total meat consumption.

This optimum solution seems to be a logical one, because in areas of dense livestock production the assembly cost is expected to be comparatively low, since trucks do not have to travel in relatively long distances to assemble the live animals available for slaughtering. On the other hand, in regions with high meat consumption, the meat distribution cost is expected to be low, since it is not necessary for carcass meat to be shipped relatively long distances from the slaughterhouses to reach the consumption centers.

Table V-1 gives the optimum flow of live animals (expressed in terms of meat equivalents) from the supply regions to the slaughtering plants of Serres and Kavala. It is readily seen from this table that the slaughtering plant of Serres is supplied by all the surrounding regions of the province of Serres, except that of Mavrothalassa which supplies the plant in Kavala. The plant of Serres also processes all the imported livestock. Prossotsani, a region of the province of Drama, partially supplies the plant of Serres. The plant of Kavala is supplied by the rest of the regions.

Table V-2 gives the optimum flow of carcass meat from the slaughtering plants of Serres and Kavala to consumption centers. As this table indicates, the plant of Serres supplies with carcass meat all the regions of the province of Serres, plus two regions--

Table V-1. Flow of live animals from the production regions to the slaughterhouses, E. Macedonia, Greece, 1972 (volume measured in metric tons of carcass meat): basic model.

| Supply Regions | Slaughtering Plants | | | | | | | | | | Total livestock supply by each region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sidirokastron | Iraklia | Serres | Nigrita | Nea Zichni | Eleftheroupolis | Kavala | Chryssoupolis | Doxaton | Drama | |
| 1. Rodopolis | | | 889 | | | | | | | | 889 |
| 2. Sidirokastron | | | 772 | | | | | | | | 772 |
| 3. Iraklia | | | 2,601 | | | | | | | | 2,601 |
| 4. Serres | | | 3,794 | | | | | | | | 3,794 |
| 5. Nigrita | | | 1,357 | | | | | | | | 1,357 |
| 6. Mavrothalassa | | | | | | | 587 | | | | 587 |
| 7. Nea Zichni | | | 1,245 | | | | | | | | 1,245 |
| 8. Rodolivos | | | 826 | | | | | | | | 826 |
| 9. Podochorion | | | | | | | 283 | | | | 283 |
| 10. Eleftheroupolis | | | | | | | 660 | | | | 660 |
| 11. Kavala | | | | | | | 974 | | | | 974 |
| 12. Chryssoupolis | | | | | | | 1,758 | | | | 1,758 |
| 13. Dipotamos | | | | | | | 214 | | | | 214 |
| 14. Doxaton | | | | | | | 1,133 | | | | 1,133 |
| 15. Drama | | | | | | | 1,559 | | | | 1,559 |
| 16. Prossotsani | | | 423 | | | | 75 | | | | 498 |
| 17. Kato Nevrokopi | | | | | | | 363 | | | | 363 |
| 18. Sidironeron | | | | | | | 85 | | | | 85 |
| 19. Paranestion | | | | | | | 181 | | | | 181 |
| 20. Promachon | | | 3,593 | | | | | | | | 3,593 |
| Total Livestock Processing in each Slaughterhouse | | | 15,500 | | | | 7,872 | | | | 23,372 |

Table V-2. Flow of carcass meat in metric tons from the slaughterhouses to the consumption centers, E. Macedonia, Greece, 1972: basic model.

| Supply Regions | Slaughtering Plants | | | | | | | | | | Total livestock supply by each region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sidirokastron | Iraklia | Serres | Nigrita | Nea Zichni | Eleftheroupolis | Kavala | Chrissoupolis | Doxaton | Drama | |
| 1. Rodopolis | | | 378 | | | | | | | | 378 |
| 2. Sidirokastron | | | 676 | | | | | | | | 676 |
| 3. Iraklia | | | 881 | | | | | | | | 881 |
| 4. Serres | | | 2,944 | | | | | | | | 2,944 |
| 5. Nigrita | | | 843 | | | | | | | | 843 |
| 6. Mavrothalassa | | | 305 | | | | | | | | 305 |
| 7. Nea Zichni | | | 570 | | | | | | | | 570 |
| 8. Rodolivos | | | 547 | | | | | | | | 547 |
| 9. Podochorion | | | | | | | 198 | | | | 198 |
| 10. Eleftheroupolis | | | | | | | 729 | | | | 729 |
| 11. Kavala | | | | | | | 2,320 | | | | 2,320 |
| 12. Chryssoupolis | | | | | | | 614 | | | | 614 |
| 13. Dipotamos | | | | | | | 91 | | | | 91 |
| 14. Doxaton | | | | | | | 537 | | | | 537 |
| 15. Drama | | | | | | | 1,742 | | | | 1,742 |
| 16. Prossotsani | | | 412 | | | | | | | | 412 |
| 17. Kato Nevrokopi | | | 223 | | | | | | | | 223 |
| 18. Sidironeron | | | | | | | 63 | | | | 63 |
| 19. Paranestion | | | | | | | 34 | | | | 34 |
| 20. Thessaloniki | | | 1,853 | | | | | | | | 1,853 |
| 21. Athens | | | 5,868 | | | | 1,544 | | | | 7,412 |
| Total Livestock Processing in each Slaughterhouse | | | 15,500 | | | | 7,872 | | | | 23,372 |

Prossotsani and Kato Nevrokopi--of the province of Drama, and lastly the exporting points of Thessaloniki and Athens (partially). The plant of Kavala supplies all the regions of the province of Kavala, all but the aforementioned regions of the province of Drama, and partially Athens.

The optimum flows of both livestock slaughterings and carcass meat is also given graphically in Figure V-1. The two-way arrows mean that a region supplying a slaughter plant with live animals is also receiving carcass meat from that plant. One-way arrow from a supply region to a slaughter plant means that while this region supplies with livestock the indicated plant, it does not receive back carcass meat from that plant. To the contrary, one-way arrow from a slaughter plant to a region means that while this plant supplies carcass meat to that region, it does receive from it any livestock supplies.

## The Alternative Solution Model II

This model differs from the basic one by only the livestock assembly cost. Specifically, it was assumed that under this model, the trucks engaged in livestock assembly will be utilized at full capacity instead of 50 percent capacity assumed in the basic model.

The optimum solution of this model ended up with the same number, size and location of the slaughter plants as that of the basic model. Concretely, the optimum solution of this model consists of two plants, located in Serres and Kavala and having sizes equivalent to 15,500 and 8,000 tons of carcass meat, respectively, since

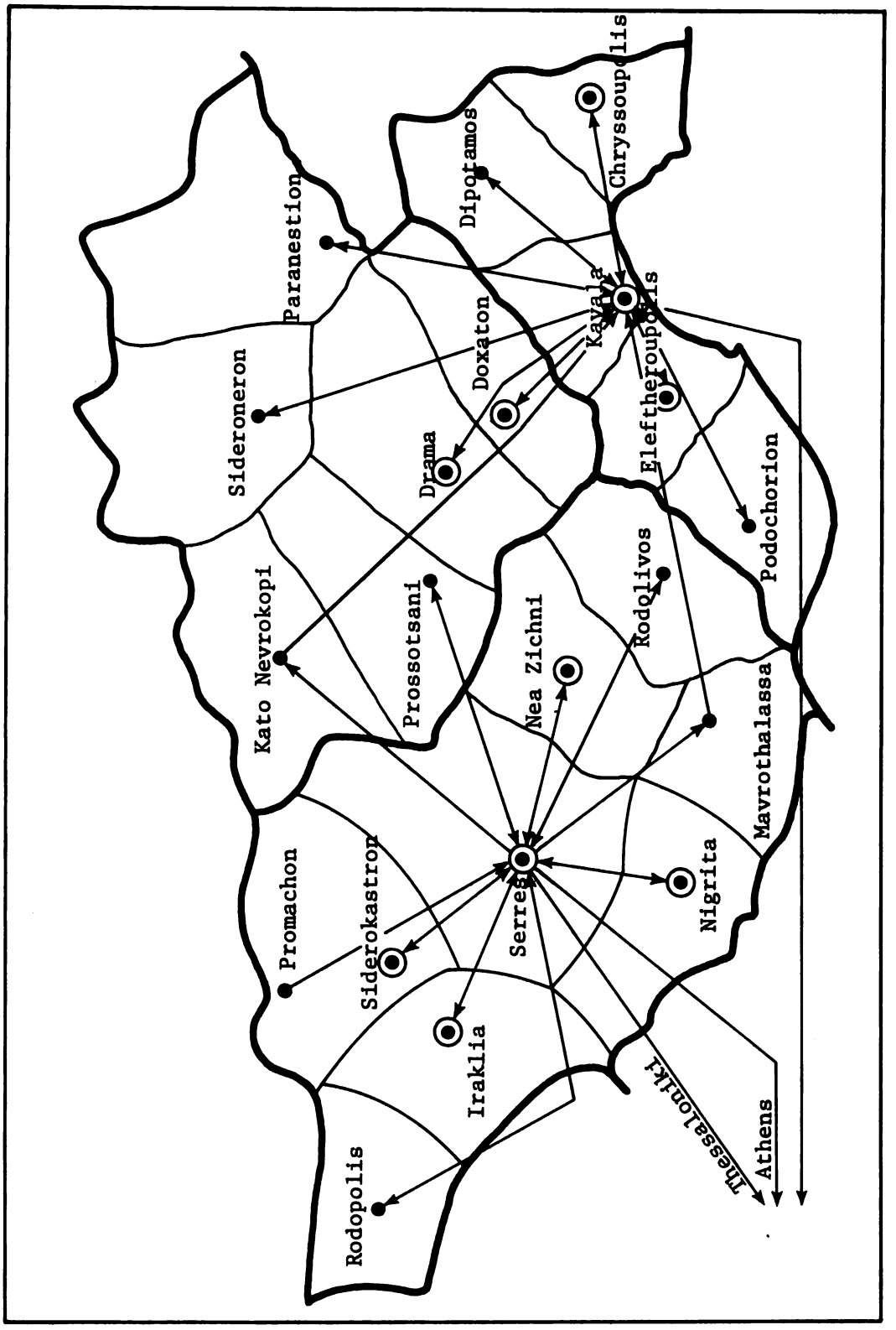


Figure V-1: Flow of live animals from the supply regions to the slaughterhouses and flow of carcass meat from the slaughterhouses to the consumption centers: Model I.

the corresponding volumes of livestock estimated to be processed by these plants are 15,500 and 7,872 tons of carcass meat equivalents.

The minimum aggregate cost of the optimal solution of this model amounts to 45.87 million drachmae. Comparing this with that of the basic model, 51.38 million drachmae, it is lower by 5.51 million drachmae. Obviously, this difference can be solely attributed to the reduced assembly cost due to the full capacity utilization of the trucks engaged in livestock assembly.

The optimum flow of live animals from the supply regions to the slaughtering plants of Serres and Kavala is given in Table V-3. It is clearly seen that this flow is exactly the same as that of the basic model (Table V-1).

The optimum flow of carcass meat from the slaughtering plants of Serres and Kavala to the consumption centers (Table V-4) differs very slightly from that of the basic model (Table V-2). In particular, under this model, Prossotsani and Kato Nevrokopi consumption centers are supplied with carcass meat from the slaughter plant of Kavala, while in the basic model they were supplied by the plant of Serres. Given the fact that the sizes of these plants are the same under both models, Athens is necessarily supplied with larger quantities of carcass meat by the plant of Serres and smaller quantities by the plant of Kavala under this model II.

## The Alternative Solution Model III

This model differs from the basic one by only the number of supply and consumption regions and number of potential slaughtering

Table V-3. Flow of live animals from the production regions to the slaughterhouses, E. Macedonia, Greece, 1972 (volume measured in metric tons of carcass meat): model II.

| Supply Regions | Slaughtering Plants | | | | | | | | | | Total livestock supply by each region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sidirokastron | Iraklia | Serres | Nigrita | Nea Zichni | Eleftheroupolis | Kavala | Chryssoupolis | Doxaton | Drama | |
| 1. Rodopolis | | | 889 | | | | | | | | 889 |
| 2. Sidirokastron | | | 772 | | | | | | | | 772 |
| 3. Iraklia | | | 2,601 | | | | | | | | 2,601 |
| 4. Serres | | | 3,794 | | | | | | | | 3,794 |
| 5. Nigrita | | | 1,357 | | | | | | | | 1,357 |
| 6. Mavrothalassa | | | | | | | 587 | | | | 587 |
| 7. Nea Zichni | | | 1,245 | | | | | | | | 1,245 |
| 8. Rodolivos | | | 826 | | | | | | | | 826 |
| 9. Podochorion | | | | | | | 283 | | | | 283 |
| 10. Eleftheroupolis | | | | | | | 660 | | | | 660 |
| 11. Kavala | | | | | | | 974 | | | | 974 |
| 12. Chryssoupolis | | | | | | | 1,758 | | | | 1,758 |
| 13. Dipotamos | | | | | | | 214 | | | | 214 |
| 14. Doxaton | | | | | | | 1,133 | | | | 1,133 |
| 15. Drama | | | | | | | 1,559 | | | | 1,559 |
| 16. Prossotsani | | | 423 | | | | 75 | | | | 498 |
| 17. Kato Nevrokopi | | | | | | | 363 | | | | 363 |
| 18. Sidironeron | | | | | | | 85 | | | | 85 |
| 19. Paranestion | | | | | | | 181 | | | | 181 |
| 20. Promachon | | | 3,593 | | | | | | | | 3,593 |
| Total livestock Processing in each Slaughterhouse | | | 15,500 | | | | 7,872 | | | | 23,372 |

Table V-4. Flow of carcass meat in metric tons from the slaughterhouses to the consumption centers, E. Macedonia, Greece, 1972: model II.

| Consumption Centers | Slaughtering Plants | | | | | | | | | | Total live-stock supply by each region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sidi-rokas-tron | Irak-lia | Serres | Nigri-ta | Nea Zichni | Elef-therou-polis | Kavala | Chrys-soupo-lis | Doxa-ton | Drama | |
| 1. Rodopolis | | | 378 | | | | | | | | 378 |
| 2. Sidirokastron | | | 676 | | | | | | | | 676 |
| 3. Iraklia | | | 881 | | | | | | | | 881 |
| 4. Serres | | | 2,944 | | | | | | | | 2,944 |
| 5. Nigrita | | | 843 | | | | | | | | 843 |
| 6. Mavrothalassa | | | 305 | | | | | | | | 305 |
| 7. Nea Zichni | | | 570 | | | | | | | | 570 |
| 8. Rodolivos | | | 547 | | | | | | | | 547 |
| 9. Podochorion | | | | | | | 198 | | | | 198 |
| 10. Eleftheroupolis | | | | | | | 729 | | | | 729 |
| 11. Kavala | | | | | | | 2,320 | | | | 2,320 |
| 12. Chryssoupolis | | | | | | | 614 | | | | 614 |
| 13. Dipotamos | | | | | | | 91 | | | | 91 |
| 14. Doxaton | | | | | | | 537 | | | | 537 |
| 15. Drama | | | | | | | 1,742 | | | | 1,742 |
| 16. Prossotsani | | | | | | | 412 | | | | 412 |
| 17. Kato Nevrokopi | | | | | | | 223 | | | | 223 |
| 18. Sidironeron | | | | | | | 63 | | | | 63 |
| 19. Paranestion | | | | | | | 34 | | | | 34 |
| 20. Thessaloniki | | | 1,853 | | | | | | | | 1,853 |
| 21. Athens | | | 6,503 | | | | 909 | | | | 7,412 |
| Total Meat Outshipments by each slaughterhouse | | | 15,500 | | | | 7,872 | | | | 23,372 |

plants. Specifically, under this model some regions were integrated into one region and thus the entire area of E. Macedonia ended up with 14 production regions, 15 consumption centers and 8 potential plants.

The optimum solution of this model is also the same as that of the basic model with regard to the number, size and location of slaughtering plants. In particular, the optimum solution of this model is comprised of two plants, located in Serres and Kavala and slaughtering livestock equivalent to 15,500 and 7,872 tons of carcass meat respectively. This suggests that the optimum size of the Serres plant is 15,500 tons of carcass meat, and the optimum size of the Kavala plant is equal to 8,000 tons.

The minimum total cost of the optimal solution of this model is 50.45 million drachmae. This is less than that of the basic model by only 930 thousand drachmae. This relatively smaller cost is entirely due to the simplification of both livestock assembly and meat distribution cost in those regions which joined each other. That is, when one region joined another, then both total livestock assembly and meat distribution costs between the joined regions became zero. Under the transhipment model employed in this analysis, the intra-regional transportation cost (both livestock assembly and meat distribution) is equalized to zero because a basic assumption of this model is that both livestock supply and meat consumption are concentrated in one point of each region.

The optimum flow of live animals from the supply regions to the slaughter plants of Serres and Kavala (Table V-5) slightly differs

Table V-5. Flow of live animals from the production regions to the slaughterhouses, E. Macedonia, Greece, 1972 (volume measured in metric tons of carcass meat): model III.

| Supply Regions | Slaughtering Plants | | | | | | | | Total meat consumption in each region |
|---|---|---|---|---|---|---|---|---|---|
| | Iraklia | Serres | Nigrita | Nea Zichni | Kavala | Chryssoupolis | Doxaton | Drama | |
| 1. Sidirokastron | | 772 | | | | | | | 772 |
| 2. Iraklia | | 3,490 | | | | | | | 3,490 |
| 3. Serres | | 3,794 | | | | | | | 3,794 |
| 4. Nigrita | | 1,944 | | | | | | | 1,944 |
| 5. Nea Zichni | | 1,245 | | | | | | | 1,245 |
| 6. Rodolivos | | 662 | | | 164 | | | | 826 |
| 7. Eleftheroupolis | | | | | 943 | | | | 943 |
| 8. Kavala | | | | | 974 | | | | 974 |
| 9. Chryssoupolis | | | | | 1,972 | | | | 1,972 |
| 10. Doxaton | | | | | 1,133 | | | | 1,133 |
| 11. Drama | | | | | 1,559 | | | | 1,559 |
| 12. Prossotsani | | | | | 861 | | | | 861 |
| 13. Paranestion | | | | | 266 | | | | 266 |
| 14. Promachon | | 3,593 | | | | | | | 3,593 |
| Total meat outshipments by each slaughterhouse | | 15,500 | | | 7,872 | | | | 23,372 |

from that of the basic model (Table V-1), taking of course, into consideration the aggregation of livestock supplies in the integrated regions. More specifically, Mavrothalassa, which appears now jointly along with Nigrita, processes all its livestock supplies in the plant of Serres. Also, the region of Prossotsani joined that of Kato Nevrokopi processes its total livestock supplies in the plant of Drama, while in the basic model Prossotsani's livestock supplies were processed in the plant of Serres. In addition, Rodolivos' supplies are processed partly in the plant of Serres and partly in the plant of Kavala, while under the basic model all its supplies were processed in the plant of Serres.

The optimum flow of carcass meat from the slaughterhouses of Serres and Kavala to the consumption centers (Table V-6) shows exactly the same pattern as that of the Model II (Table V-4), taking into account, of course, the fact that some regions appear jointly under this model.

All the deviations of the optimal solution of this model from that of the basic model, seem that can be attributed to the changed volumes of livestock supplies and meat consumption of the jointly appearing regions and to the changed livestock assembly and meat distribution costs between them and the plants.

The usefulness of this model is that it gives an indication of the bias generated in estimating the aggregate cost due to ignoring the intra-regional transportation cost. The larger a supply or consumption region, the greater is the downward bias in estimating intra-regional transportation cost. Thus the total costs of assembly,

Table V-6. Flow of carcass meat in metric tons from the slaughterhouses to the consumption centers, E. Macedonia, Greece, 1972: model III.

| Consumption Centers | Slaughtering Plants | | | | | | | | Total livestock supply be each region |
|---|---|---|---|---|---|---|---|---|---|
| | Irak-lia | Serres | Nigrita | Nea Zichni | Kavala | Chrys-soupo-lis | Doxa-ton | Drama | |
| 1. Sidirokastron | | 676 | | | | | | | 676 |
| 2. Iraklia | | 1,259 | | | | | | | 1,259 |
| 3. Serres | | 2,944 | | | | | | | 2,944 |
| 4. Nigrita | | 1,148 | | | | | | | 1,148 |
| 5. Nea Zichni | | 570 | | | | | | | 570 |
| 6. Rodolivos | | 547 | | | | | | | 547 |
| 7. Eleftheroupolis | | | | | 927 | | | | 927 |
| 8. Kavala | | | | | 2,320 | | | | 2,320 |
| 9. Chryssoupolis | | | | | 705 | | | | 705 |
| 10. Doxaton | | | | | 537 | | | | 537 |
| 11. Drama | | | | | 1,742 | | | | 1,742 |
| 12. Prossotsani | | | | | 635 | | | | 635 |
| 13. Paranestion | | | | | 97 | | | | 97 |
| 14. Thessaloniki | | 1,853 | | | | | | | 1,853 |
| 15. Athens | | 6,503 | | | 909 | | | | 7,412 |
| Total livestock processing in each slaughterhouse | | 15,500 | | | 7,872 | | | | 23,372 |

processing and distribution incurred are underestimated. To cope with this problem one of the following two things can happen: (a) either to construct the mathematical model in such a way as to include the intra-regional transportation cost; or (b) to designate regions as small as possible so that the bias generated is small.

## The Alternative Solution Model IV

This model differs from the basic one by only the volumes of the regional livestock supplies, including the assumption of no meat imports. Projected livestock slaughterings instead of those actually taken place in 1972 are considered in this model. These projections basically refer to the year 1977. However, because of their optimistic view--acknowledged even by the experts themselves who did the projections--they are considered applying to the year 1980.

The optimum number of plants was again two. However, both the optimum plant locations and optimum plant sizes appeared to be somewhat different from those of the basic model. Concretely, the optimum plant location was achieved for the plants of Serres and Drama by yielding a total cost for livestock assembly and processing and meat distribution equal to 68.07 million drachmae. Two other combinations of two-plant sets were also considered. Both of them came out with higher total cost than that of the optimal solution. These sets were Serres - Kavala on the one hand, yielding a total cost of 68.65 million drachmae and Serres - Doxaton on the other hand, yielding a total cost of 68.67 million drachmae.

The optimum plant sizes were determined to be 15,500 tons of carcass meat for both plants. This is so, because the optimal solution of this model determines that the optimum volume of livestock to be processed by the plant of Serres is equivalent to 15,500 tons of carcass meat, and by that of Drama is 15,080 tons. The latter corresponds to 97.3 percent of the full capacity of a plant size equivalent to 15,500 tons.

Neither the size nor the location of the first plant, Serres, of this model is different from that of the basic model. What is different is the optimum size and location of the second plant, which is Drama in this model, while Kavala was in the basic model. The difference in the optimum plant location between this model and the basic model might be explained by the projected comparatively greater increases of the livestock supplies in the province of Drama than in the province of Kavala.

The optimum size of the second plant, Drama, of this model is 15,500 tons of carcass meat, as contrasted to 8,000 tons of that (Kavala) of the basic model. The enlargement in the size of the second optimum plant (Drama) of this model as compared to the size of the corresponding plant (Kavala) of the basic model became necessary to process the higher volume of livestock supplies assumed in this model.

The optimum flow of live animals from the supply regions to the slaughtering plants of Serres and Drama is given in Table V-7. As this table shows, the plant of Serres is supplied by all the regions of the province of Serres, except the regions of Mavrothalassa,

Table V-7. Flow of live animals from the production regions to the slaughterhouses, E. Macedonia, Greece, 1980, (volume measured in metric tons of carcass meat): model IV--optimum solution.

| Supply Regions | Slaughtering Plants | | | | | | | | | | Total livestock supply by each region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sidirokastron | Iraklia | Serres | Nigrita | Nea Zichni | Eleftheroupolis | Kavala | Chryssoupolis | Doxaton | Drama | |
| 1. Rodopolis | | | 1,369 | | | | | | | | 1,369 |
| 2. Sidirokastron | | | 1,184 | | | | | | | | 1,184 |
| 3. Iraklia | | | 3,996 | | | | | | | | 3,996 |
| 4. Serres | | | 5,809 | | | | | | | | 5,809 |
| 5. Nigrita | | | 2,072 | | | | | | | | 2,072 |
| 6. Mavrothalassa | | | | | | | | | | 906 | 906 |
| 7. Nea Zichni | | | 1,070 | | | | | | | 836 | 1,906 |
| 8. Rodolivos | | | | | | | | | | 1,258 | 1,258 |
| 9. Podochorion | | | | | | | | | | 402 | 402 |
| 10. Eleftheroupolis | | | | | | | | | | 935 | 935 |
| 11. Kavala | | | | | | | | | | 1,375 | 1,375 |
| 12. Chryssoupolis | | | | | | | | | | 2,486 | 2,486 |
| 13. Dipotamos | | | | | | | | | | 302 | 302 |
| 14. Doxaton | | | | | | | | | | 1,954 | 1,954 |
| 15. Drama | | | | | | | | | | 2,685 | 2,685 |
| 16. Prossotsani | | | | | | | | | | 862 | 862 |
| 17. Kato Nevrokopi | | | | | | | | | | 625 | 625 |
| 18. Sidironeron | | | | | | | | | | 145 | 145 |
| 19. Paranestion | | | | | | | | | | 309 | 309 |
| 20. Promachon | | | | | | | | | | | 0 |
| Total livestock processing in each slaughterhouse | | | 15,500 | | | | | | | 15,080 | 30,580 |

Rodolivos and Nea Zichni. The latter supplies it partially. All the other regions supply the plant of Drama.

The optimum flow of carcass meat from the slaughterhouses of Serres and Drama to the consumption centers is given in Table V-8. As the table indicates all the regions of the province of Serres, plus Podochorion of the province of Kavala, Thessaloniki and to a large extent Athens are supplied with carcass meat by the plant of Serres. All the other consumption centers are supplied by the plant of Drama.

Figure V-2 presents graphically the optimum flows of both livestock and carcass meat for the optimal solution of this model.

Because the recommendations regarding the number, size and location of slaughter plants in the area of E. Macedonia will be based upon the projected livestock supplies, for this reason a second best solution of this model will be presented as well, in both tables and graph. This was done in order that alternative solutions could be available and thus some flexibility be provided in the decision-making process.

As a second best solution in this model is considered the optimum solution for three plants. This was achieved for the plants of Serres, Kavala and Drama yielding a total cost of 69.74 million drachmae. Three additional combinations of three plant sites were also examined, all of which generated a higher total cost than that of Serres, Kavala and Drama. These are:

a. Serres, Chryssoupolis and Drama, yielding a total cost of 70.48 million drachmae;

Table V-8. Flow of carcass meat in metric tons from the slaughterhouses to the consumption centers, E. Macedonia, Greece, 1980: model IV--optimun solution.

| Consumption Centers | Slaughtering Plants | | | | | | | | | | Total meat consumption in each region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sidi-rokas-tron | Irak-lia | Serres | Nigri-ta | Nra Zichni | Elef-therou-polis | Kavala | Chrys-soupo-lis | Doxa-ton | Drama | |
| 1. Rodopolis | | | 378 | | | | | | | | 378 |
| 2. Sidirokastron | | | 676 | | | | | | | | 676 |
| 3. Iraklia | | | 881 | | | | | | | | 881 |
| 4. Serres | | | 2,944 | | | | | | | | 2,944 |
| 5. Nigrita | | | 843 | | | | | | | | 843 |
| 6. Mavrothalassa | | | 305 | | | | | | | | 305 |
| 7. Nea Zichni | | | 570 | | | | | | | | 570 |
| 8. Rodolivos | | | 547 | | | | | | | | 547 |
| 9. Podochorion | | | 198 | | | | | | | | 198 |
| 10. Eleftheroupolis | | | | | | | | | | 729 | 729 |
| 11. Kavala | | | | | | | | | | 2,320 | 2,320 |
| 12. Chryssoupolis | | | | | | | | | | 614 | 614 |
| 13. Dipotamos | | | | | | | | | | 91 | 91 |
| 14. Doxaton | | | | | | | | | | 537 | 537 |
| 15. Drama | | | | | | | | | | 1,742 | 1,742 |
| 16. Prossotsani | | | | | | | | | | 412 | 412 |
| 17. Kato Nevrokopi | | | | | | | | | | 223 | 223 |
| 18. Sidironeron | | | | | | | | | | 63 | 63 |
| 19. Paranestion | | | | | | | | | | 34 | 34 |
| 20. Thessaloniki | | | 3,295 | | | | | | | | 3,295 |
| 21. Athens | | | 4,863 | | | | | | | 8,315 | 13,178 |
| Total meat outshipments by each slauthterhouse | | | 15,500 | | | | | | | 15,080 | 30,580 |

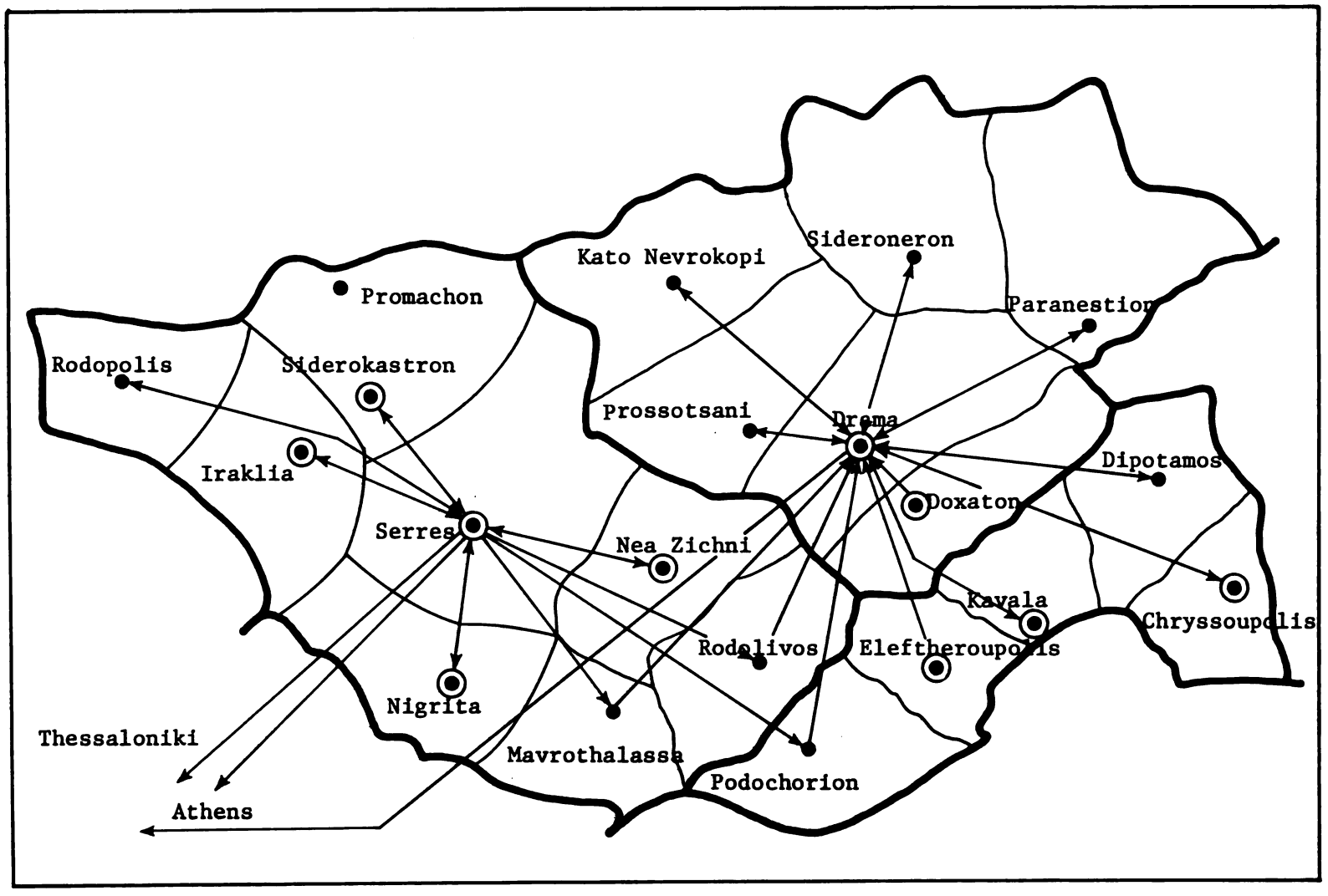


Figure V-2: Flow of live animals from the supply regions to the slaughterhouses and flow of carcass meat from the slaughterhouses to the consumption centers: Model IV--optimum solution.

b. Serres, Kavala and Doxaton, yielding a total cost of 70.91 million drachmae; and

c. Iraklia, Chryssoupolis and Doxaton, yielding a total cost of 73.40 million drachmae.

The optimum plant sizes are 15,500 tons of carcass meat annually for the plant of Serres and 8,000 tons for both plants of Kavala and Drama, since the estimated optimum volumes of livestock to be processed by the corresponding plants are equivalent to 15,500, 8,000 and 7,080 tons of carcass meat respectively. As it is seen above, for the first two plants, the optimum volumes processed by them coincide exactly with the recommended plant sizes. For the third plant, Kavala, the optimum processed volume of 7,080 tons while approximates the most the model plant size of 7,000 tons than that of 8,000 tons, the latter was selected to represent Kavala's plant size, since no plant was assumed to operate above its full capacity.

The optimum flow of live animals (expressed in terms of meat equivalents) from the supply regions to the slaughtering plants of Serres, Kavala and Drama is given in Table V-9. As this table shows, all the regions of the province of Serres supply with livestock the plant of Serres, except the region of Mavrothalassa which supplies the plant of Kavala, Nea Zichni whose supplies are split between the plants of Serres and Drama, and Rodolivos which also supplies the plant of Drama. The plant of Kavala is supplied by all the regions of the province of Kavala plus Mavrothalassa (totally) of Serres and Doxaton (partially) of Drama. The plant of Drama is supplied by all the livestock supplies of all the regions of the province

Table V-9. Flow of live animals from the production regions to the slaughterhouses, E. Macedonia, Greece, 1980 (volume measured in metric tons of carcass meat): model IV--second best solution.

| Supply Regions | Slaughtering Plants | | | | | | | | | | Total livestock supply by each region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sidirokastron | Iraklia | Serres | Nigrita | Nea Zichni | Eleftheroupolis | Kavala | Chryssoupolis | Doxaton | Drama | |
| 1. Rodopolis | | | 1,369 | | | | | | | | 1,369 |
| 2. Sidirokastron | | | 1,184 | | | | | | | | 1,184 |
| 3. Iraklia | | | 3,996 | | | | | | | | 3,996 |
| 4. Serres | | | 5,809 | | | | | | | | 5,809 |
| 5. Nigrita | | | 2,072 | | | | | | | | 2,072 |
| 6. Mavrothalassa | | | | | | | 906 | | | | 906 |
| 7. Nea Zichni | | | 1,070 | | | | | | | 836 | 1,906 |
| 8. Rodolivos | | | | | | | | | | 1,258 | 1,258 |
| 9. Podochorion | | | | | | | 402 | | | | 402 |
| 10. Eleftheroupolis | | | | | | | 935 | | | | 935 |
| 11. Kavala | | | | | | | 1,375 | | | | 1,375 |
| 12. Chryssoupolis | | | | | | | 2,486 | | | | 2,486 |
| 13. Dipotamos | | | | | | | 302 | | | | 302 |
| 14. Doxaton | | | | | | | 674 | | | 1,280 | 1,954 |
| 15. Drama | | | | | | | | | | 2,685 | 2,685 |
| 16. Prossotsani | | | | | | | | | | 862 | 862 |
| 17. Kato Nevrokopi | | | | | | | | | | 625 | 625 |
| 18. Sidironeron | | | | | | | | | | 145 | 145 |
| 19. Paranestion | | | | | | | | | | 309 | 309 |
| 20. Promachon | | | | | | | | | | | 0 |
| Total livestock processing in each slaughterhouse | | | 15,500 | | | | 7,080 | | | 8,000 | 30,580 |

of Drama except that of Doxaton (partially), plus the aforementioned regions of Rodolivos and Nea Zichni belonging in the province of Serres.

The optimum flow of meat distribution from the plants of Serres, Kavala and Drama to the consumption centers is given in Table V-10. As this table shows, all the regions of the province of Serres are supplied by the plant of Serres. Similarly, the plant of Kavala supplies only regions of the province of Kavala, and the plant of Drama supplies only regions of the province of Drama. Thessaloniki is supplied by the plant of Serres, and Athens is supplied by all three plants.

Figure V-3 presents graphically the optimum flows of both livestock and carcass meat from the regions to the slaughterhouses and vice versa. The meaning of the arrows has already been explained in the second section of this chapter.

## The Alternative Solution Model V

This model differs from the previous one by only the degree of plant capacity utilization. That is, in this model plants are assumed to be operating at 90 percent of their capacity instead of 100 percent as was assumed in all the previous models. Because of this assumption, at least three plants would be required to process the projected volume of livestock equivalent to 30,580 tons of carcass meat. The optimum number of plants is three. The optimum location of plants is the same as that of the second best solution of Model IV, i.e., Serres, Kavala and Drama. The optimum sizes of these plants are

Table V-10. Flow of carcass meat in metric tons from the slaughterhouses to the consumption centers, E. Macedonia, Greece, 1980: model IV--second best solution.

| Consumption Centers | Slaughtering Plants | | | | | | | | | | Total meat consumption in each region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sidirokastron | Iraklia | Serres | Nigrita | Nea Zichni | Eleftheroupolis | Kavala | Chryssoupolis | Doxaton | Drama | |
| 1. Rodopolis | | | 378 | | | | | | | | 378 |
| 2. Sidirokastron | | | 676 | | | | | | | | 676 |
| 3. Iraklia | | | 881 | | | | | | | | 881 |
| 4. Serres | | | 2,944 | | | | | | | | 2,944 |
| 5. Nigrita | | | 843 | | | | | | | | 843 |
| 6. Mavrothalassa | | | 305 | | | | | | | | 305 |
| 7. Nea Zichni | | | 570 | | | | | | | | 570 |
| 8. Rodolivos | | | 547 | | | | | | | | 547 |
| 9. Podochorion | | | | | | | 198 | | | | 198 |
| 10. Eleftheroupolis | | | | | | | 729 | | | | 729 |
| 11. Kavala | | | | | | | 2,320 | | | | 2,320 |
| 12. Chryssoupolis | | | | | | | 614 | | | | 614 |
| 13. Dipotamos | | | | | | | 91 | | | | 91 |
| 14. Doxaton | | | | | | | | | | 537 | 537 |
| 15. Drama | | | | | | | | | | 1,742 | 1,742 |
| 16. Prossotsani | | | | | | | | | | 412 | 412 |
| 17. Kato Nevrokopi | | | | | | | | | | 223 | 223 |
| 18. Sidironeron | | | | | | | | | | 63 | 63 |
| 19. Paranestion | | | | | | | | | | 34 | 34 |
| 20. Thessaloniki | | | 3,295 | | | | | | | | 3,295 |
| 21. Athens | | | 5,061 | | | | 3,128 | | | 4,989 | 13,178 |
| Total meat outshipments by each slaughterhouse | | | 15,500 | | | | 7,080 | | | 8,000 | 30,580 |

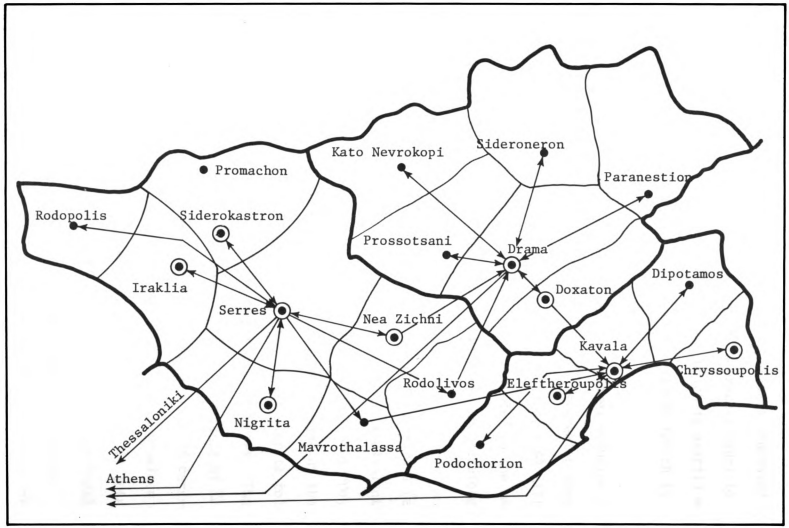


Figure V-3: Flow of live animals from the supply regions to the slaughterhouses and flow of carcass meat from the slaughterhouses to the consumption centers: Model IV--second best solution.

15,500 tons of carcass meat for Serres and 9,500 tons for both Kavala and Drama. This is so, because the optimum volumes processed by these plants were 13,950 tons for Serres (which is exactly equal to 90 percent of 15,500 tons), 8,550 tons for Drama (which is exactly equal to 90 percent of 9,500 tons) and 8,080 tons for Kavala (which is equal to 85 percent of 9,500 tons).

The minimum aggregate cost of the optimal solution of this model amounts to 71.62 million drachmae. This is greater than that of the second best solution of the previous model by 1.68 million drachmae. This difference can be largely attributed to the smaller (90 percent) capacity utilization of the plants--and therefore greater unit processing cost--assumed in this model.

Table V-11 gives the optimum flow of live animals (expressed as always in this analysis in terms of carcass meat equivalents) from the livestock supply regions to the slaughter plants of Serres, Kavala and Drama. As this table shows, out of all the regions of the province of Serres, Sidirokastron, Iraklia, Serres and Nigrita totally and Rodopolis by about two-thirds supply the plant of Serres. The plant of Kavala is supplied by all the regions of the province of Kavala plus Mavrothalassa of Serres, and Doxaton of Drama by 86 percent. The plant of Drama is supplied by all the regions of the province of Drama except that of Doxaton which sends only 14 percent of its total livestock supplies, and the remained regions (Nea Zichni and Rodolivos totally, and Rodopolis partially) of the province of Serres.

Table V-12 gives the optimum flow of carcass meat from the slaughter plants of Serres, Kavala and Drama to the consumption centers.

Table V-11. Flow of live animals from the production regions to the slaughterhouses, E. Macedonia, Greece, 1980 (volume measured in metric tons of carcass meat): model V.

| Supply Regions | Slaughtering Plants | | | | | | | | | | Total livestock supply by each region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sidirokastron | Iraklia | Serres | Nigrita | Nea Zichni | Eleftheroupolis | Kavala | Chryssoupolis | Doxaton | Drama | |
| 1. Rodopolis | | | 889 | | | | | | | 480 | 1,369 |
| 2. Sidirokastron | | | 1,184 | | | | | | | | 1,184 |
| 3. Iraklia | | | 3,996 | | | | | | | | 3,996 |
| 4. Serres | | | 5,809 | | | | | | | | 5,809 |
| 5. Nigrita | | | 2,072 | | | | | | | | 2,072 |
| 6. Mavrothalassa | | | | | | | 906 | | | | 906 |
| 7. Nea Zichni | | | | | | | | | | 1,906 | 1,906 |
| 8. Rodolivos | | | | | | | | | | 1,258 | 1,258 |
| 9. Podochorion | | | | | | | 402 | | | | 402 |
| 10. Eleftheroupolis | | | | | | | 935 | | | | 935 |
| 11. Kavala | | | | | | | 1,375 | | | | 1,375 |
| 12. Chryssoupolis | | | | | | | 2,486 | | | | 2,486 |
| 13. Dipotamos | | | | | | | 302 | | | | 302 |
| 14. Doxaton | | | | | | | 1,674 | | | 280 | 1,954 |
| 15. Drama | | | | | | | | | | 2,685 | 2,685 |
| 16. Prossotsani | | | | | | | | | | 862 | 862 |
| 17. Kato Nevrokopi | | | | | | | | | | 625 | 625 |
| 18. Sidironeron | | | | | | | | | | 145 | 145 |
| 19. Paranestion | | | | | | | | | | 309 | 309 |
| 20. Promachon | | | | | | | | | | | 0 |
| Total livestock processing in each slaughterhouse | | | 13,950 | | | | 8,080 | | | 8,550 | 30,580 |

Table V-12. Flow of carcass meat in metric tons from the slaughterhouses to the consumption centers, E. Macedonia, Greece, 1980: model V.

| Consumption Centers | Slaughtering Plants | | | | | | | | | | Total meat consumption in each region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sidi-rokas-tron | Irak-lia | Serres | Nigri-ta | Nea Zichni | Elef-therou-polis | Kavala | Chrys-soupo-lis | Doxa-ton | Drama | |
| 1. Rodopolis | | | 378 | | | | | | | | 378 |
| 2. Sidirokastron | | | 676 | | | | | | | | 676 |
| 3. Iraklia | | | 881 | | | | | | | | 881 |
| 4. Serres | | | 2,944 | | | | | | | | 2,944 |
| 5. Nigrita | | | 843 | | | | | | | | 843 |
| 6. Mavrothalassa | | | 305 | | | | | | | | 305 |
| 7. Nea Zichni | | | 570 | | | | | | | | 570 |
| 8. Rodolivos | | | 547 | | | | | | | | 547 |
| 9. Podochorion | | | | | | | 198 | | | | 198 |
| 10. Eleftheroupolis | | | | | | | 729 | | | | 729 |
| 11. Kavala | | | | | | | 2,320 | | | | 2,320 |
| 12. Chryssoupolis | | | | | | | 614 | | | | 614 |
| 13. Dipotamos | | | | | | | 91 | | | | 91 |
| 14. Doxaton | | | | | | | 537 | | | | 537 |
| 15. Drama | | | | | | | | | | 1,742 | 1,742 |
| 16. Prossotsani | | | | | | | | | | 412 | 412 |
| 17. Kato Nevrokopi | | | | | | | | | | 223 | 223 |
| 18. Sidironeron | | | | | | | | | | 63 | 63 |
| 19. Paranestion | | | | | | | | | | 34 | 34 |
| 20. Thessaloniki | | | 3,295 | | | | | | | | 3,295 |
| 21. Athens | | | 3,511 | | | | 3,591 | | | 6,076 | 13,178 |
| Total meat outshipment by each slaughterhouse | | | 13,950 | | | | 8,080 | | | 8,550 | 30,580 |

As the table indicates, each plant supplies with carcass meat only the regions of the province in which each one belongs. Thessaloniki is supplied by the plant of Serres, while Athens is supplied by all the plants but in different quantities.

## The Alternative Solution Model VI

This model assumes a standard unit processing cost regardless of the size of plant and regardless of the volume processed in each plant. This is exactly what is happening today in Greece with the livestock slaughtering as has already been described in Chapter II. In other words, no economies of size in livestock processing are assumed in this model as contrasted to all the other models.

The unit livestock slaughtering cost is taken as equal to 1,050 drachmae per ton of carcass meat equivalent. This cost reflects both slaughtering fees (averaged at 50 drachmae per head of cattle or 250 drachmae per ton of carcass meat, since one head of cattle yields on the average 200 kilograms of carcass meat) and slaughterers' payment (averaged at 160 drachmae per cattle or 800 drachmae per ton of carcass meat equivalent).[30]

Since economies of size are not assumed in this model, the result is that the optimum solution is solely affected by the assembly and distribution cost. Because the sum of the total livestock assembly and meat distribution cost becomes smaller and smaller as the number of processing plants becomes larger and larger, the optimum

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[30]About these data see the text in pages 31-32 and 82.

solution of this model was achieved when all the potential (ten) plants were included in the livestock slaughtering industry of the study area. This optimum solution generated an aggregate minimum cost of livestock assembly, processing and meat distribution equal to 41.60 million drachmae. However, when the number of plants was reduced to nine, the total cost was increased to 41.98 million drachmae, and when the number of plants was reduced to six, the total cost was increased to 44.92 million drachmae. These figures clearly indicate that under no economies of size in plant processing, the optimum (minimum cost) solution has a general tendency to build as many plants as there are supply regions.

The optimum flow of live animals from the supply regions to the slaughterhouses is given in Table V-13. The optimum flow of carcass meat from the slaughterhouses to the consumption centers is given in Table V-14. It is obvious from these tables that both livestock assembly pattern and meat distribution pattern are entirely determined by the corresponding transportation cost pattern, i.e., the structure of livestock assembly plus meat distribution cost. This can be readily seen from a quick comparison of these Tables V-13 and 14 with Tables V-15 and 16. The latter ones give the optimum flow of live animals from the supply regions to the slaughterhouses (Table V-15) and the optimum flow of carcass meat from the slaughterhouses to the consumption centers (Table V-16). Both these Tables (V-15 and 16) have been computed on the basis of only livestock assembly and meat distribution cost, and as it is seen have almost the same pattern as Tables V-13 and 14. Slight differences exist only in the plants of Sidirokastron and Iraklia.

Table V-13. Flow of live animals from the production regions to the slaughterhouses, E. Macedonia, Greece, 1972 (volume measured in metric tons of carcass meat): model VI.

| Supply Regions | Slaughtering Plants | | | | | | | | | | Total livestock supply by each region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sidirokastron | Iraklia | Serres | Nigrita | Nea Zichni | Eleftheroupolis | Kavala | Chryssoupolis | Doxaton | Drama | |
| 1. Rodopolis | 756 | 133 | | | | | | | | | 889 |
| 2. Sidirokastron | 772 | | | | | | | | | | 772 |
| 3. Iraklia | | 2,601 | | | | | | | | | 2,601 |
| 4. Serres | | | 3,794 | | | | | | | | 3,794 |
| 5. Nigrita | | | | 1,357 | | | | | | | 1,357 |
| 6. Mavrothalassa | | | | 587 | | | | | | | 587 |
| 7. Nea Zichni | | | | | 1,245 | | | | | | 1,245 |
| 8. Rodolivos | | | | | 826 | | | | | | 826 |
| 9. Podochorion | | | | | | 69 | 214 | | | | 283 |
| 10. Eleftheroupolis | | | | | | 660 | | | | | 660 |
| 11. Kavala | | | | | | | 974 | | | | 974 |
| 12. Chryssoupolis | | | | | | | | 1,758 | | | 1,758 |
| 13. Dipotamos | | | | | | | 214 | | | | 214 |
| 14. Doxaton | | | | | | | | | 1,133 | | 1,133 |
| 15. Drama | | | | | | | | | | 1,559 | 1,559 |
| 16. Prossotsani | | | | | | | | | | 498 | 498 |
| 17. Kato Nevrokopi | | | | | | | 363 | | | | 363 |
| 18. Sidironeron | | | | | | | 85 | | | | 85 |
| 19. Paranestion | | | | | | | 181 | | | | 181 |
| 20. Promachon | 3,593 | | | | | | | | | | 3,593 |
| Total livestock processing in each slaughterhouse | 5,121 | 2,734 | 3,794 | 1,944 | 2,071 | 729 | 2,031 | 1,758 | 1,133 | 2,057 | 23,372 |

Table V-14. Flow of carcass meat in metric tons from the slaughterhouses to the consumption centers, E. Macedonia, Greece, 1972: model VI.

| Consumption Centers | Slaughtering Plants | | | | | | | | | | Total meat consumption in each region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sidi-rokas-tron | Irak-lia | Serres | Nigri-ta | Nea Zichni | Elef-therou-polis | Kavala | Chrys-soupo-lis | Doxa-ton | Drama | |
| 1. Rodopolis | 378 | | | | | | | | | | 378 |
| 2. Sidirokastron | 676 | | | | | | | | | | 676 |
| 3. Iraklia | | 881 | | | | | | | | | 881 |
| 4. Serres | | | 2,944 | | | | | | | | 2,944 |
| 5. Nigrita | | | | 843 | | | | | | | 843 |
| 6. Mavrothalassa | | | | | 305 | | | | | | 305 |
| 7. Nea Zichni | | | | | 570 | | | | | | 570 |
| 8. Rodolivos | | | | | 547 | | | | | | 547 |
| 9. Podochorion | | | | | 198 | | | | | | 198 |
| 10. Eleftheroupolis | | | | | | 729 | | | | | 729 |
| 11. Kavala | | | | | | | 2,031 | | 289 | | 2,320 |
| 12. Chryssoupolis | | | | | | | | 614 | | | 614 |
| 13. Dipotamos | | | | | | | | 91 | | | 91 |
| 14. Doxaton | | | | | | | | | 537 | | 537 |
| 15. Drama | | | | | | | | | | 1,742 | 1,742 |
| 16. Prossotsani | | | | | 228 | | | | 184 | | 412 |
| 17. Kato Nevrokopi | | | | | 223 | | | | | | 223 |
| 18. Sidironeron | | | | | | | | | | 63 | 63 |
| 19. Paranestion | | | | | | | | | 34 | | 34 |
| 20. Thessaloniki | | 1,853 | | | | | | | | | 1,853 |
| 21. Athens | 4,067 | | 850 | 1,101 | | | | 1,053 | 89 | 252 | 7,412 |
| Total meat outshipment by each slaughterhouse | 5,121 | 2,734 | 3,794 | 1,944 | 2,071 | 729 | 2,031 | 1,758 | 1,133 | 2,057 | 23,372 |

Table V-15. Flow of live animals from the production regions to the slaughterhouses, E. Macedonia, Greece, 1972 (volume measured in metric tons of carcass meat), based upon only assembly and distribution costs.

| Supply Regions | Slaughtering Plants | | | | | | | | | | Total livestock supply by each region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sidirokastron | Iraklia | Serres | Nigrita | Nea Zichni | Eleftheroupolis | Kavala | Chryssoupolis | Doxaton | Drama | |
| 1. Rodopolis | 889 | | | | | | | | | | 889 |
| 2. Sidirokastron | 772 | | | | | | | | | | 772 |
| 3. Iraklia | | 2,601 | | | | | | | | | 2,601 |
| 4. Serres | | | 3,794 | | | | | | | | 3,794 |
| 5. Nigrita | | | | 1,357 | | | | | | | 1,357 |
| 6. Mavrothalassa | | | | 587 | | | | | | | 587 |
| 7. Nea Zichni | | | | | 1,245 | | | | | | 1,245 |
| 8. Rodolivos | | | | | 826 | | | | | | 826 |
| 9. Podochorion | | | | | | 69 | 214 | | | | 283 |
| 10. Eleftheroupolis | | | | | | 660 | | | | | 660 |
| 11. Kavala | | | | | | | 974 | | | | 974 |
| 12. Chryssoupolis | | | | | | | | 1,758 | | | 1,758 |
| 13. Dipotamos | | | | | | | 214 | | | | 214 |
| 14. Doxaton | | | | | | | | | 1,133 | | 1,133 |
| 15. Drama | | | | | | | | | | 1,559 | 1,559 |
| 16. Prossotsani | | | | | | | | | | 498 | 498 |
| 17. Kato Nevrokopi | | | | | | | 363 | | | | 363 |
| 18. Sidironeron | | | | | | | 85 | | | | 85 |
| 19. Paranestion | | | | | | | 181 | | | | 181 |
| 20. Promachon | 3,593 | | | | | | | | | | 3,593 |
| Total livestock processing in each slaughterhouse | 5,254 | 2,601 | 3,794 | 1,944 | 2,071 | 729 | 2,031 | 1,758 | 1,133 | 2,057 | 23,372 |

Table V-16. Flow of carcass meat in metric tons from the slaughterhouses to the consumption centers, E. Macedonia, Greece, 1972, based upon only assembly and distribution costs.

| Consumption Centers | Slaughtering Plants | | | | | | | | | | Total meat consumption in each region |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sidi-rokas-tron | Irak-lia | Serres | Nigri-ta | Nea Zichni | Elef-therou-polis | Kavala | Chrys-soupo-lis | Doxa-ton | Drama | |
| 1. Rodopolis | 378 | | | | | | | | | | 378 |
| 2. Sidirokastron | 676 | | | | | | | | | | 676 |
| 3. Iraklia | | 881 | | | | | | | | | 881 |
| 4. Serres | | | 2,944 | | | | | | | | 2,944 |
| 5. Nigrita | | | | 843 | | | | | | | 843 |
| 6. Mavrothalassa | | | 305 | | | | | | | | 305 |
| 7. Nea Zichni | | | | | 570 | | | | | | 570 |
| 8. Rodolivos | | | | | 547 | | | | | | 547 |
| 9. Podochorion | | | | | 198 | | | | | | 198 |
| 10. Eleftheroupolis | | | | | | 729 | | | | | 729 |
| 11. Kavala | | | | | | | 2,031 | | 289 | | 2,320 |
| 12. Chryssoupolis | | | | | | | | 614 | | | 614 |
| 13. Dipotamos | | | | | | | | 91 | | | 91 |
| 14. Doxaton | | | | | | | | | 537 | | 537 |
| 15. Drama | | | | | | | | | | 1,742 | 1,742 |
| 16. Prossotsani | | | | | | | | | 210 | 202 | 412 |
| 17. Kato Nevrokopi | | | | | 223 | | | | | | 223 |
| 18. Sidironeron | | | | | | | | | 63 | | 63 |
| 19. Paranestion | | | | | | | | | 34 | | 34 |
| 20. Thessaloniki | | 1,308 | 545 | | | | | | | | 1,853 |
| 21. Athens | 4,200 | 412 | | 1,101 | 533 | | | 1,053 | | 113 | 7,412 |
| Total meat outshipment by each slaughterhouse | 5,254 | 2,601 | 3,794 | 1,944 | 2,071 | 729 | 2,031 | 1,758 | 1,133 | 2,057 | 23,372 |

The fact that the optimum solution of this model VI generates an aggregate cost of 41.60 million drachmae as contrasted to 51.38 million drachmae of the optimum solution of the basic model which has the same characteristics as this model VI except that the basic model assumes a modern technology in livestock slaughtering, it does not mean that this model VI is better than the basic model for the following main reasons:

a. The unit processing cost in model VI does not include all the costs (fixed and variable) involved in livestock processing, as is the case with all the other models. Actually, this cost does not reflect any specific fixed or operational costs, except the labor cost (i.e., the slaughterers' payment) incurred. "Charges for the use of slaughterhouses are not necessarily related to actual operating costs,"[31] as the FAO study points out.

b. Model VI assumes continuation of the old slaughtering system; it does not assume the use of modern technology in livestock assembly as all the other models assume, and which technology, by the experts' opinions, affects the quality of meat.

However, this model has some importance from both an analytical and practical point of view. Analytically, it shows that when no economies of size are assumed in processing, the general tendency is to locate as many processing plants in an area as there are supply

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[31] Ibid., p. 32.

regions. Practically, it shows that if the current slaughtering system can continue in Greece without the occurrence of any special problems (e.g., management problems and maintenance costs of slaughterhouses, meat quality deterioration, etc.), then it might be better for the country in general and E. Macedonia in particular to go on with the current system of livestock slaughtering in the existing slaughterhouses.

However, the opinion of FAO and other experts is that the present slaughtering system needs a replacement. Based on this fact, the study was conducted. In other words, the current analysis starts from the following point: In case the present slaughtering system is to be replaced, what should be the optimum number, size and location of new slaughtering plants, so that the aggregate cost of livestock assembly, processing and meat distribution is minimized?

The question of continuing with the current slaughtering system versus adopting a modern one is another problem which needs a detailed benefit-cost analysis. But this is beyond the scope of the present study.

## Summary

Empirical results for six alternative solution models have been obtained in this chapter. Of these, four models (I, II, III and IV) refer to 1972 livestock supplies and the remained (IV and V) models refer to projected livestock supplies. All models but VI assume economies of size in processing, and all models except V assume 100 percent plant capacity utilization in processing. Furthermore, all

models but II assume 50 percent truck capacity utilization in livestock assembly, and all models but III assume 20 production regions, 21 consumption centers and 10 potential slaughter plants.

The empirical findings for each of these six models have as follows:

1. The optimum solution for the basic model ended up with two plants, located in Serres and Kavala and having sizes equal to 15,500 and 8,000 tons of carcass meat. The minimum aggregate cost of livestock assembly and processing and meat distribution amounts to 51.38 million drachmae.
2. Model II yielded the same optimum number, size and location of processing plants. Its minimum total cost is 45.87 million drachmae, i.e., by 5.51 million drachmae lower than that of the basic one. This can be totally attributed to the reduced livestock assembly cost due to the full capacity utilization of trucks engaged in livestock assembly. While the optimum flow of live animals is exactly the same as that of the basic model, the optimum flow of carcass meat slightly differs from that of the basic model.
3. Model III gave also the same optimum number, size and location of slaughtering plants as that of the basic model. Its minimum total cost amounts to 50.45 million drachmae. This is less than that of the basic model by 930 thousand drachmae and is primarily due to ignoring more intra-regional transportation cost as a result of enlarging some regions through joining sets of two smaller regions into one. The optimum

flow of live animals and carcass meat slightly differs from that of the basic model, as long as the aggregation factor is taken into consideration.

4. Model IV--referring to projected livestock supplies--gave an optimal solution of two plants, having optimum sizes equal to 15,500 tons for both plants and optimum locations Serres and Drama. It yielded a minimum aggregate cost equal to 68.07 million drachmae. As second best solution for this model was considered the minimum cost solution for three plants. The optimum plant location for this solution is Serres, Kavala and Drama, and optimum sizes are 15,500 tons for Serres and 8,000 tons for both Kavala and Drama. Its minimum cost amounts to 69.94 million drachmae.
5. Model V--assuming 90 percent plant capacity utilization--ended up with three plants as an optimum number, located in Serres, Kavala and Drama and having optimum size, equal to 15,500 tons of carcass meat for Serres and 9,500 tons for both Kavala and Drama. Its minimum total cost is 71.62 million drachmae.
6. Model VI does not assume any economies of size in processing and reflects the current livestock slaughtering system in Greece. Its optimal solution basically ends up with each region's production processed locally unless there is no plant in that region. In such a case, that region's livestock supplies are shipped for processing in the nearest plant.

# CHAPTER VI

# SUMMARY, IMPLICATIONS, LIMITATIONS AND NEEDED RESEARCH

## Summary

Greece is a developing country. To achieve rapid economic development, it needs to rationally utilize its limited resources. In this way the maximum total output will be produced from a given amount of resources. On the other hand, imports of goods and services must also be reduced as much as possible--without deteriorating the welfare of people--to prevent the corresponding outflow of foreign exchange. The savings of foreign exchange achieved in this way can be invested in other productive economic activities. Either case (rational utilization of resources and reduction of imports) can substantially contribute to the economic growth and development of the country.

Under this spirit, Greece has started developing its livestock and meat industry these last few years in an effort to match livestock production with the notably increased total meat consumption. Large amounts of loans with low interest rates along with higher output prices and input subsidies were offered to livestock producers to accomplish a relatively faster development of the industry. The incentives given seem to have been working and the industry started to grow up significantly.

The anticipated substantial expansion of the livestock production by the end of the 1970's, coupled with the fact that the existing livestock slaughterhouses are becoming more and more obsolete in buildings, machinery, equipment and technology, sooner or later may necessitate the establishment of new slaughtering plants. However, before an action be undertaken in such a case, the following problems should first be investigated:

1. How many slaughtering plants should be built in total in order to slaughter the anticipated higher volume of livestock production?
2. How large should the plants be, so that economies of size can be achieved and thus the costs of slaughtering be minimized?
3. Where should these slaughtering plants be located, so that the aggregate costs of (a) assembling the live animals from the production points to the plant locations, (b) slaughtering the live animals in the slaughterhouses, and (c) transporting the carcass meat from the plant locations to the consumption centers be minimized?

To answer these questions the present analysis was conducted. The analytical tool was the transhipment model, a special kind of a transportation linear programming model. The main characteristic of this model is that it takes simultaneously into consideration the assembly, processing and distribution costs.

The matrix format was originally constructed by professor Stephen Harsh of Michigan State University and modified by the author.

The size of the matrix used in this analysis is 81 rows by 420 columns. Because of its large size, the APEX-I computer program was utilized in the analysis. The computer analysis was done in the computer center of Michigan State University.

The data needed for this computer program are:

1. Regional livestock supplies available for slaughtering;
2. Regional meat consumption;
3. Livestock assembly cost per unit of product between all the livestock supply regions and all the potential plants;
4. Livestock processing unit cost for different plant sizes and levels of capacity utilization;
5. Meat distribution cost per unit of product between all the potential plants and all the meat consumption centers.

The procedures used for obtaining these basic data for the computer analysis are described in brief below.

Regional livestock supplies were calculated on the basis of annual livestock slaughterings given for every community (village or town) of each province. These data were provided by the provincial offices of the Ministry of Agriculture. The livestock slaughterings (expressed in terms of carcass meat) were summed up for all the communities included in a specific region. Thus, the annual livestock supplies measured in tons of carcass meat were calculated for that region.

Regional meat consumption was calculated on the basis of meat inflows and outflows taken place in the province in which the region in question belongs. In this way, the total meat consumption

in that province was estimated. To estimate the total meat consumption by the urban population of a province, the national per capita meat consumption was multiplied by that population. This amount was subtracted from the total provincial meat consumption and this represents total meat consumption by the non-urban population of that province. Dividing this amount by the number of non-urban population of the province, per capita meat consumption of this population in that province was calculated. Finally, on the basis of a region's population structure and per capita meat consumption of urban and non-urban population, total meat consumption for each region was estimated.

Livestock slaughtering cost was calculated on the basis of the FAO study conducted for Greece in 1966. The calculations were basically directed to making the appropriate adjustments needed to incorporate the inflation taken place in the country since then. Also some other adjustments were made to take into consideration the input price differentials existing among various provinces. That is, the input prices of all plants used in this analysis were adjusted to those of E. Macedonia.

Livestock assembly and meat distribution costs were obtained through questionnaires. The interviewed people were both truckers and butchers involved in either or both livestock assembly and/or meat distribution. Then, the cost averages were calculated for the same sizes of trucks and the same distances. These costs were used along with the matrix of distances between supply or consumption regions and slaughterhouses to construct the transportation cost matrices for both livestock assembly and meat distribution.

Both the unit transportation cost for the various distances and the unit processing cost for the different plant sizes comprise the "unit cost" row of the computer matrix formulated. This matrix, having a size of 81 rows by 420 columns, was used in the computer analysis of the problem in question.

Six alternative solution models were constructed and tested in order to find out what might be the impact of changing the corresponding variable--characterizing each model--upon the optimal solution of the basic model. The basic characteristics of these models are summarized in Table VI-1. As this table indicates, all the models except IV and V refer to 1972 livestock supplies. The latter models refer to 1980 projections of livestock supplies amounting to 30,580 tons of carcass meat. Out of the six models, only model II refers to full capacity utilization of trucks engaged in livestock assembly. The remaining five models refer to 50 percent capacity utilization of those trucks. All models except III assume that the entire area of E. Macedonia is divided into 20 livestock supply regions and 21 meat consumption regions as well as 10 potential slaughtering plants. Only model V assumes 90 percent maximum plant capacity utilization and only model VI assumes standard processing cost, i.e., it does not assume economies of size and modern technology in livestock processing.

The optimum solutions for these six models with regard to number, size, and location of slaughtering plants plus the minimum aggregate costs of livestock assembly, processing and meat distribution are summarized in Table VI-2. As this table shows, when slaughtering plants are allowed to be utilized at full capacity and economies of

Table VI-1. The characteristics of the various alternative solution models.

| Model Characteristics | Alternative Soultion Models | | | | | |
|---|---|---|---|---|---|---|
| | Basic | II | III | IV | V | VI |
| 1. Realized livestock supplies in 1972 | X | X | X | | | X |
| 2. Projected livestock supplies to 1980 | | | | X | X | |
| 3. Fifty percent capacity utilization of trucks engaged in livestock assembly | | X | | | | |
| 4. Full capacity utilization of trucks engaged in livestock assembly | X | | X | X | X | X |
| 5. Full capacity utilization of trucks engaged in meat distribution | X | X | X | X | X | X |
| 6. Ninety percent capacity utilization of slaughtering plants | | | | | X | |
| 7. Full capacity utilization of slaughtering plants | X | X | X | X | | X |
| 8. Twenty supply regions, 21 consumption centers and 10 potential plants | X | X | | X | X | X |
| 9. Fourteen supply regions, 15 consumption regions and 8 potential plants | | | x | | | |
| 10. Modern technology (economies of size) in livestock processing is assumed | X | X | X | X | X | |
| 11. Standard unit cost (no economies of size) in processing is assumed | | | | | | X |

Table VI-2. Main research findings for each alternative solution model.

| Research Variables | Basic Model | | Model II | | Model III | |
|---|---|---|---|---|---|---|
| 1. Optimum number of plants | 2 | | 2 | | 2 | |
| 2. Optimum location of plants | Serres | Kavala | Serres | Kavala | Serres | Kavala |
| 3. Optimum volume of livestock processed by each plant (tons of carcass meat) | 15,500 | 7,872 | 15,500 | 7,872 | 15,500 | 7,872 |
| 4. Suggested optimum plant sizes (in tons of carcass meat) | 15,500 | 8,000 | 15,500 | 8,000 | 15,500 | 8,000 |
| 5. Minimum aggregate costs of livestock assembly and processing and meat distribution (in million drachmae) | 51.38 | | 45.87 | | 50.45 | |

*See Table V-13 or V-14.

**Unit slaughtering charges do not include all the cost items, as all the other models do. They include only labor cost (slaughterers' payments) plus "slaughtering fees."

Source: Tables V-1 through V-14.

| Model IV | | | | | Model V | | | Model VI |
|---|---|---|---|---|---|---|---|---|
| Optimum Solution | | 2nd Best Solution | | | | | | |
| 2 | | 3 | | | 3 | | | 10 |
| Serres | Drama | Serres | Drama | Kavala | Serres | Drama | Kavala | * |
| 15,500 | 15,080 | 15,500 | 7,080 | 8,000 | 13,950 | 8,080 | 8,550 | * |
| 15,500 | 15,500 | 15,500 | 8,000 | 8,000 | 15,500 | 9,500 | 9,500 | * |
| 68.07 | | 69.94 | | | 71.62 | | | 41.60** |

size assumed in livestock processing, the optimum number of plants ends up to be two in all the models. When the livestock supplies amount to 23,372 tons of carcass meat (actual supplies of year 1972), the optimum location of plants is Serres and Kavala. Their optimal sizes were determined to be 15,500 and 8,000 tons of carcass meat respectively. When the livestock supplies amount to 30,580 tons of carcass meat (projected supplies), then the optimum location of plants was found to be Serres and Drama. In this case, their corresponding optimal plant sizes were estimated to 15,500 tons of carcass meat for either plant. When the optimal solution includes three plants (2nd best solution of model IV, or optimum solution of model V), then the optimal location of plants was indicated to be Serres, Karala and Drama, i.e., the capitals of the corresponding provinces. Only under no economies of size in livestock processing (as it is the current livestock slaughtering system in Greece), all the potential plants are included in the optimal solution.

## Implications

In this study no specific recommendations shall be made. What will be done is to present the trade-offs (i.e., advantages and disadvantages) of alternative solutions. Then, it is left up to the political process to make the final decision, presumably taking into consideration (explicitly or implicitly) not only economic and financial factors but social and political factors as well.

Out of the first five models, which assume use of modern technology in livestock slaughtering, only those models (IV and V)

which are based upon the projected livestock supplies shall be considered here. The main reason for this is that this analysis was primarily conducted for planning purposes. Therefore, if new slaughter plants with modern technology are to be constructed in E. Macedonia, they should be planned on the basis of having the capacity to process the anticipated future volume of livestock production.

From these two models IV and V, which are based upon 1980 livestock supplies, the former, which assumes a full plant capacity utilization, is selected for further analysis. The reason for this is that model IV gives more reasonable solutions and lower minimum aggregate cost than model V. The full capacity utilization of plants which model IV assumes can be accomplished without any special problems, since it was based on the assumption that plants will operate only 250 days a year and 8 hours a day. However, the operating days for a plant can be readily expanded to 270 or more days annually. This essentially implies that the degree of plant capacity utilization will be adequately below its full capacity and, therefore, the estimated volumes of livestock to be processed by these plants seems to be possible.

Model VI, which reflects a continuation of the current livestock slaughtering system, will also be considered as an alternative solution to the problem. That is, it will be examined if it is to the benefit of the participants of the livestock-meat industry in E. Macedonia to continue with the current system of livestock slaughtering or to modernize its slaughtering systems and plants.

Thus, to help the decision making process, the trade-offs of (a) model IV versus model VI, and (b) optimal solution versus second optimal solution of model IV will be presented next.

Model IV versus Model VI

Should the findings of model IV (either of optimal solution with two plants or second optimal solution with three plants) be adopted for implementation, then the probable implications which might be generated could be both positive and negative ones, or compared to the currently existing slaughtering system (model VI).

As positive implications (advantages) of model IV over model VI can be considered:

1. Positive externalities will be possibly created under a system of two or three slaughtering plants suggested by model IV. The substantially greater volume of livestock slaughterings in each of these plants will generate greater amounts of livestock by-products, such as blood, etc. These, in turn, may make beneficial the establishment of related plants to process those by-products, which can be used as ingredients of fertilizers, feeding stuffs, etc. Thus, additional incomes might be provided to producers and probably others.
2. The transportation industry may be forced to be adjusted accordingly, both organizationally and operationally. Since the products (both live animals and carcass meat) will be transported in relatively longer distances and larger volumes

under the proposed system of two or three plants than the existing many plants system, the industry will probably be equipped with the proper size and types of trucks to perform efficiently the transportation functions.

3. The livestock assembly function may be forced to be organized more efficiently. Livestock public or private markets might become necessary for assembling live animals and supply them for slaughtering to the plants in larger amounts. Thus, the livestock function will be coordinated and the trucks will most probably be utilized in greater capacity than before, thus reducing the transportation cost per unit of transported product.
4. Other marketing functions which might be improved in response to better reorganization of livestock slaughtering might be the grading of both livestock and meat. This may help to make relatively easier the trade of live animals without requiring a personal inspection of them by the buyers. Meat packaging is also expected to be developed in the locations of the slaughtering plants in order to facilitate the safe shipment of carcass meat to relatively longer distances. The marketing information system regarding the availability (number, kinds of animals, grade, etc.) of livestock supplies in each location (village or town etc.) and other related information is expected to be significantly improved in order to allow for an efficient performance of other marketing functions.

5. Marketing institutions or firms (e.g., meat wholesalers, retailers, etc.) are expected to be reorganized and improve their performance. The improvement of marketing functions and the development of some marketing institutions (such as auction markets, etc.) will enable them to give up some of their unnecessary functions (e.g., personal inspection of the purchased live animals or carcass meat). Thus, the freed time they may devote for a better management of their business. In addition, some marketing channels (such as commission men and possibly local dealers) might be eliminated from the livestock-meat marketing system as a consequence of the development of auction markets, grading function, etc.
6. Livestock producers' welfare is also expected to be improved, since they are going to be paid according to the quality of their product. Thus, progressive and successful producers are going to be paid better than less efficient producers because of the improved quality of their products. This will encourage them to expand even more their livestock production.

Towards the same direction of expanding the quantity and improving the quality of livestock production may work the additional incomes which producers are likely to earn from the processing of livestock slaughtering by-products, and the accurate weighing of live animals since automatic scales are expected to be established in key places, such as auction markets, slaughtering plants, etc.

7. Consumers' welfare will probably be improved as well, as a result of expected improvement in the quality of meat (according to meat technologists) due to employing modern livestock slaughtering systems. The expected development of meat grading and standardization function will better satisfy the diversified needs of different consumers and thus to improve their welfare. The continuous flow of adequate quantities of meat at reasonable prices which might be achieved as a result of improving the overall livestock-meat marketing system, will also work towards improving consumers' welfare.
8. Private business might be encouraged to enter into the livestock slaughtering industry since the prospects for making satisfactory profits from processing substantially larger volumes of livestock in each plant are favorable. Government, as a consequence, may give up its responsibility from these activities and enter into other ones in which the private sector is reluctant to enter. Such activities could be the production of any public goods, such as the construction of roads, investments in national health and education programs, etc.
9. Economies of size in veterinary inspection of slaughtered animals is expected to be achieved, since one or two veterinarians in each of the two or three new slaughtering plants can inspect the total volume of slaughtered animals. In contrast, under the old system of 21 plants (requiring at least one veterinarian in each plant) it will require at least 21

veterinarians in total in E. Macedonia and, therefore, the social cost of veterinary inspection (not directly born by the marketing firms, since veterinarians work for the government) will be comparatively much higher.

10. An additional impact of improving the livestock slaughtering system might be the establishment of new rules and regulations concerning the livestock slaughtering and the information data which might flow as a consequence. Such a rule, for example, could be all the livestock be slaughtered in the authorized slaughterhouses. If such a thing happens, then it would be easy to obtain accurate information data regarding the number and kind and also age of animals slaughtered. This, in turn, will help future research to end up with more accurate and objective conclusions.

As negative implications (<u>disadvantages</u>) of model IV over model VI can be considered the following:

1. Labor (slaughterers') displacement as a result of both expected reduction of slaughter plants to two or three from the currently existing 21 and especially as a result of substitution of capital (modern livestock slaughtering machinery and equipment) for labor. Of course, at the present time--when not much unemployment exists in the country because its significant industrialization progress--it may not be a serious problem to absorb these unemployed slaughterers in other jobs. However, the social cost which will be incurred for training

them in new jobs (if their age will allow it) must not be ignored.

2. Revenue loss for the communities currently having slaughterhouses, since they will lose the "slaughtering fees" paid to them for the right of using the slaughterhouse facilities.
3. Unit slaughtering cost, charged upon the marketing firms (local dealers, butchers, etc.) who assume the responsibility of livestock slaughtering, will be higher under the new system than under the old one. The reason is that under the new system marketing firms will bear the entire cost burden while under the old system they bear only part of it such as slaughterers' labor cost and slaughtering fees.
4. Total transportation cost will be higher under the new system of two or three plants than under the old system of 21 plants. The reason is that under the new system trucks will travel relatively long distances in order to ship livestock from supply regions to slaughterhouses and carcass meat from slaughterhouses to consumption centers. With the sharp upward movement in oil prices, the transportation cost problem will become more accute and in such a degree so that it may overweigh the benefits of the economies of size which are expected to be generated by the modern slaughtering systems and plants.
5. Outflow of foreign exchange is expected to take place with the new slaughtering system in order to import the required new machinery and equipment. Under the old system it is assumed that no change will take place with regard to slaughterhouses' machinery and equipment.

6. Problems of disposing larger amounts of waste will have to be faced by the administrators of the new system of two or three plants. In other words, a pollution problem may be generated under the new slaughtering system while under the old system such a problem has not been serious.

## Optimal Solution versus Second Optimal Solution of Model IV

Should the government proceed with the establishment of new slaughtering plants and systems in E. Macedonia, the question which will be raised will be: what solution should be adopted for implementation? Optimal or second optimal solution? That is, should two or three plants be built in the area? Again the decision maker will consider the trade-offs which will appear in deciding one versus the other solution.

Specifically, in deciding to implement the findings of optimal solution (two plants) rather than the second optimal solution (three plants), the possible positive trade-offs (advantages) might be the following:

1. Aggregate cost of livestock assembly, slaughtering and meat distribution will be lower (68.07 million drachmae) as compared to 69.94 million drachmae of the second optimal solution. This, at least, implies that social cost will be lower under the optimal solution proposal than under the second one.
2. Comparatively less slaughtering machinery and equipment might be imported under a two plant system than under a three plant

system and, therefore, less outflow of foreign exchange may take place under the former than under the latter alternative solution.

3. Larger volumes of livestock by-products will be concentrated in the slaughter plant locations under a two-plant system than under a three-plant system. This may make more encouraging the establishment of plants for processing these by-products to the benefit of the industry participants.

In contrast, the possible positive trade-offs (advantages) in implementing the second optimal solution rather than the optimal solution of model IV, i.e., in building three instead of two new slaughter plants, might be the following:

1. A fairer regional economic development and decentralization of economic activity (which is a basic goal of every Greek government) will be achieved, since this solution suggests, at least, one plant for each of the three provinces. It is obvious that in such a case, resources (labor, etc.) will be utilized from each province, thus contributing to their economic development.
2. Because each province constitutes an administrative entity, the provision of establishing at least one plant in each province will prevent the possible creation of political problems on the national government.
3. Total transportation cost will be lower as compared to optimal solution. With the continuously rising oil prices,

transportation cost may become a decisive factor upon the efficient performance of the entire livestock-meat marketing system.

## Limitations

This study to determine the optimum number, size and location of livestock slaughtering plants through the transhipment linear programming model is obviously a static analysis of a clearly dynamic industry. That is, the analysis refers to a specific point of time with regard to livestock supplies, meat consumption, processing cost, transportation cost, etc., while all these variables are continuously changing with the passage of time. The consideration of the alternative solution models alleviates to some extent this problem but it does not eliminate it. More complex computer programs, such as polyperiod or dynamic linear programming might solve this problem to a large extent, at least, from the operational standpoint.

To conduct the analysis in terms of tons of carcass meat instead of number of head of livestock, changed the structure of the analysis from a multi-product (cattle, sheep/goats, hogs) analysis to essentially a single product (carcass meat) analysis. This per se constitutes a limitation. However, the fact that the greater proportion of slaughtered animals are cattle (on the basis of which the cost data were essentially calculated) largely alleviates this problem. Of course, the application of multi-product computer programming of the transhipment model can eliminate this problem. But the linear programming formulation of the transhipment model makes the

solution of multi-product plant location problems both difficult and costly.

The aggregation of supply points into supply areas and disregard of the intra-regional transportation costs constitutes another limitation, because at least it underestimates the total transportation (livestock assembly and meat distribution) cost. This problem can be largely avoided either by considering each supply point separately in the computer program or by constructing very small supply regions so that the aggregation bias be negligible. However, such an approach will greatly increase the cost of computer analysis while it may not add too much information, as can be concluded from a quick comparison of the results of models I and III.

The restriction of the potential plant sites instead of giving the chance to all livestock production and meat consumption points to be potential plant sites is a limitation per se. However, such a limitation can be substantially alleviated by carefully selecting the potential plant sites so that they satisfy the criterion of density in either livestock production and/or meat consumption.

Another limitation imposed by the nature of the linear programming formulation of the transhipment model upon the computer analysis is the procedure used in arriving at the final solution. Specifically, in order to obtain the final (minimum cost) solution, an iterative procedure must be followed. That is, in every computer run adjustments must be made upon the unit processing cost according to the flow of raw product to the processing plants given in the immediately preceding run. Furthermore, when the solution is stabilized,

i.e., when the flow of product or total cost does not continue changing, it does not mean that the final solution was obtained. It must be tested with another computer run with a smaller number of plants until a solution is obtained with a greater total cost than the previous one. When this is done, the computer run which generates the minimum total cost gives the optimum solution. This is obviously a troublesome procedure and can be eliminated with other computer programs which automatically yield the optimal solution.

The clearly existing seasonality in livestock slaughterings (as Table II-3 indicates) constitutes another limitation to this analysis, which assumes a regular flow of live animals to the slaughterhouses throughout the year. These peaks and slumps in the volumes of livestock slaughterings will most likely affect the processing cost, since during the peak seasons overtime work (which is usually paid at a higher rate) will be required. Also, they may affect upwards the size of the plant, which may be constructed on the basis of peaks rather than on the average volumes of livestock slaughterings. This might be so in order that the plant be capable of processing those peak volumes without any special problems. However, in off-peak seasons the plants will operate at a lower level of capacity and unit processing cost for any size of plant will be increased.

The quality of the data used in this analysis may also be a limitation. Thus: (a) the projected livestock supplies run the risk of being crude ones since they were based upon the experience and knowledge of the area by extension agronomists in Serres, Kavala and Drama, who made the projections. No micro-production study, using

any conventional analytical technique (e.g., econometric model, etc.) and including in it causal variables such as meat prices, etc. were used to this end; (b) total regional meat consumption was estimated through inductions from the national and provincial per capita meat consumption. No household consumption survey was undertaken to this end, while the structure of population, per capita income and other variables, which significantly affect per capita meat consumption, differ to a lesser or greater degree from region to region; (c) processing cost data reflect an average cost in processing a certain amount of livestock. No cost differentials are estimated for processing different mixes of livestock and for different levels of capacity utilization of plants. These are important cost data, since they can give insights about the organization and performance of the livestock slaughtering system. Furthermore, in adjusting the processing cost data of the FAO study (conducted in 1966) to current prices, the inflation taken place in the country since then was almost uniformly applied to all cost items (due to the lack of detailed such cost data) while this is not generally the case.

## Needed Research

The primary objective of this study was the determination of the optimum number, size and location of livestock slaughtering plants in the area of E. Macedonia. The only decision making criterion used in the analysis was that of minimizing the total cost of livestock assembly, processing and meat distribution. The data upon which the analysis was based were either primary (such as those on livestock

assembly and meat distribution cost) or secondary ones, such as those of processing costs. Meat consumption data are essentially inductions from those of the nation or provinces to the specific regions. Projected livestock supplies were based upon the experience, and the personal knowledge of the situation by the extension agronomists of each province. Since a limited amount of time and funds were available for this study, and since this was an individual effort, there is room for additional research in this and related areas, if more detailed information is to be obtained and more successful decisions are to be made. In the following pages are listed some topics upon which a more thorough investigation should be undertaken in the future.

1. Regional Livestock Production. An econometric study for projecting the regional livestock production or supply is required. If time, money and personnel is available, it would be preferable to undertake a micro-production study with primary data and thus to formulate a livestock supply function for each region separately. If this will not be possible, then the analysis can be conducted on a wider area basis, such as the whole province or geographic area (E. Macedonia, etc.) If the latter will be the case, then the appropriate inductions should be made. In either case, the variables which should be taken into consideration would be meat prices, input prices (e.g., prices of feed grains, alfalfa, etc.), input and output subsidies, availability of resources (arable land, pasture, etc.). Number and size of farms, age of

farmers, climatic and soil conditions, credit policies, etc. may also be taken into consideration.

2. Regional Meat Consumption. A household consumption survey for estimating regional meat consumption by kinds of meat is also required. It would be preferable to formulate for each region a separate demand function, since meat consumption is greatly affected not only by purely economic variables (e.g., meat prices, per capita disposable income, etc.), but also by socioeconomic variables, such as age, family size, education, occupation, etc.

3. Livestock Slaughtering Cost. An economic-engineering study is needed to give the following information:

   a. Requirements of variable inputs (labor, oil, water, electricity, etc.) for operating livestock slaughtering plants of: (1) different sizes operating at the same capacity and processing a certain product mix; (2) different plant capacity utilization but having the same size of plants and operating at the same product mix; (3) different product mixes but operating at the same plant size and capacity utilization.

   b. Requirements of fixed inputs (land, buildings, machinery and equipment) for different plant sizes and different product mixes, if these make any difference upon the resource requirements.

   c. After specifying the input requirements and given the input prices, the unit livestock slaughtering cost must be computed for: (1) different sizes of plants but operating at the same capacity and product mix; (2) same sizes of plants but operating at different capacities and using the same product mix; (3) same sizes and capacities of plants but using different product mixes.

   d. Estimation of the short run and long run livestock processing functions and curves to find out if and to what extent economies of size exist in livestock slaughtering.

e. Estimation of regional seasonality in livestock slaughtering and its impact upon the slaughtering cost.

4. Transportation Cost. In this area it would be useful to estimate both the livestock assembly cost function and the meat distribution cost function on either owned or rented trucks. As exogenous variables can be selected the following:

   a. size of truck used in transportation;

   b. the travelled distance;

   c. the livestock species transported;

   d. the degree of truck capacity utilization.

   Such an analysis may provide a useful information as to efficiently organizing the livestock assembly function which so much affects the total marketing efficiency of the livestock-meat industry.

5. A Benefit-Cost Analysis. Such an analysis is finally required on a very detailed basis so that both the benefits and costs of the proposed new modern system of livestock slaughtering as contrasted to the old system can be estimated. This, in turn, will help in making successful decisions to the benefit that would flow to industry participants and society as a whole.

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Technical Offices in Serres, Kavala and Drama. Maps of the provinces with distances among the villages.

Veterinary Offices of the Ministry of Agriculture in the capitals of each province. Detailed data on slaughterings in each slaughterhouse monthly and annually and by livestock species, livestock and meat inflows and outflows taken place annually in each province.

# APPENDICES

APPENDIX A-1

QUESTIONNAIRE FOR TRUCKERS

Name_____

Location of your activity_____

Please answer the following questions with great care and accuracy. The information you provide may contribute to the improvement of your business.

1. Do you charge a standard rate of transportation services?

   Yes_____ No_____

2. When you determine the transportation rates, what factors do you take into consideration?

   a. Distance _____
   b. Volume shipped _____
   c. Land topography (e.g., mountainous land, etc.)_____
   d. Feature of road construction (e.g., asphalt, gravel, etc.)_____
   e. Other_____

3. Do you apply uniform transportation rates in transporting any kind of carcass meat? Yes_____ No_____. If no, what are the rates per kind of meat?_____

4. When you return from the shipment destination to your headquarters, do you come with empty or utilized truck?

   a. Empty backhaul_____ b. Full backhaul_____

5. What is the radius in kilometers of your activity for transporting the following:

   a. Live animals_____ b . Carcass meat_____

6. On the following table, indicate which type of marketing firm does the shipment of either live animals or carcass meat.

| Types of Marketing Firms | Shipping: | |
|---|---|---|
| | a) Live Animals | c) Carcass Meat |
| a. Local Dealer | | |
| b. Butcher | | |
| c. Meat Semi-wholesaler | | |
| d. Meat Wholesaler | | |
| e. Other | | |

7. What kinds of transportation modes do you use in shipping either live animals and/or carcass meat? What is their capacity and what are the transportation cost rates per head of each kind of animal or per ton of carcass meat and per kilometer?

| Transportation modes used in shipping either live animals or carcass meat | Truck Capacity in terms of metric tons of carcass meat | Truck Capacity in terms of no. of live animals for each specie | Livestock transportation cost rates in drachmae per head of each kind of animal and per kilometer | | | Transportation cost rates per ton of carcass meat and per kilometer |
|---|---|---|---|---|---|---|
| | | | Cattle | Sheep/Goats | Hogs | |
| 1. Tricycle of 1/4 ton | | | | | | |
| 2. Common truck of 1/2 ton | | | | | | |
| 3. Common truck of 1 and 1 1/2 tons | | | | | | |
| 4. Common truck of 2 tons | | | | | | |
| 5. Common truck of 2.5 tons | | | | | | |
| 6. Common truck of 4 tons | | | | | | |
| 7. Common truck of 6 and 8 tons | | | | | | |
| 8. Common truck of 10 and 12 tons | | | | | | |
| 9. Refrigerated truck of 6 tons | | | | | | |
| 10. Refrigerated truck of 8 tons | | | | | | |
| 11. Refrigerated truck of 10 tons | | | | | | |
| 12. Refrigerated truck of 12 tons | | | | | | |

Notes_____

8. What transportation fees do you charge for the shipment of both live animals and carcass meat in drachmae per full load of each kind and size of transportation mode and for different distance ranges?

| Distance ranges in kilometers | Transportation cost rates for both live animals and carcass meat in drachmae per full load with the following transportation modes and for the corresponding distance ranges | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Common Trucks of: | | | | | | | Refrigerated Trucks of: | | | |
| | Tricycle of 1/4 ton | 1/2 ton | 1 & 1 1/2 tons | 2 tons | 2.5 tons | 4 tons | 6 & 8 tons | 10 & 12 tons | 6 tons | 8 tons | 10 tons | 12 tons |
| 0 - 10 | | | | | | | | | | | | |
| 11 - 20 | | | | | | | | | | | | |
| 21 - 30 | | | | | | | | | | | | |
| 31 - 40 | | | | | | | | | | | | |
| 41 - 50 | | | | | | | | | | | | |
| 51 - 100 | | | | | | | | | | | | |
| 101 - 150 | | | | | | | | | | | | |
| 151 - 200 | | | | | | | | | | | | |
| 201 - 250 | | | | | | | | | | | | |
| 251 - 300 | | | | | | | | | | | | |
| 301 - 400 | | | | | | | | | | | | |
| 401 - 500 | | | | | | | | | | | | |
| 501 - 600 | | | | | | | | | | | | |
| 601 - 700 | | | | | | | | | | | | |

Notes:

# APPENDIX A-2

## QUESTIONNAIRE OF LIVESTOCK AND MEAT SHIPMENTS

(It is directed to butchers, local dealers, meat wholesalers, etc.)

Name_____

Location of activity (village, town or city)_____

Occupation (e.g., butcher, local dealer, etc.)_____

Please answer the following questions, clearly and accurately, keeping in mind that the information you will provide may help to improve the organization and performance of livestock and meat transportation function.

1. Who assumes responsibility of shipping live animals from livestock producers to slaughterhouses and carcass meat from the slaughterhouses to your store?

| Person who assumes responsibility of shipping: | Live Animals | Carcass Meat |
|---|---|---|
| a. Yourself | | |
| b. Local Dealer | | |
| c. A person of your staff | | |
| d. Other | | |

2. Do you own or rent trucks for shipping either live animals and/or carcass meat?

| Transportation | In the Shipment of: | |
|---|---|---|
| | a. Live Animals | b. Carcass Meat |
| a. Owned | | |
| b. Rented | | |

3. Is it more beneficial to own or rent trucks for shipping the required live animals and/or carcass meat? Yes____ No____ Why?

_____

4. Do you negotiate the transportation rates with truckers? Yes____ No____

5. Do you think that the transportation rates for shipping live animals and/or carcass meat are high? Yes____ No____. If yes, how do you think they can be reduced?_____

_____

6. How many times per month do you make either livestock or meat shipments and in what amount?

| Shipment of: | Frequency of shipments per month | Amounts shipped each time |
|---|---|---|
| a. Live animals | | |
| b. Carcass meat | | |

7. Livestock Transportation. List cases of livestock transportation from the purchase locations (e.g., livestock producers' gates) to the slaughterhouses, what kind and size of transportation mode did you use each time, what was their capacity, how many and what kind of animals did you actually ship each time, what was the corresponding shipping distance and how much money did you pay in total in each case?

| Cases of shipping live animals (List approximate dates) | What kind and size of transportation mode did you use? (e.g., truck of 2 tons, etc.) | What was the capacity of the truck used, in terms of number of animals for each specie | How many live animals of each specie did you actually ship each time? | What was the shipping distance in kilometers? | How much did you pay per load in each case? | In how many villages or towns did those producers belong? | What was the distance (in kilometers) between those villages or towns? |
|---|---|---|---|---|---|---|---|
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Notes:

8. Meat Transportation. List cases of carcass meat transportation from the slaughterhouse or warehouses of meat wholesalers to your store, what kind and size of transportation mode did you use each time, what was their capacity, what quantity did you ship each time, what was the shipping distance and how much did you pay in each case?

| Cases of carcass meat shipments (List approximate dates) | What kind of transportation mode did you use? (e.g., refrigerated truck of 10 tons, etc.) | What was the capacity of the truck used in terms of tons of carcass meat? | What quantity (tons) of carcass meat did you actually ship each time? | What kind or kinds of meat did you ship? | From which locations (slaughterhouses or warehouses of meat wholesaler, etc.) did you make the shipment? | What was the shipping distance from the supply source to your store in kilometers? | How much did you pay per load in each case? |
|---|---|---|---|---|---|---|---|
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Notes:

Appendix Table A-3. Distance matrix in kilometers, East Macedonia, Greece.

| Location | 1 Sidiro-kastron | 2 Iraklia | 3 Serres | 4 Nigrita | 5 Nea Zichni | 6 Elefthe-roupolis | 7 Kavala | 8 Chryssou-polis | 9 Doxaton | 10 Drama |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Rodopolis | 38 | 34 | 64 | 79 | 94 | 162 | 170 | 201 | 145 | 134 |
| 2. Sidirokastron | 0 | 15 | 26 | 48 | 56 | 124 | 132 | 163 | 107 | 96 |
| 3. Iraklia | 15 | 0 | 30 | 45 | 60 | 128 | 136 | 167 | 111 | 100 |
| 4. Serres | 26 | 30 | 0 | 22 | 30 | 98 | 106 | 137 | 81 | 70 |
| 5. Nigrita | 48 | 45 | 22 | 0 | 52 | 85 | 102 | 133 | 103 | 92 |
| 6. Mavrothalassa | 78 | 75 | 52 | 30 | 49 | 55 | 72 | 103 | 100 | 89 |
| 7. Nea Zichni | 56 | 60 | 30 | 52 | 0 | 68 | 76 | 107 | 51 | 40 |
| 8. Rodolivos | 76 | 80 | 50 | 72 | 20 | 44 | 61 | 92 | 49 | 38 |
| 9. Podochorion | 99 | 103 | 73 | 60 | 43 | 25 | 42 | 73 | 67 | 78 |
| 10. Eleftheroupolis | 124 | 128 | 98 | 85 | 68 | 0 | 17 | 48 | 42 | 53 |
| 11. Kavala | 132 | 136 | 106 | 102 | 76 | 17 | 0 | 31 | 25 | 36 |
| 12. Chryssoupolis | 163 | 167 | 137 | 133 | 107 | 48 | 31 | 0 | 56 | 67 |
| 13. Dipotamos | 172 | 176 | 146 | 142 | 116 | 57 | 40 | 33 | 65 | 76 |
| 14. Doxaton | 107 | 111 | 81 | 103 | 51 | 42 | 25 | 56 | 0 | 11 |
| 15. Drama | 96 | 100 | 70 | 92 | 40 | 53 | 36 | 67 | 11 | 0 |
| 16. Prossotsani | 81 | 85 | 55 | 77 | 25 | 69 | 52 | 82 | 27 | 16 |
| 17. Kata Nevrokopi | 107 | 111 | 81 | 103 | 51 | 95 | 78 | 109 | 53 | 42 |
| 18. Sidironeron | 143 | 147 | 117 | 139 | 87 | 100 | 83 | 114 | 58 | 47 |
| 19. Paranestion | 137 | 141 | 111 | 133 | 81 | 87 | 70 | 101 | 38 | 41 |
| 20. Promachon | 18 | 25 | 44 | 66 | 74 | 142 | 150 | 181 | 125 | 114 |
| 21. Thessaloniki | 115 | 91 | 95 | 85 | 125 | 146 | 163 | 194 | 176 | 165 |
| 22. Athens | 625 | 601 | 605 | 595 | 635 | 656 | 673 | 704 | 686 | 675 |

Sources: These data have been provided by the Technical Offices of Serres, Kavala and Drama.

Appendix Table A-4. Estimation of per capita meat consumption by the non-urban population of each province in E. Macedonia, Greece, 1972.

| | Economic Variables | Serres | Kavala | Drama |
|---|---|---|---|---|
| 1. | Total Meat Production in tons* | 12,071 | 3,889 | 3,819 |
| 2. | Net Exports (exports minus imports) in tons* | 4,927 | - 63 | 808 |
| 3. | Total Meat Consumption in tons* | 7,144 | 3,952 | 3,011 |
| 4. | Urban Population | 68,735 | 58,762 | 37,842 |
| 5. | Per Capita Meat Consumption of Urban Population in kilograms | 41.4 | 41.4 | 41.4 |
| 6. | Total urban Meat Consumption [(4) x (5)] in tons* | 2,845 | 2,433 | 1,566 |
| 7. | Total non-urban Meat Consumption [= (3) - (6)] in tons* | 4,299 | 1,519 | 1,445 |
| 8. | Non-urban Population | 134,163 | 49,515 | 53,167 |
| 9. | Per Capita Meat Consumption of Non-urban Population [(7) ÷ (8)] in kilograms | 32.04 | 30.68 | 27.18 |

*Metric tons

Sources: 1. The Agricultural and Veterinary Offices of the Ministry of Agriculture in Serres, Kavala and Drama.

2. National Statistical Service of Greece, "The Population of Greece," 1972, pp. 53-55, 92-93 and 157-160.

Appendix Table A-5. Slaughtering cost by plant sizes and by different levels of plant capacity utilization, E. Macedonia, Greece.

| Plant | Capacity Utilization of Plant % | Volume Processed (tons of carcass meat) | Total Fixed Cost ('000 drachmae) | Total Variable Cost ('000 drachmae) | Total Cost ('000 drachmae) | Unit Cost drs/ton of Carcass Meat |
|---|---|---|---|---|---|---|
| A | 100 | 2,750 | 2,670 | 2,055 | 4,725 | 1,718 |
| | 90 | 2,475 | 2,670 | 1,850 | 4,520 | 1,826 |
| | 80 | 2,200 | 2,670 | 1,644 | 4,314 | 1,961 |
| | 110 | 3,025 | 2,670 | 2,261 | 4,931 | 1,630 |
| B | 100 | 4,000 | 2,963 | 2,964 | 5,927 | 1,482 |
| | 90 | 3,600 | 2,963 | 2,668 | 5,631 | 1,564 |
| | 80 | 3,200 | 2,963 | 2,371 | 5,334 | 1,667 |
| | 110 | 4,400 | 2,963 | 3,260 | 6,223 | 1,414 |
| C | 100 | 5,000 | 3,817 | 3,433 | 7,250 | 1,450 |
| | 90 | 4,500 | 3,817 | 3,090 | 6,907 | 1,535 |
| | 80 | 4,000 | 3,817 | 2,746 | 6,563 | 1,641 |
| | 110 | 5,500 | 3,817 | 3,776 | 7,593 | 1,382 |
| D | 100 | 7,000 | 4,816 | 4,319 | 9,135 | 1,305 |
| | 90 | 6,300 | 4,816 | 3,887 | 8,703 | 1,382 |
| | 80 | 5,600 | 4,816 | 3,455 | 8,271 | 1,477 |
| | 110 | 7,700 | 4,816 | 4,751 | 9,567 | 1,242 |
| E | 100 | 8,000 | 5,204 | 4,926 | 10,130 | 1,266 |
| | 90 | 7,200 | 5,204 | 4,433 | 9,637 | 1,338 |
| | 80 | 6,400 | 5,204 | 3,941 | 9,145 | 1,429 |
| | 110 | 8,800 | 5,204 | 5,419 | 10,623 | 1,207 |

Appendix Table A-5. Continued.

| Plant | Capacity Utilization of Plant % | Volume Processed (tons of carcass meat) | Total Fixed Cost ('000 drachmae) | Total Variable Cost ('000 drachmae) | Total Cost ('000 drachmae) | Unit Cost drs/ton of Carcass Meat |
|---|---|---|---|---|---|---|
| F | 100 | 9,500 | 5,671 | 5,814 | 11,485 | 1,209 |
| | 90 | 8,550 | 5,671 | 5,233 | 10,904 | 1,275 |
| | 80 | 7,600 | 5,671 | 4,651 | 10,322 | 1,358 |
| | 110 | 10,450 | 5,671 | 6,395 | 12,066 | 1,155 |
| G | 100 | 15,500 | 6,674 | 8,202 | 14,875 | 960 |
| | 90 | 13,950 | 6,674 | 7,382 | 14,056 | 1,008 |
| | 80 | 12,400 | 6,674 | 6,562 | 13,236 | 1,067 |
| | 110 | 17,050 | 6,674 | 9,022 | 15,696 | 921 |

Source: These data have been computed on the basis of the data of Table IV-5.

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Professional Thesis Preparation
Cliff and Paula Haughey
144 Maplewood Drive
East Lansing, Michigan 48823
Telephone (517) 337-1527