AN ECONOMETRIC ANALYSIS OF THE FEED-GRAIN LIVESTOCK ECONOMY OF GREECE

By

Vassilios Constantinou Kalaitzis

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ABSTRACT

AN ECONOMETRIC ANALYSIS OF THE
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The purpose of this dissertation effort was to develop an econometric model capable of analyzing demand/supply conditions prevailing in the Greek feed-grain cattle economy over the period 1951-1972. The dissertation itself presents a summary of the methodology and procedures used in developing five submodels incorporating the supply/demand conditions in five industries -- roughage, feed-grain, beef, veal and milk -- along with a subsequent predictability test for each submodel. Utilizing average annual data, each submodel examines domestic and import demand and domestic supply.

The impact of a number of domestic macro-economic and agricultural policy variables on production and consumption can be studied through exogenous variables used as proxies for these factors. And, by means of domestic interaction components, the impact of various foreign policies and economic factors on Greek feed-grain cattle economy may also be calculated.

More specifically this research attempts to portray realistically:

a) impacts of feed production upon production of beef, veal and milk in Greece;

b) impacts of increasing incomes on beef, veal and milk consumption.

The method employed was ordinary least squares along with polynomial distributed lag equations to estimate supply response in beef and milk production. Supply response for both crop and livestock products was calculated by utilizing a finished product supply equation and a supply equation consisting of number of acres planted and yield per acre or number of animals slaughtered (milked) and average per animal quantity of finished product.

In the absence of data beyond the year 1972, the model's predicting ability was tested using as actual values the exogenous variables for the years 1951 and 1969. Predictions were then made for the years 1970, 1971 and 1972, and these values were compared with actual values for the same years, a comparison which enabled a judgment as to whether the model is reliable in making projections.

Rising incomes have been the main demand shifter in beef, veal and milk consumption in Greece, while policy variables, such as subsidies, have also played a crucial role in increasing short-run production of both crops and livestock products. This study indicates that if the production of beef, veal and/or milk is to be increased in the short-run, a high beef-feed, veal-feed and milk-feed ration is required. However, in the long-run increased output of these products depends on an abundant supply of feed-grain and roughage.

This study also reveals that production and consumption of the aforementioned livestock products heavily depend on feed-grain imports and on imports of finished products of beef and/or veal. And, if a keen demand arises for feed-grain as a result of adverse production conditions in other areas of the world or as a result of high feed-grain prices in the world market, beef, veal and milk production in Greece will decline in both the short- and the long-run.

Given unstable world conditions, then, a positive program to increase the output of feed-grain combined with an increase in the consumption of other than red-meats and a general policy encouraging growth and development of the feed-grain cattle economy in Greece will be required if production expansion policies are to be carried out.

ΔΕ ΦΘΑΝΕΙ Ο ΗΛΙΟΣ ΜΟΝΑΧΑ
Η ΓΗΣ ΚΑΡΠΟ ΝΑ ΔΩΣΗ
ΧΡΕΙΑΖΟΝΤΑΙ ΚΑΙ ΑΛΛΑ ΠΟΛΛΑ
ΚΑΙ ΠΡΟ ΠΑΝΤΟΣ Η ΓΝΩΣΗ

ΚΩΣΤΗΣ ΠΑΛΑΜΑΣ

THE SUN IS NOT ENOUGH
FOR THE EARTH TO GIVE THE FRUITS
MANY OTHER THINGS ARE NEEDED AND,
ABOVE ALL, KNOWLEDGE

COSTIS PALAMAS

Dedicated

to

My Family and My Teachers

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CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

Introduction

The feed-grain cattle economy (sub-sector) is a major element in the Greek agricultural economy. In fact, the vast expense associated with the importation of red meat and feed-grain coupled with a growing domestic and world demand for both products should make livestock, and cattle in particular, a crucial sub-sector in the overall growth of the Greek agricultural sector.

This thesis does not intend to examine Greece's comparative advantage in the production of beef, veal, milk, feed-grain and roughage. Instead, this study will contribute to the growing stock of knowledge concerning the dynamics of the Greek feed-grain cattle economy. More specifically, it intends to provide both descriptive and quantitative information on this sub-sector which would be used for further quantitative, predictive and prescriptive analysis.

The Problem

The agricultural situation in Greece over the sample period examined here (1951-1972) could be described as one wherein:

a) low and unstable farm incomes persisted;

b) low product prices have held in the market;

c) uncertainty has existed as to the future;

d) there has been inadequate production planning leading to chronic mismatching of supply and demand; and

e) there have been huge payments for imports of red meat (veal and beef) and concentrated dairy products (especially evaporated milk).

Almost everyone in Greece has experienced an increasing cost of living or has noticed that prices in the country have increased tremendously during the 1970s. Price indexes recordd this price increase during the last five to six years.

One of the expenditure groups that has been of particular importance to Greek consumers over the last twenty-five years is red meat, an item that all Greek consumers want to purchase. Therefore, when the price of meat increases, all consumers - and particularly those within the low income brackets - begin to feel the impact of high prices in the economy.

But food prices not only represent a cost of living to consumers; they also act to determine farmers' income and allocate resources within the economic system. Thus, while consumers desire low food prices, farmers desire high prices for their products, and society desires prices that result in an efficient allocation of resources. As a result of these conflicts, national economic policy is formulated to maintain a stable price over time. Yet a stable price level is not the only possible goal of a government's economy policy; there could be other goals as well, such as: (a) increase in income, (b) improved distribution of income, (c) full employment, (d) a balance of payments, (e) saving of traditions and values.

The supply of meat is relatively fixed at any point in time due to the technical and biological aspects of production and distribution. It typically takes a relatively long period of time for red meat producers to respond to changes in product prices or input costs. Thus, a policy designed to control these prices or costs would not seem to affect the supply of meat in the shortrun, though in the longer run such a policy could affect this supply. Due to the high inflationary pressure which Greece experienced from 1973 on, the government was forced to reduce its money supply. The result of this reduction was that interest rates went up; this represented an increased cost of production for meat producers in Greece.* Such an increase in production costs, ceteris paribus, should tend to reduce meat supplies in subsequent time periods, further driving upwards meat prices which in turn affects people's standard of living.

A government facing such perplexities looks at imports as a solution to a high meat prices problem. And an examination of the import figures reveals that, indeed, a considerable amount of Greek currency is used to pay for meat imports. But Greek farmers and agricultural economists argue that the government should not import cheap meat and feed-grains to subsidize consumers and thus reduce the cost of production of industrial goods at the expense of farm incomes and farmers' welfare. They also argue that the government should use stronger protective policies to promote a self-sufficient

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*There is evidence, however, that the relative importance of the interest rate is small except for the highly specialized new firms.

meat production program to cope with the current world-wide red meat shortage. According to the aforementioned view, further liberization of trade would eliminate all small farms in Greece.

Import policy changes regarding beef and veal may affect domestic production, distribution and consumption of beef and veal through expectations and related uncertainty. There are strong interdependencies prevailing between the beef and veal and milk and feed industries everywhere. Feed supplies, for example, are affected by unpredictable elements such as weather, which influence production decisions to adjust livestock inventories. By the same token, conditions of unstable demand for beef and veal at the retail level - due mainly to government intervention - creates problems for beef producers which are transmitted back to the demand for feed.

Scope of the Problem and Study Hypotheses

Low prices for beef and veal at the farm level cause - in the short run - great fluctuations in the price(s) of these products and, thus, in producers' incomes. This means that farmers slaughter their beef and veal cows in order to meet their current expenses. From the other end of the spectrum a great demand for red meat was observed in Greece over the sample period examined, a demand which cannot be matched so far by domestic production.

Domestic producers could meet this demand for beef and veal, however, if the prices of these products are set at a profitable point at the farm level. For this to be so, two things have to take place: first, either the price of products should increase to high

enough levels or, second, the feed-grain prices should be substantially reduced or some combination of both. But even if these two events happen to take place, for a stable flow of beef and/or veal to appear in the market, coming from the domestic producers only, would take a considerable amount of time. Supply response to price changes is not an automatic process; it takes time. It is the purpose of this research effort empirically to test this proposition.

It is the belief of domestic producers that imports of beef and veal should be abandoned altogether since policy on these imports have caused erratic production cycles of these products in Greece. Import policy, they say, has not been consistent over the last two or three decades in Greece; it has not dealt adequately with the long range demand for meat. And this inconsistency causes anxiety and uncertainty for domestic producers and, hence, has serious effects on their planning and decision-making process. In terms of importation of meat, it is significant to ask here whether imports of beef, veal and feed-grain have either been "pushed in" or "pulled in." This thesis will examine this proposition.

Feed-grain and forage are the most important cost items in the production of beef, veal and milk. Yet feed-grains have to compete for resources with other products which use the same resources in their production process. The same holds true for roughage production and/or demand.

"Technological change" always has an impact on the production of livestock products. Since there is no way to retreat from science and technology, there has to be a better understanding of scientific evolution and its impact. This dissertation tests and quantifies the impact of technological change upon the production of the livestock products at hand.

Rising income is hypothesized to be the most crucial demand shifter for beef, veal and milk in Greece, over the period cited here. It was the aim of this research to quantify the income relationships with respect to the demand for the products considered here.

Finally, some analytical aspects of the supply function were examined in order to better perceive the production process for beef, veal and milk in Greece.

Purpose of the Study

The overall purpose of this study was to test how relevant the price mechanism has been to the development (growth) of the feedgrain cattle economy in Greece over the period 1951-1972.

Low prices at the farm level of livestock products, price uncertainty, instability of farm income and future government policies, profitability of crop enterprises and, import-export policies complicate decision making and planning processes for livestock producers. Under these unfavorable conditions, they are skeptical about expanding and/or adjusting their operations despite increasing demand.

In terms of these problems and in view of the goals in achieving self-sufficiency in livestock products and at the same time reducing livestock imports, this study was undertaken in an effort to link the cattle industry to the feed-grain industry and then these two to the rest of the economy, to analyze some past unique characteristics and trends of the cattle-feed-grain economy which may be relevant in the future.

Research Objectives

General Research Objectives

The first major objective of the study was to obtain descriptive knowledge of the dynamics of the feed-grain-cattle economy in Greece in order to understand the forces behind the demand and supply schedules of outputs produced and of inputs used and to prescribe actions to be taken in case they are needed.

The second major objective was to estimate a system of relationships which integrates some of the interrelationships between the consumer, the producer and the importer. Clearly, these segments are interrelated, but the main aim was to ascertain what the relevant factors are which have a serious impact within each subsystem, and not how to drive the whole system (economy) simultaneously.

Specific Research Objectives

1. To investigate the beef producing industry in Greece to determine: (a) what changes have taken place during the period between

1951 to 1972 and what implications these changes have for the future of beef; (b) what the critical relations and/or links in the beef production and consumption process are which need to be understood by both farmers and policy-decision makers, if any action to to be taken in the future to correct the gap between production and consumption of beef in Greece.

2. To investigate the veal producing industry in Greece in order to see: (a) what changes in the composition of the national herd have taken place over the sample period and what impacts these changes have had on the consumption and production of veal over time; (b) what factors affect the consumption and production of veal in Greece and what policy implications these factors have for tackling the deficit in veal production.

3. To investigate the milk producing industry in Greece to determine: (a) what factors influence production and consumption of milk and what variables are relevant from a policy-design point of view; (b) what structural and locational changes have taken place in milk industry.

4. To investigate the mechanism which links feed-grain production with the cattle economy by first describing an economic model to represent the endogenous mechanism and then fitting the model using econometric estimation methods to see what factors influence supply and/or demand for feed-grains in Greece.

5. To investigate the impacts of a growing economy and particularly of increasing incomes on the consumption of beef, veal and milk and, further, to see what factors determine the imports of these livestock products and the inputs (feed-grains) needed to produce these products.

Data Collection

Data were collected from both primary and secondary sources: primary data, from cattle feeders, dairy enterprises and feed-grain growers, and secondary data, from the Ministry of Agriculture, the Agricultural Bank of Greece (A.B.G.), the Central Market Bureaus in Athens and Thessaloniki and publications both in Greek and in English, such as OECD publications, EEC publications, FAO publications and others.

This study is based mainly upon secondary data, which were collected from several sources as the aforementioned and compared for consistency. Where differences arose, efforts were made to determine reasons for these inconsistencies. In some cases judgments were necessary and these were made on the basis of reasonableness and the author's experience as both an agronomist and an economist.

Limitation of the Study

The purpose of the study was to make an inquiry into the production and the consumption of beef, veal, milk, feed-grain and roughages on one hand, and into the imports of beef, veal and feed-grain on the other.

Based on time-series data, this study was limited by the data available and their accuracy. Greater availability of the data would have improved the validity of the inferences drawn.

Significance of the Study

It is expected that the results of the study will be widely used both in Greece and abroad, though the Agricultural Bank of

Greece and Greek Ministries of Commerce and Cooperation will be among those government agencies with primary interest in the results of this thesis.

Furthermore, the primary people in the business involved in the feed-grain cattle economy of Greece want to use some of the results of this research effort as will farmers and their Cooperative Associations.

Outline of the Study

After this introductory chapter, Chapter II is devoted to a discussion of the Greek agricultural sector and the major problems faced during the study period and today.

Chapter III provides a description of beef, veal, milk and feedgrain industries to provide the reader the necessary familiarity with the feedgrain cattle economy of Greece.

Chapter IV discusses the methodological approach used to derive the final econometric models estimated in this thesis. In addition, the theoretical economic model underlying the feedgrain-cattle-economy is discussed in detail.

Chapter V discusses the development of demand relationships and the factors which influence demand for both feedgrain and livestock products. Furthermore, the empirical results for demand analysis are given in this chapter.

Chapter VI discusses the supply relationships underlined in the feedgrain-cattle-economy and the empirical results of the supply analysis are given, along with a discussion about the use of polynomial long models.

Chapter VII provides a discussion about trends and projections and the projection capability of the model is examined using Theil's inequality coefficient to check each equation's prediction efficiency.

Finally Chapter VIII gives a summary, conclusions and recommendations for future research, along with some policy implication drawn from the empirical analysis.

CHAPTER II

THE AGRICULTURAL SECTOR IN THE WHOLE ECONOMY

The purpose of this chapter was: (a) to expose the unfamiliar reader to the features of the Greek agricultural sector and its place within the whole economy, and (b) to provide descriptive knowledge of the industries which comprise the feed-grain cattle economy. Tables referring to this chapter can be found in Appendix A of this work.

General Views

Writing in 1953, Professor G. Koutsoumaris stressed that there are "two main shortcomings in Greek agriculture; a low labor productivity, and allocative and productive inefficiency in respect to capital (including land). It is on these areas that agricultural development policy should focus."[1] Writing at the same time, the late Professor C. Evelpidis[2] in a remarkable study about the farm crisis in the Greek agricultural sector pointed out that the crisis is a permanent one caused by structural problems, the subsistence

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[1]G. Koutsoumaris, "Resource Productivity and Development Policy for Greek Agricultural - An illustrative Study," Journal of Farm Economics, 36 (1954).

[2](I Chronia Georgiki Krisis is tin Ellada (Athens: Papazisis, 1953), pp. 3, 18, 42, 43.). "The Permanent Farm Crisis in Greece " (in Greek) (Athens: Papazisis, 1953).

orientation of the agricultural sector, excessive labor employed in agriculture, lack of any modern marketing system and lack of any international trade orientation which explains the inability of Greek agriculture to cope with international developments in that sector.

In 1965 Professor S. Triantis maintained that a striking characteristic of Greece's agriculture is that of relatively low resource mobility and hence less economical allocation of productive resources than in more advanced countries.[3] And Professor P. Yotopoulos, after studying one of the poorest agricultural regions in Greece, Epirus, concluded that Greek agriculture is efficient but poor."[4*]

In light of these very general remarks a more definite picture of the Greek agricultural sector will be given in the subsequent sections.

Excess Labor Devoted to Agriculture

The table below indicates the agricultural population and the economically active population engaged in agriculture in Greece. It can be observed that the population employed by the Greek agricultural sector was rather high, 40.7 percent in 1971 and 35.0 in 1975.

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[3]Common Market and Economic Development, Center of Planning and Economic Research Center (Athens, 1965).

[4]P. Yotopoulos Allocative Efficiency in Economic Development Center of Planning and Economic Research (Athens, 1976), pp. 217-225.

*"Efficient in the sense that marginal productivities of the factors employed in agriculture do not differ significantly from their opportunity cost" (Ibid, p. 11).

TABLE 1

ACTIVE AGRICULTURAL POPULATION IN GREECE

	1951	1961	1964	1967	1970	1971	1975
Active employed civilian							
Total Population (in thousands)	3,278	3,640	3,555	3,469	3,384	3,327	
Of which in agriculture (in thousands)	1,864	1,960	1,770	1,600	1,447	1,355	
As a percentage (%)	56.9	53.8	49.8	46.1	42.8	40.7	35.0*

Sources: (1) OECD, Manpower Statistics
(2) KEPE, Athens
*(3) Ministry of Agriculture

Adopted from: OECD, Agricultural Policy Reports, Agricultural Policy in Greece (Paris, 1973), p. 20.

Such excess labor results in a labor productivity which compared with other sectors in terms of Gross Domestic Product (GDP) is rather low. This is given in Table 2.

For an optimum allocation of resources and under the assumption of perfect knowledge and perfect competition, the excess labor needs to be combined with appropriate amounts of land and capital in order to give the maximum product possible. Since these latter factors are not available, the economic theory easily explains the low labor productivity in the agricultural sector compared with that in other sectors or in other countries. Too much labor is combined with too little land and capital and the result is lower productivity of the more abundant factor, i.e., labor.

TABLE 2

LABOR PRODUCTIVITY. GROSS PRODUCT AT 1963 PRICES.
Million Drachmae*

	1963	1966	1969	1970
Whole economy				
Gross Domestic Product (GDP)	120,402	150,661	183,164	197,345
Active population	3,583	3,497	3,412	3,384
GDP per active person	33,604	43,083	53,682	58,317
Agriculture				
Gross Agricultural Product (GAP)	31,472	34,395	35,298	38,346
Active population	1,831	1,655	1,497	1,447
GAP per active person	17,188	20,782	23,579	26,500
Other sectors				
GDP	88,930	116,266	147,866	158,999
Active population	1,752	1,842	1,915	1,937
GDP per active person	50,759	63,119	77,215	82,085

Sources: (1) OECD, National Accounts
(2) KEPE, Athens

Adopted from: OECD, Agricultural Policy Reports, Agricultural Policy in Greece (Paris, 1973), p. 22.

*30 drachmae = $1.0 in 1973 and floating thereafter.

Agricultural Land

Greece's land area is about 131 thousand square kilometers, or just over 50 thousand square miles, though only a little over one-quarter of this is cultivated. About half the total cultivated area con

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consists of farms of less than five hectares while farms of over twenty hectares accounted for only 9.3 percent in 1970. Eighty-eight percent of holdings are farmed directly by their owners, and tenant farming accounts for a very small percentage. Table 3 below gives the distribution and number and area of agricultural holdings by size in 1950, 1960 and 1970. Economic pressure in agriculture and non-existing opportunities for employment in the other sectors of the Greek economy have resulted in no profound changes of the farm structure, i.e., in the number of farmers employed in agriculture and the size of farms.

TABLE 3

DISTRIBUTION AND NUMBER AND AREA OF AGRICULTURAL HOLDINGS BY SIZE: 1950, 1960, 1970.

Size of Holdings (1 hectare = 2.471 acres)	Percentage of Total No. of Holdings 1950	1960	1970	Percentage of Total Cultivated Area 1950	1960	1970
Up to 1 hectare	28.0	23.0	21.8	6.0	3.6	3.1
1 - 4.9 hectares	57.0	57.8	57.3	43.0	45.1	41.7
5 - 9.9 hectares	11.0	15.1	15.8	22.0	31.1	30.5
10 - 19.9 hectares	3.0	3.4	4.1	10.0	13.6	15.4
20 and over hectares	1.0	.7	1.0	19.0	6.6	9.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

Sources: (1) FAO, World Agricultural Structure. Study No. 1, "General Introduction: Number and Size of Holdings," (Rome, 1961), pp. 59, 66.

(2) For 1960 and 1970: Statistical Yearbook of Greece. National Statistical Service of Greece, Annual Series.

Smallness of farms is an obstacle to the use of modern machinery and techniques in general, and the land consolidation program which exists today in Greece cannot produce any really viable holdings. On the other hand, the Greek laws and traditions of inheritance law and dowry result in excessive subdivision and fragmentation of agricultural holdings, and this in turn means misallocation of time and other resources as well.[5]

Due to this fragmentation problem Greece is pursuing a number of policy alternatives today to increase economically viable holdings. Such policies include the establishment of "group farming"[6,7] subsidized officially by government agencies and the establishment of a "Soil Bank"[8] to take care of the land which is left behind mainly by emigrants, the introduction of Societes Anonymes[9] in agriculture and the enhancement of the cooperative movement.[10] Other

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[5]K. Thompson, Farm Fragmentation in Greece. The Problem and Its Setting. (Athens: Center of Planning and Economic Research, 1963), p. 29.

[6]S. Mariadis, and V.C. Kalaitzis, "Collective Farming. A Solution to the Structural Problem of Small Farm Acreage in Greece" (in Greek) (Geoponika, July-August, 1976).

[7]V.C. Kalaitzis, "Observations on the New Institution of Group Farming Enterprises," Hellenic Agricultural Economic Review, 9, No. 2 (July, 1973).

[8]A. Pepelasis, "To Provlima Tou Mikrou Klirou," "The Problem of Small Farm Holdings" (in Greek). Agrotiki Trapeza, Tephchi 10-12, 1976 and by the same author: "Agrotiki Politiki Kai Anaptixi" (Athens: Papazisis, 1976), pp. 146-161.

[9]X. Zolotas, "I Ellas Kai i E.O.K." Oikonomikos Tachydromos, 1976.

[10]Kalaitzis, 19.

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measures taken by the state to overcome this structural problem in agriculture include investment in irrigation projects: 18.4 percent of cultivated land is irrigated which makes irrigation one of the most essential elements in Greek agriculture. The irrigation projects are financed mainly by the government which provides long-term interest-free loans and which, since the end of 1972, has assumed the responsibility for all the costs.[11]

Farm Size in Greece

Table 4 below reveals that the average size of a farm in Greece was 7.67 acres in 1961 and 8.23 acres in 1971. Thus the size problem today remains actually the same as it was 10 or 20 years ago. This smallness is further deteriorated by a fragmentation problem. Each farm in Greece is, on the average, divided into 7 separate plots and that makes farm business operations even more inefficient.

Capital in Greek Agriculture

Greek agriculture is characterized as a labor intensive sector[12] and, as such, it might feel relatively little need for mechanization. But this does not mean that capital is not required for investment. The gross domestic asset formation was 3,415 million

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[11]OECD, Agricultural Policy Reports, Agricultural Policy in Greece. (Paris, 1973), p. 21.

[12]S. Triantis, "Common Market and Economic Development. The EEC and Greece," (Athens: Center of Planning and Economic Research, 1965), p. 48.

TABLE 4

NUMBER OF AGRICULTURAL HOLDINGS,
FARM SIZE AND IRRIGATED LAND, GREECE 1961, 1971.

	1961	1971
Number of Holdings	1,140,163[1]	1,036,600[1]
Total Areas ('000 Stremmata)	36,733	35,863
Total Areas ('000 hectares	3,673	3,586
Average Size (Stremmata)	32.21	34.59
Average Size (hectares)	3.2	0.8
Irrigated Land ('000 Stremmata)	4,890	7,337
Irrigated Land ('000 hectares	0.484	0.734

Source: National Statistical Service of Greece, Statistical Yearbook of Greece (Athens, 1973).

[1]Excluding 16,009 for 1961 and 10,660 for 1971 holdings with animals only.

dollars in 1960 (in constant 1958 prices) and it increased to 6,320 million dollars (in constant 1958 prices) in 1972 which is almost a 100 percent increase over that of 1960. However, if we compare this with other sectors' asset formation, for example, dwellings, we see that the latter's increase was almost threefold:[13] it increased from 5,646 million dollars in 1960 to 15,606 million dollars in 1970 in constant 1958 prices.

Greece's climate is dry and precipitation is irregular and varies considerably from year to year. This requires the government to spend a considerable amount of money on irrigation which in 1970

[13]National Accounts of Greece, 1948-1970, No. 21. (Athens, 1972).

accounted for about 80 percent of investment in land improvement. Several types of subsidies (input subsidies, price intervention schemes and compensation payments) provide other ways for government to invest money in the agricultural sector, while training and research is still another field in which money is invested by the government with the aim of improving farmers' productive capacity and to increase knowledge about the farm sector's operation. Finally, only in the last few years has the government supported co-operatives in assuming responsibility for commercial and industrial operations previously in the hands of the Agricultural Bank of Greece (A.B.G.) or the State.

Despite such investment efforts by government, however, the capital invested in the sector is not sufficient.

Agriculture and Foreign Trade

While Greece's overall trade balance is heavily in deficit (it reached a record level of more than $800 million in 1969), trade in agricultural products shows a favorable balance. The agricultural trade balance, including raw cotton, moved from a surplus of $68 million in 1955 to one of $170 million in 1967. Yet the favorable balance of trade in agriculture is less than the balance on each of the two main invisible items (emigrants' remittances and maritime transport), but higher than that of tourism.

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The Geographical Pattern of Agricultural Trade

Imports are coming into Greece notably form three major regions: North America, EEC and, to some extent, from EFTA. Approximately 1/6 of all Greek agricultural imports consists mainly of cereals used as feeding stuff which come from North America. Beef and veal imports come mainly from EEC countries, although Yugoslavia has been one of the main suppliers of live animals and, to some extent, meat. Eastern Europe also plays a part in agricultural imports, but its exports to Greece are rather irregular and are carried on through bilateral trade agreements.

On the other side, Greek agricultural exports go mainly to EEC, which at present absorbs roughly one-half of total Greek exports. North America and the EFTA countries absorb much smaller quantities, usually even smaller than that of Eastern Europe. This heavy EEC export orientation of Greek agriculture has been criticized quite a lot by many in Greece, since it is believed that by this heavy reliance on the EEC market Greece loses her bargaining power. These critics support instead the idea that a wider range of export markets is more profitable for Greece since this naturally could even out risks. With violent fluctuations in the prices of export goods and the strong competition by other countries this heavy reliance on the EEC market seems by itself very considerable. Myrdal writing in 1956 pointed out that

> A country like Greece, trying to earn half its export proceeds by finding markets for its tobacco, is continually forced to accept a number of concessions regarding its imports, which it would not accept if it had a freerer position since they run counter to its development policy. Often it is compelled to open its boundaries to the import of a number of consumption goods while there is idle capacity at home to produce them.[15]

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[15]Gunnar Myrdal, An International Economy. Problems and Prospects (New York: Harper and Row, 1956), p. 256.

CHAPTER III

THE INDUSTRIES INVOLVED

1. The Cattle Industry

The objectives of this section are: (a) to present some of the unique features of the cattle economy and (b) to provide the necessary descriptive knowledge which may be used for the quantitative analysis which follows in Chapter V.

Size and Composition of the Cattle Industry

Table 5 reveals the size of the national herd and its components for the years 1961 to 1972. The national herd consists of: (a) the domestic herd (local unimproved), (b) the local improved herd, i.e., cattle resulting from cross-breedings with domestic cattle and dairy-beef and, finally, (c) the so-called foreign improved herd, i.e., exotic or pure breeds used mainly for milk production.

Regional Patterns of the Cattle Industry

Most cattle were (and still are) maintained in the plain areas over the sample period and these numbers have increased since 1961.

The numbers in Table 6 illustrate that the number of cattle fed in the last two categories of land is decreasing, and cattle population in the level areas is increasing. This means that pasture areas which are utilized by beef and dual purpose breeds are underutilized, while

TABLE 5

CATTLE POPULATION OF ALL AGES ON DEC. 31, 1961-1972
(IN THOUSAND HEAD)

				OXEN, BULLS, COWS & HEIFERS								
				LOCAL UNIMPROVED			LOCAL IMPROVED			FOREIGN IMPROVED		
YEAR	TOTAL	MALE	FEMALE	Total	Male	Female	Total	Male	Female	Total	Male	Female
1961	1 069	323	746	767	250	517	261	65	197	40	8	32
1962	0 060	313	747	705	225	480	309	79	231	46	10	36
1963	1 034	301	732	645	201	444	449	89	250	49	11	38
1964	1 017	299	718	561	169	392	405	118	288	50	12	38
1965	1 046	308	738	499	149	350	489	145	345	57	14	43
1966	1 082	317	764	439	129	310	572	168	404	70	20	50
1967	1 094	320	775	394	113	282	624	186	438	76	21	55
1968	1 038	282	756	328	83	244	641	180	462	69	19	50
1969	1 097	262	735	290	69	221	639	177	462	68	17	51
1970	952	250	702	251	60	191	629	172	458	72	19	53
1971	986	260	726	223	51	172	672	184	488	91	25	67
1972	1 055	270	785	204	45	159	738	193	545	113	32	80

SOURCE: N.S.S.G., Agricultural Statistics of Greece, Annual Publications, 1961,...,1972.

an increase in feed-grain and forage will be required to feed the rising population in the plain areas. This trend further implies that production resources devoted to the production of cattle have to compete with resources devoted to the production of other crops.

TABLE 6

LOCATION OF THE NATIONAL HERD ACCORDING TO THE ALTITUDE
(in percentage of 1961 population)

Year	Level Areas	Semimountain Areas	Mountainous Areas	Total
1961	56	23	21	100
1972	64	20	16	100

Source: Statistical Yearbook of Greece, 1962 and 1972.

More specifically, the regional location of the cattle industry according to the state administrative regions is as in Table 7. Important to note is that regions of Macedonia, Epirus and central Greece and Euboea have a large population, mainly because of the rainfall there which reaches 1,000 mm or more.

Cattle Breeds

In 1961 72 percent of all Greek cattle belonged to the two indigenous (domestic or local) breeds of Greek Shorthorn and Greek Steppe cattle, while 24 percent belonged to the various cross-breeds, i.e., domestic improved breeds; only the remaining 4 percent were foreign breeds. This situation changed in 1971, however, when the percentages ran as follows: indigenous breeds; 23 percent, cross-breeds, 68 percent and foreign breeds, only 9 percent.

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[1]FAO, European Breeds of Cattle, Vol. II (Rome, 1966).

TABLE 7

OXEN, BULLS, HEIFERS, COWS AND BUFFALOES (ALL AGES) ON DECEMBER 31, 1966, BY GEOGRAPHIC REGION

Head

Geographic Region	Oxen, bulls, heifers, cows								Buffalo	
	Total		Local Unimproved		Local Improved		Foreign Improved			
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Greece, Total	317,272	764,384	129,065	310,210	168,341	404,008	19,866	50,166	5,707	27,519
Greater Athens	445	3,920	71	317	300	1,893	74	1,710	-	-
Rest of Central Greece, Euboea	22,078	64,268	5,846	25,632	12,979	29,568	3,253	9,068	2	60
Peloponnese	24,225	34,564	9,377	16,551	10,926	12,515	3,922	5,498	1	-
Ionian Islands	6,403	8,851	1,458	1,575	4,666	6,416	279	860	-	3
Epirus	9,117	31,864	6,226	19,749	2,226	10,036	665	2,079	2	33
Thessaly	22,338	93,565	7,564	41,170	13,864	48,918	910	3,477	48	770
Macedonia	148,897	331,519	60,507	117,876	83,318	198,218	5,072	15,425	3,120	15,625
Thrace	56,436	130,687	24,790	50,537	28,252	72,463	3,394	7,687	2,533	11,026
Aegean Islands	18,631	43,578	8,858	20,733	8,339	19,943		2,402	1	2
Crete	8,702	21,568	4,368	16,070	3,471	4,038	863	1,460	-	-

Source: N.S.S.G., Agricultural Statistics of Greece, Year 1966, pp. 96-97.

Improvements in all breeds have been stimulated through a state program of artificial insemination executed by trained technicians and administered under the responsibility of the Ministry of Agriculture.

The Greek Shorthorn is still found mostly in Southern Greece, while the Greek Steppe breed prevails in Macedonia, Thrace and the Eastern area of Thessaly. Both of these breeds are small in size with an average liveweight for the Shorthorn of 180-200 kg. and for the Steppe, 285-300 kg. The muscular structure of both of these two breeds is not good for meat production purposes.

Because of the low productivity of the aforementioned two breeds, Greece with the help of F.A.O., has undertaken a program of improving the national herd. Thus, Friesians from the United States and Denmark, Simentals from Yugoslavia and Angelin, Hereford, Holstein Jerseys, Abderdeen Angus and Brown Swiss from United States and Europe have been introduced for both increasing the quality of the indigenous stock and for pure breeding purposes.

Brown Swiss has been used to a greater extent due, mainly, to its dual-purpose characteristics in that the breed can produce both milk and meat. The puprose of the whole program of improvement has had to take into account the nutritional aspects of a poorly fed rural population in Greece which needs both these products. Brown Swiss has been respected for its good quality meat along with its high production of meat weight gained daily under the rough Greek conditions (the rate of gain is, on the average, 1.05 kg a day for bulls and .85 kg for heifers). The results for the beef breeds "have not been really satisfactory owing to the lack of opportunities to express their hereditary characters economically because of dietary restriction."[2]

Friesians have a good reputation as a dairy breed, while Simentals from Yugoslovia have been used mainly for breeding purposes, after being kept in barns for fattening.

Production Systems of Beef, Veal and Milk

Beef, Veal and Milk Production from the Indigenous Herds:

Both local and local improved herds are of low productivity in both meat and milk operation. Yet, the animals are well adapted to the country's conditions, and during the decade 1950-1960 and early in the 1960s the same animals were used as draft animals, though progressive mechanization of agriculture has almost eliminated this use.

For meat production purposes these local herds are not efficient animals because of their poor muscular development and the work which they used to perform. The usual practice in Greece was for calves to be allowed to suckle their dams for at least two months, and the milk available to the farmer in the short lactation period of six to eight months averaged some 530 kg. If the animals were kept in barns and supplemented with feed-grain the average milk yield would go up to 1,200 kg.

The animals of these two herds usually graze in a communal herd and one man is able to watch over more than 100 animals. In general however, each Greek family has 1 to 3 animals which provide milk to the family and, sometimes, beef as well.

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[2] Ibid., p. 308.

The main thrust of government policy has been the upgrading of these local herds by crosses with foreign breeds, a thrust which has been carried out successfully by the program of artificial insemination referred to previously. Cows and calves pasture together, thus competing for pasture land which is usually low quality communal pasture with almost nothing invested on it due to the farmers' ignorance and lack of cooperation between them.

Beef, Veal and Milk from the Local Improved Herd

As Table 5 reveals, this is the largest component in the Greek herd in terms of cattle units and, for that reason, in terms of production of beef, veal and milk. In 1972, crossbreeds represented 69.95 percent of the total cattle population with 19.34 domestic and 10.71 foreign improved.

The average milk production per year is somewhere in the range of 1,500-3,000 kg., depending on the breed used for crosses and feeding practices.[3] The diversification system, operative in Greece over the sample period, dictated that beef and/or milk production was a supplementary farm activity to the whole family farm business. Here, the farmer usually produces his own feed-grain and raises his own calves, thus solving partially the problem of calf and feed shortages.

The potentiality of the local improved herd to produce meat and milk is rather good if adequate forage and pastures are provided

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[3] L. Ananikas, "Potential Livestock Production Adjustments on Family Farms in Central Macedonia, Greece," Ph.D. Dissertation, Michigan State University, 1974, p. 34.

them for grazing. Forage is grown on the farm and supplemented with the required balanced grain and concentrates. Feed-grain is also produced on the farm and is fed to the animals.

Research in the United States[4] indicates that cross-bred calves have certain superior characteristics which include: (a) greater viability compared to the purebred calves; (b) larger muscular development; (3) an ability to be weaned earlier; (4) a higher pregnancy rate; and, for these reasons, (5) a yield of higher returns to factors of production.

Specialized Beef Production[5]

For beef-production purposes, the foreign improved herd has not been satisfactory owing to poor dietary and management conditions. However, for milk production purposes, the Friesians have been productive wherever feeding could be undertaken in good quality and appropriate quantity, at least at a level which has permitted the herd to be milked without drawing too much upon their body reserves. Most successful in this sense, however, has been Brown Swiss because of its dual-purpose characteristics and the rather good management treatment which it has happened to receive from farmers.

Beef production takes place in four separate phases: (a) producing the calf, (b) growing the calf, (c) fattening the calf and (d) producing from animals culled from the producing herd. The whole

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[4] C.R. Shumway, E. Bentley and E.R. Barric, "Economic Analysis of a Beef Production Innovation: Dairy Beef Cross-breeding," North Carolina State University, Dept. of Economics, ERP-26 (March 1974).

[5] Ananikas, pp. 32-33.

set of steps takes place mostly on the same farm, but it can take place on various farms as well.

There are two distinct types of beef production. The first, a cow-calf operation, is based on imported breeds mainly from the United States which are used for both breeding and fattening purposes. Usually, the calves are retained until finished, pastured most of the time and fed with feed-grain and forage during wintertime. Management know-how, including knowledge of disease, diet and marketing information, is the most serious deficiency in this type of operation.

The second type of beef production is the large scale calf operations. It involves mainly improved breeds imported from Yugoslavia and the United States and includes only the fattening process. The calves can be either confined or pastured, depending on pasture quality and location of the business (weather variability). The practice here exercised by farmers is to purchase the calves at an initial weight of 50-60 kg. and sell (them) at 450-500 kg. Yugoslavian calves are purchased at weaning weight and sold at 450-500 kg. The composition of the feeding is usually 5-6 kg. of alfalfa and other forage and 2-3 kg. concentrates daily. A daily weight gain of 1-1.2 kg. on the average is the target to be reached.

Specialized beef production is not aided by the government since there is no quality differentiation marketing system which would give higher prices to higher quality meat. Recently, many cattle feeders have tried such a system without any success.

The following diagram in Figure 1 helps explain the definition of a "beef animal," which is adopted later in this thesis for the quantitative analysis.

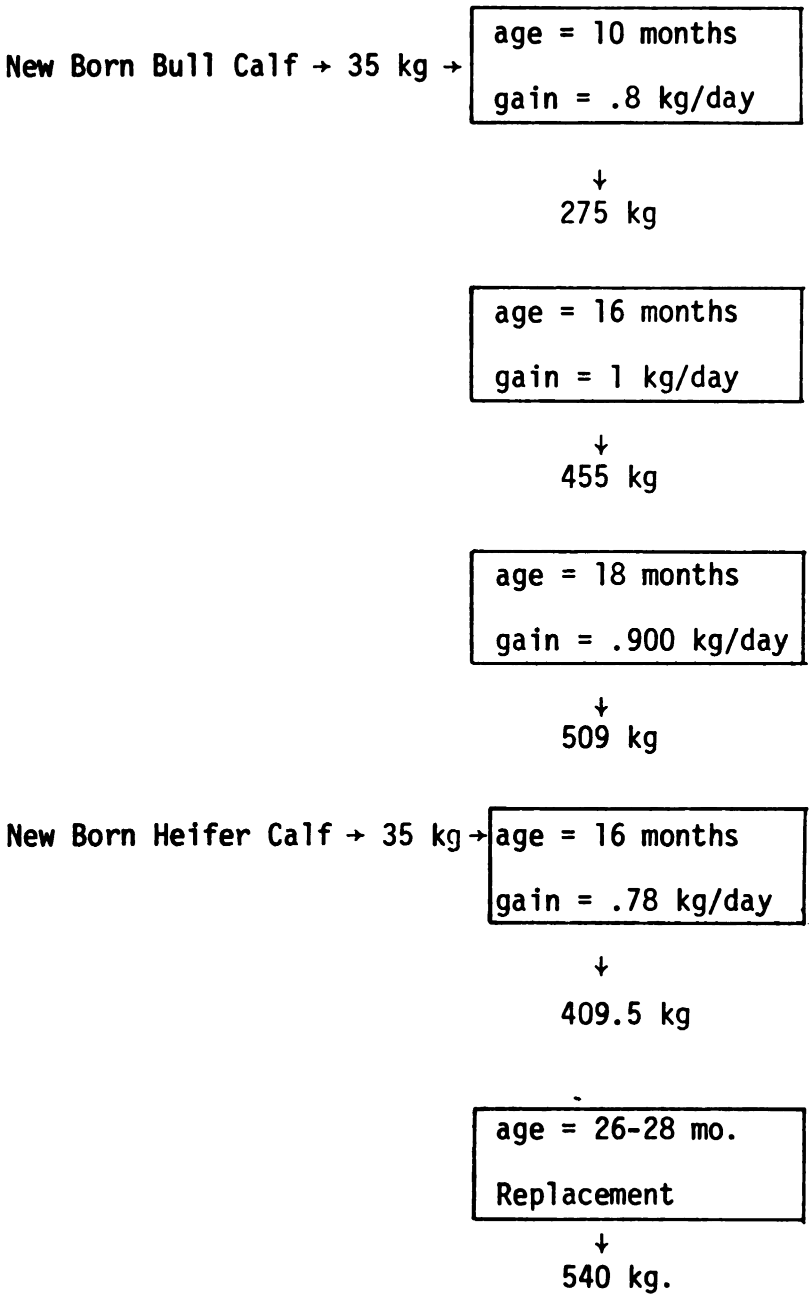

Figure 1. Bull Calves and Heifers Flow Diagram

Source: L. Ananikas, "Potential Livestock Production Adjustments on Family Farms in Central Macedonia, Greece," Ph.D. dissertation, Michigan State University, 1975.

The above diagram applies, of course, to specialized beef production units which use crossed beef herd animals. If, however, the numbers are changed, then, by the same token, a "beef cow" can be obtained from the other two types of herds as well. Thus, veal is defined in this study as the meat which comes from cattle two years of age or younger, and beef, as the meat coming from animals of two years of age and older.

Dairy Production

The bulk quantity of milk is produced by both the local breeds and the local improved breeds. Friesians and Holstein breeds are used for milk production. As the number of foreign improved breeds increases, the tendency is to establish specialized dairy cattle farms located close to the big cities. However, the number of this kind of farms is still small. Out of 1,047,260 total holdings in 1971 only 10,660 belong in this category.[6]

The size of operation depends mainly upon capital availability, feed supply, land availability, milk prices and managerial skills. The main products produced in this type of operation are milk and replacement heifers. Bull calves are considered as a by-product of this milking herd and are sold as deacon calves to specialized beef production farms. The average milk production in these operations is, on the average, 4,000 kg. per year.

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[6] Statistical Yearbook of Greece, 1972, p. 142. Included here are all the livestock confined operations (beef, pork and poultry).

The average per cow milk production ranged from 676 kg. per cow per year in 1951 to 1279 kg. per cow per year in 1972. Milking cows graze in the open pastures and are fed only with small amounts of feed-grain and concentrates. Further, in the lower regions and peri-urban areas, where the need for milk is greater, the higher producing cows may be entirely stall-fed on balanced ratios or may be allowed out for exercise and some grazing. In this case milk production ranges from 3,000 kg to 3,600 kg.*

Livestock Productivity** in Greece

This section freely draws from the work done by Lawrence H. Shaw on postwar growth of Greek agricultural production.[7] Shaw uses two measures of productivity. The first measure includes implicitly the effect of composition and covers the period 1935/38 and 1945/63, while the second measure utilized by Shaw covers the period 1954-1963; it is one of pure productivity and excludes all composition effects.

The measure of livestock productivity is given in Table 7 in Appendix B. This table is constructed in terms of index numbers. Aggregate livestock productivity (3.5 percent) moved in a parallel

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*According to personal interview with milk producers outside of Thessaloniki, Laterini, Serras and Larissa.

**Productivity: in the sense of aggregate output production.

[7] H. Lawrence Shaw, Postwar Growth in Greek Agricultural Production, Center of Planning and Economic Research Special Studies Series (Athens, 19), pp. 214-230.

way with livestock numbers between 1947/49 and 1961/63. Livestock productivity was basically constant from 1947 to 1952. Since 1953, however, it has been increasing at approximately a constant rate.

Table B-7 in Appendix B presents indices of the measure of pure livestock productivity for the period 1954 to 1963. Over this period pure livestock productivity increased at a rate of 4.3 percent per year. This is considerably faster than the increase in the measure of livestock productivity including composition for the same period. The pure livestock productivity over the period 1957/59 to 1961/63 was found to be 5.7 per cent per year. Shaw concludes that, "This faster growth for the measure of pure livestock productivity as compared with the measure of livestock productivity including the effects of composition, indicates that composition change has had a negative effect on livestock production in the period 1954-1963."[8]

From Table B-8 in Appendix B it may be seen that until 1969 cattle productivity lagged behind the productivity of the other livestock products. Since 1960, however, it has increased considerably and it has come to rank first among the livestock products. In fact, Table B-8 in Appendix B reveals that cattle productivity increased considerably faster than the productivity in livestock lines, growing at a rate in excess of 6 percent per year in both measures.

Regional Patterns of Growth in Livestock Productivity

Regional patterns of gorwth in livestock productivity is shown in Table 9 in Appendix B where it can be seen that cattle

[8]By the term "composition" Shaw means "a different organization of production" (Shaw, p. 39 and 218).

productivity increased faster than the productivity in other livestock and faster in Crete, the Aegean Islands and Thrace (14.0, 11.0 and 10.4 respectively).

Number of Cattle per Holding

From Table 8 below it can be seen that 79.2 percent of the holdings raise 1 to 4 cattle, 16.19 percent of the holdings raise 5 to 9 cattle and small percentages of holdings raise cattle in quantities above 10 head. In other words 95.39 percent of the holdings raise 1 to 9 head of cattle.

The prevailing future holding in the Greek cattle industry is that of a family operation which raises 1 to 4 head of cattle.

TABLE 8

NUMBER OF HOLDINGS, NUMBER OF CATTLE AND NUMBER OF CATTLE PER HOLDING. GREECE 1971[1]

	Number of Cattle per Holding[2]						
	Total	1-4	5-9	10-19	20-29	30-49	50 +
Number of Holdings	243,300	192,720	39,400	9,100	1,220	620	240
Percentages	100%	79.2	16.19	3.74	0.50	0.25	0.09
Number of Cattle	836,280	413,500	244,920	113,240	22,000	28,210	14,500

1. From a five percent elaboration of total farm. Livestock Census of March 14, 1971.

2. Include dairy, beef cattle and dual-purpose cattle.

Source: National Statistical Service of Greece, "Statistical Yearbook of Greece," (Athens, 1971), p. 172.

The Typical Greek Livestock Farm

A typical livestock farm should be described as one which has an average farm size of 7.67 acres which is further divided into 7 separate plots and is highly diversified.

Nearly all the cattle is dual-purpose in nature (i.e., cattle are raised on the farm to produce both milk and beef). Milk is still the main product of the small farm, and the decisions taken by the farmers refer mainly to milk.

The main crops grown by a typical farm are usually wheat (barley and/or oats), maize, cotton, tobacco, alfalfa, in the northern part of Greece, and olive trees, vine trees, fruits and vegetables in both the North and the South with the exception of olive trees which are not grown in the North due to climatic conditions.

The number of cattle is usually up to two (2) cattle per farm. It was found that almost 83.2 percent of the livestock farms have an average of 1-5 milking cows in a case study carried out by Professor G. Kitsopanidis in a sample of 416 farms in Central Macedonia, Greece.[9] In the introduction of this study he states: "At first, business farmers did not show any particular interest for cow milk production because of strong competition from some cash crops for the most efficient utilization of the available land, labour and capital." And the study attributes this trend to unfavorable conditions of climate,

[9]G. Kitsopanidis, "The Economics of Milk Production in Central Macedonia, Greece." Reprint from the "Hellenic Agricultural Economic Review," Vol. VI, No. 1 (Thessaloniki, 1970), p. 7.

TABLE 9

NUMBER OF FARMS STUDIED AND NUMBER OF COWS MILKED

Number of Cows per Farm	Farms Number	Percentage	% Cumulative
1-2	213	51.2	51.2
3-5	133	32.0	83.2
6-10	59	14.2	97.4
11 and over	11	2.6	100.0
Total	416	100.0	

Source: Kitsopanidis, op. cit., p. 7.

soil and technical and economic conditions of cow milk production prevailed in Greece.

In a typical livestock farm the following feed stuffs are fed to cattle: Feed grains (maize, barley, oats, rye), fodder seeds (vetch and vetchling-lathyrus), fodder plants for hay (barley, oats, vetch, peas, clovers, centil, bitter vetch, grass cut for hay, etc.), fodder plants for green feed and roots (maize, sorghum, marigolds), and fodder plants for grazing (barley, oats, vetch, vetching).

Other feeding stuffs such as pulp of beet, cotton cake, lucerne dry, and some of the minerals have lately only been added to the cattle diet in Greece and especially in the more systematic intensive units of cattle production.

The Feed Grain Industries

Over the entire sample period it seems that the area (and production) under wheat remained stable, while total wheat production and average yield per hectare increased from 1,219 kg and 1,167 kg/h in 1954 to 1,930 kg and 1,959 kg/h in 1970, respectively. On the other hand, the area under rye decreased from 12,000 hectares in 1954 to 7,000 hectares in 1970, and its production decreased from 51,000 tons in 1954 to 9,000 tons in 1971. The average yield per hectare increased from 818 kg/h in 1954 to 1,285 kg/h in 1970 (See Table C-1 in Appendix C).

An increase can be noted in the area under barley: from 211,000 hectares in 1954 to 341,000 hectares in 1970. Its production increased, too, from 233,000 tons in 1954 to 718,000 tons in 1970, and the average yield almost doubled, going from 1,015 kg/h in 1954 to 2,015 kg/h in 1970 (see Table C-1). But there was a decrease in the area under oats which dropped from 138,000 hectares in 1954 to 80,000 hectares in 1970. Its production also declined from 150,000 tons in 1954 to 106,000 tons in 1970, while average yield increased from 1083 kg/h in 1954 to 1,325 kg/h in 1970 (see Table C-1).

Finally, the area under maize decreased from 253,000 hectares in 1954 to 170,000 in 1970, although production almost doubled, increasing from 254,000 tons in 1954 to 481,000 tons in 1970. The average yield almost trippled, increasing from 1,005 kg/h in 1954 to 2,829 kg/h in 1970 (see Table C-1).

The table in Appendix C thus reveals that a considerable increase in productivity has occurred in wheat, barley and maize production. This is partly due to better varieties used over the time, to better management techniques used, to increased mechanization almost in every phase of production and to use of better pesticides.

It seems that a limiting factor exists, however in that Greece now has almost reached the limit of geographic expansion of feed-grains land. Further expansion on feed-grain acreage will depend largely on the major irrigation projects carried out in the agricultural sector of Greece, since water supply is the most important limiting factor.

Another factor which is revealed is that Greece achieved a certain degree of diversification of farming during the sample period. The acreage once devoted to other principal crops is now under industrial and feed crops. Thus, the rate of growth over the period 1947-49 to 1965-67 was as follows:[10]

Grains	5.0 percent
Feed Crops	9.4 percent
Industrial Crops	7.0 percent
Tree Crops	5.5 percent

Grains experienced a rate of growth equal to 3.7 percent in Thrace in the 1952/54 to 1961/63 period, the highest in the country. Macedonia had a rate of 3.6 percent. Feed crops and hay experienced rates of growth as high as 24.8 and 28.4 percent, respectively, in the Aegean Islands over the same period, while legumes had their highest rate of growth, 22.0, in Epirus over the same period.[11] In 1966, the largest area under feed-grain was the region of Macedonia.

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[10]Shaw , pp. 54-60, Table 2.6.

[11]Shaw , p. 62, Table 2.7.

The structure of the farms which grow feed-grains remains typical of the Greek farm in general which has an average of 8.3 hectares of arable land and is largely diversified. Large feed-grain operations exist only in the region of Thessaly. Nevertheless, important changes in farm structure are occurring in Greece (though slowly) or can be expected in the years to come. The farm labor movement to the cities or abroad and increased labor costs have resulted in a more labor extensive agriculture, with the relative importance of dairying and, hence, of grassland farming diminished, while that of crops, especially cereals, has increased.

CHAPTER IV

METHODOLOGICAL APPROACH

Introduction

The general and specific objectives of this study have been stated earlier. In a broad sense, time series data were used for demand and supply analysis in a primarily single equation approach. Numbers of livestock and yields of livestock were utilized as separate dependent variables affected by farm prices. It was assumed that most of the supply response was related to the conversion of some farm products (inputs) into livestock products (outputs) and that a substitution took place with other farm products.

The method of estimating each equation was the ordinary least-squares method. The equations given in the models were chosen by considering a priori knowledge of the industries, by using relevant economic theory and, finally, by taking into account the reliable data that exist in Greece today. Models which utilize time lag techniques were also tried.

Diagrammatic Presentation of Feed-Cattle Economy: Inputs and Outputs

An effort was made to include important features of the economic problems faced by both the producers of livestock products such as veal, beef and milk and by the producers of feed-grains and roughage. The model depicts the imports economy for livestock and feed-grains products in order to examine the relationships between the domestically produced products and the imported ones. It helps the reader to visualize, in a simple diagrammatic presentation, the association of inputs used to produce the outputs in the feed-cattle economy (see Figure 2).

Figure 2 attempts to give a visual picture of the major interactions involved in the greek feed-grain-livestock economy. Four major distinct interactions can be distinguished:

a) demand for and supply of inputs which go to the production of feed supplies. These inputs are also demanded by the entrepreneurs who produce other outputs in other enterprise combinations;

b) supply and demand interaction for each commodity produced, i.e., feedstuffs. Feedstuffs are used as inputs to produce livestock products;

c) livestock products which are directly or indirectly (processed) consumed by humans and/or animals (milk, for example), thus giving another set of interaction forces of supply and demand;

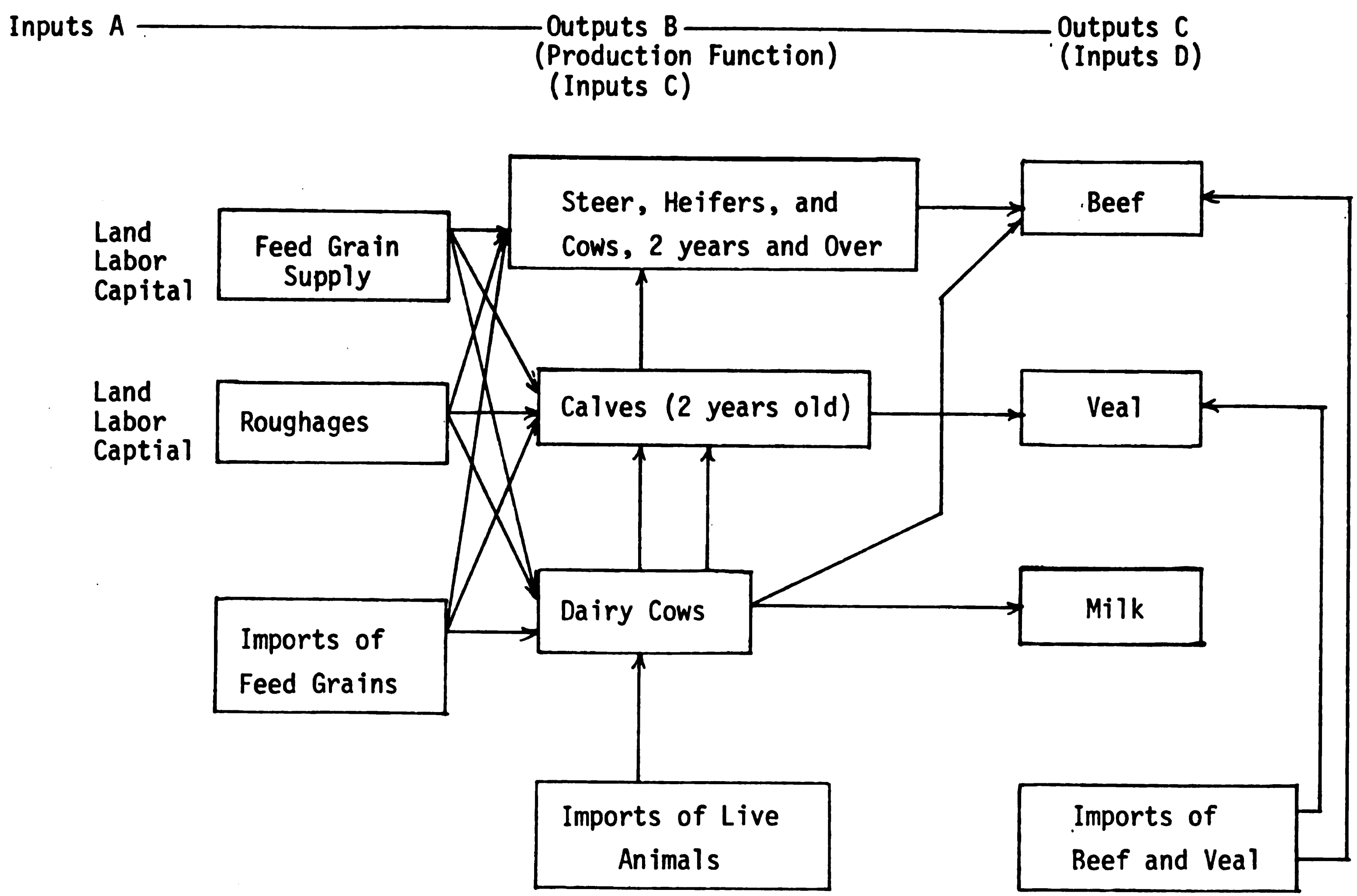

Figure 2. Input-Output Relationships in Livestock Products Production (Beef, Veal, Milk).

d) The existence of a competitive process for the foreign feed-grains imported to Greece since other importing countries compete with Greek (domestic) livestock producers for access over the same feed grains.

The recursive linkage among these major interactions is more easily understood to take place in the livestock feed-stuffs demand and livestock products price (supply) formation procedures. Due to the dual character of the cattle herd and due to the very diversified type of farming prevailing in Greece, multiple enterprise or resource allocation competition is assumed to exist in the production side of the feed-grains-cattle economy.

Land, buildings and tools are still considered as fixed factors in a specific livestock enterprise in Greece and cannot be shifted relatively easily from one enterprise to another. This observation (assumption) leads to specification of a recursive type of model.

Whenever a time lag seemed to be the major factor explaining a production phenomenon, distributed lag techniques were employed to obtain "better" results.

Figure 2 shows that outputs A are produced from inputs A. In other words, feed-grains are produced when inputs such as land, labor, capital (in the form of fertilizer, machinery, seed, etc.) are used. These outputs A can then be either treated as such or used as new inputs (inputs B) to produce new products (outputs B). Outputs B, which include the live animals of calves, steer, heifers and cows can again, either be treated as such and be sold as live animals, or be used as inputs (inputs C) to produce outputs C which comprise the livestock products being studied here, i.e., beef, veal and/or milk.

Figure 2 also gives the path production of feed-grain and roughage and of beef, veal and/or milk. In this diagram imports of feed-grain, live animals and (final products of) beef and veal are provided in order to illustrate the second open alternative (path of production) which can be followed by the Greek government. This second route can be a complementary path of securing livestock products for Greek consumers as well and is considered as such in this thesis.

From Figure 2 it is clear that domestic (Greek) consumer demand can be met either by following the first route i.e., by producing beef and veal domestically, or by importing them or by a combination of the two alternatives. The inputs used in the production process of beef, veal and milk can be provided to the cattle industry by choosing among the same three routes . Thus, Figure 2 specifies the policy options open to the domestic producers, to domestic consumers and/or to the government. This topic will be elaborated further later on.

Figure 2 shows, too, that feed-grain and (to a lesser extent) roughage compete for production resources with other crops. Land utilized for feed-grain is also used for grain which goes for human consumption. The same holds true for labor and capital. Thus, since in this case land and capital are the most rare resources in Greece it can safely be said that cattle production competes with human population for grain. In addition, other crops use the production resources which are devoted to grain (and hence, livestock products) production. It helps, then, to think of other crops which should enter into the model structure as competitive or complementary products.

Further Diagrammatic Development of the Model

For a more explicit diagrammatic presentation of the feed-cattle economy of Greece the diagram in Figure 3 has been drawn. Here, a more detailed picture of the feed-cattle economy is given. More specifically, the new element which has been added in Figure 3 is the government which has its influence on the aforementioned economy through trade regulations, institutional framework and policy designing.

This diagrammatic presentation provides thought-stimulating insights and helps one to think of the whole system of the economy considered here. Thus, beginning at the base of the diagram retail demand and supply for inputs and outputs can be formulated. Then, wholesale demand and supply can be taken as a new subsystem. Proceeding upwards, the farm supply of livestock products can be distinguished and demand for inputs can be recognized easily. Furthermore, the foreign trade element (imports) of both inputs and products is clearly formulated.

The rest of the world demand stands at the very top of the diagram, while the government stands at the very bottom. Needless to say, in this last component of the feed-cattle economy variables such as subsidies, advisory work, resources and development (technology), etc. are included. Thus, this segment plays an important role and seriously affects behavior of the parts involved in the system at hand.

In terms of this paper's organization and estimation procedure, the wholesale supply and demand component was reduced for reasons such as lack of data concerning the structure and behavior of the wholesale

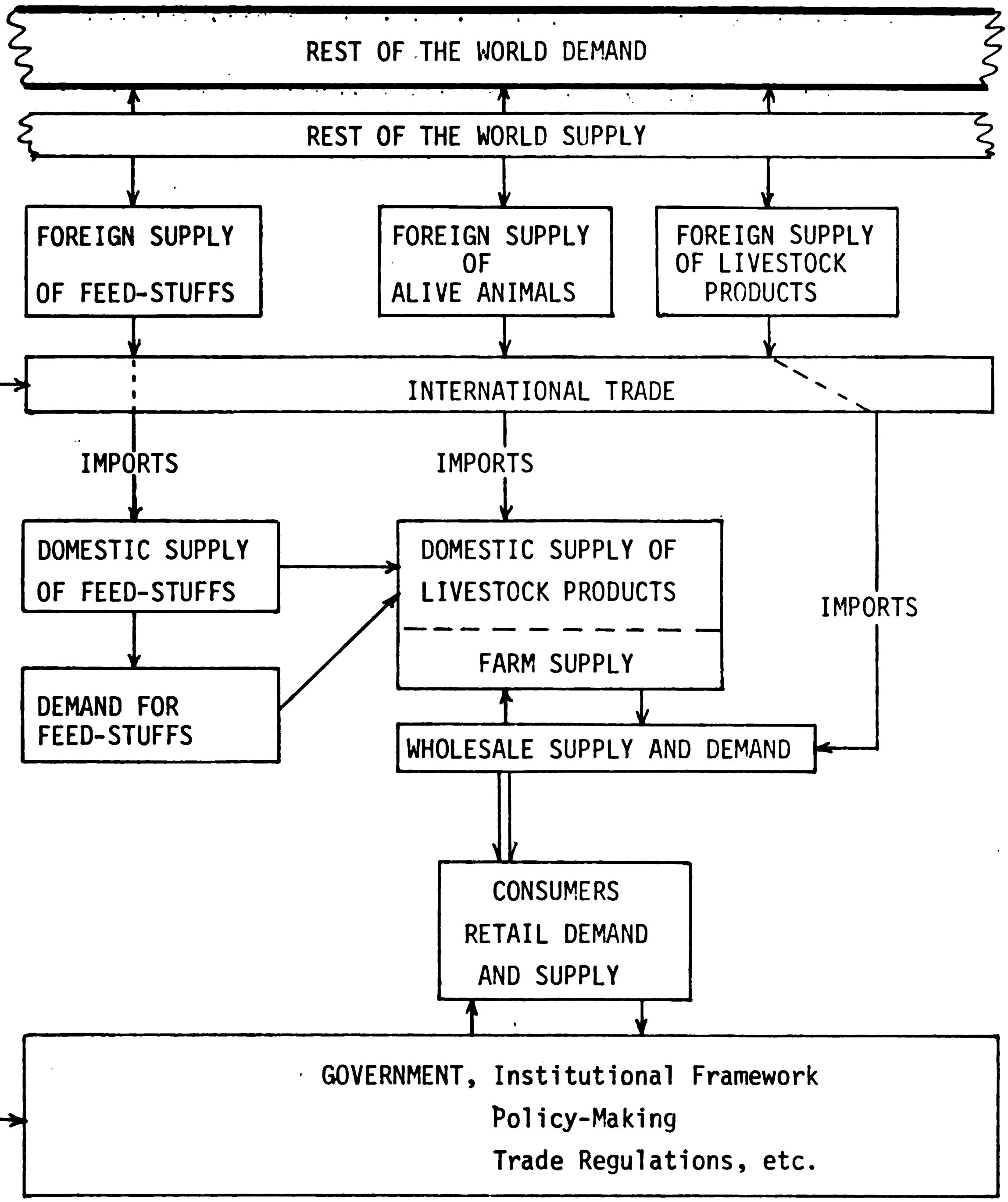

Figure 3. The Feed-Cattle Economy in Greece and Its Domestic and Foreign Environment.

industries involved in the feed-grain-cattle economy of Greece. This by no means implies, however, that this component of the system is not important. On the contrary, the efficiency of this component and its performance influence both supply and demand for the products being studied here. Relationships between marketing margins and retail and farm prices are explained in a later section of the next chapter.

An even more detailed graphic presentation of the relationships which exist in the whole feed-grain economy is provided in figure 4. This diagram depicts the endogenous variables of the system as circles and the exogenous ones as rectangles. Yet this is a kind of tentative division of these variables in these two categories since, sometimes, there is no clear demarcation line to what variable is endogenous and what variable is exogenous to the system.

Beef consumption and production are linked with both current and lagged prices, and any difference between these two schedules may be presented in the form of an identity equation. Here beef production is defined as the total meat which is ready for consumption at time t, regardless of its source of origin (domestic, imported as frozen or as live animals which are slaughtered within the country etc.).

Heavy arrows depict stronger relationships, most of which have been estimated in the empirical analysis of this thesis. The setup of this diagram in Figure 4 helps one to visualize both the individual variables used in each equation and to list all the equations which formulate the sybsystems and the whole system in general.

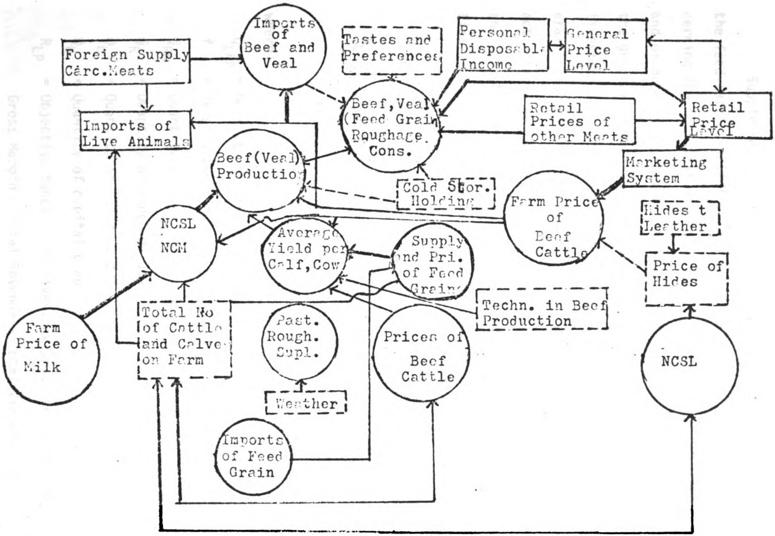

Figure 4. Demand,Supply and Price Structure of the Greek Feed-Cattle Economy

Livestock Supply and Derived Input Demand

Supply response functions for the commodities produced in the feed-cattle-subsector are based on micro-level assumptions concerning the technical nature of feed grain and livestock production and producer's objective functions. Equations (4.1) and (4.2) are the general production function and objective function assumed for livestock activities, while equations (4.3) and (4.4) are the general production and objective function assumed for feed grain activities; equations (4.5) and (4.6) are the production function and the objective function for roughage (pasture) activities. Finally (4.7) and (4.8) are for the trade activities.

$$Q_{LPP} = f\,(Q_{FG}, Q_R, Q_L, Q_K) \tag{4.1}$$

$$\begin{aligned} R_{LP} = {} & P_{LPP} \quad Q_{LPP} - P_{FG} \cdot Q_{FG} - P_R \cdot Q_R - P_L \cdot Q_L - P_K \cdot Q_K \\ & - FC + \lambda_1 [Q_{LPP} - f\,(Q_{FG}, Q_R, Q_L, Q_K)] \end{aligned} \tag{4.2}$$

where:

Q_{LPP} = Quantity of livestock products produced

f = denotes function

Q_{FG} = Quantity of feed grain used

Q_R = Quantity of roughage used

Q_L = Quantity of labor used

Q_K = Quantity of capital used

R_{LP} = Objective function in livestock products production, i.e., Gross Margin = Total Revenue - Total Variable Cost

P = Price

FC = Fixed capital expenses used

λ = Lagrangian operator.

The subscripts are defined as follows:

LPP = Livestock products produced

FG = Feed grains index

R = Roughage index

L = Labor used in the production process

K = Capital (in general) used in the production process

For the feed-grain production activities the equations are:

$$Q_{FG} = f\ (Q_F, Q_L, Q_K) \tag{4.3}$$

$$\begin{aligned} R_{FG} = P_{FG}\ \ Q_{FG} - P_F \cdot Q_F - P_L \cdot Q_L - P_k \cdot Q_k - FC + \\ + \lambda_2[Q_{FG} - f\ (Q_F, Q_L, Q_K)] \end{aligned} \tag{4.4}$$

For the roughage activities the equations are:

$$Q_R = f\ (Q_F, Q_L, Q_K) \tag{4.5}$$

$$\begin{aligned} R_R = P_R \cdot Q_R - P_F \cdot Q_F - P_L \cdot Q_L - P_K \cdot Q_K - FC \\ + \lambda_3[Q_R - f\ (Q_F, Q_L, Q_K)] \end{aligned} \tag{4.6}$$

where:

Q_F: Quantity of fertilizer used in the production of feed grain and roughage

Finally for the trade activities the equations are:

$$Q_{LIMP} = f\ (Q_K, Q_L) \tag{4.7}$$

$$R_{IMP} = P_{LIMP} \cdot Q_{LIMP} - P_K \cdot Q_K - P_L \cdot Q_L - FC +$$

$$+\lambda_4[Q_{LIMP} - f\ (Q_K, Q_L)] \qquad (4.8)$$

where:

LIMP = Imports of livestock products (beef and veal) imported.

Livestock production in Greece is assumed to be a function of the quantity of feed grain, the quantity of roughage, the quantity of labor used, the quantity of capital used in a general form, mainly the variable capital. In addition, livestock production is a function of the fixed assets existing in the specific livestock category. The fixed assets invested in the livestock industry in Greece are not that specialized, on the average, over the time period examined. But when fixed is defined to include feeder animals, feeding facilities and other specialized capital and/or machinery used to produce the livestock products being considered, then, for the Greek conditions, and compared with the total capital investment in other farm enterprises, it can be said that fixed assest play a considerable role in these two livestock industries.

For the country as a whole the magnitude of fixed assets in the veal and beef industries could by proxy be presented by the breeding stock (of each industry) in existence at any given point of time. Strictly speaking, due to the aggregation of inputs used in equation (4.1) it cannot be defined as a production function but more correctly as an aggregate input-output equation. The objective function assumed for livestock producers (veal, beef, and milk producers) is given by equation (4.2). A single enterprise objective function is assumed based upon the assumption that livestock production activities require in general specialized inputs not easily adoptable to other farm production activities. In this sense the livestock producer is taken to view his revenue as being realized from a single source and does not consider other enterprises. Thus, the existence of fixed assets for the enterprise constrains the producer from maximizing his revenue by its effect upon the marginal productivity of variable inputs and by the generation of fixed costs specific to the enterprise.

The feed grain production function is thought to depend upon the use of fertilizer, the amount of labor and the amount of capital in form of combine machines and upon the weather index taken as the rainfall measured in mm of rain.

Finally the import production function is taken to depend mainly upon the amount of capital needed to buy the quantity of beef and veal needed to meet the domestic demand and/or the quantity of labor in terms of real labor employed in that industry. The micro-level production functions and objective functions can easily be transformed to macro-supply response functions and derived demand functions as it was shown diagramatically in the previous section. Thus, all that is needed is the transformation of the micro-level assumptions to macro-level ones. In the language of mathematics this transformation is accomplished by assuming the producer is maximizing his objective function (R) subject to certain constraints imposed due to the fact that his budget expenses are limited. The mathematical conditions for optimizing such an objective function require that the partial derivatives of the objective functions with respect to production factors are equal to zero.* The Marginal Value Product (MVP_{xi}) of each production factor must equal its price for the constraints to be satisfied and the profits (revenue) to be maximized.

Thus, one equation for each input can be written expressing what was said in the text.

$$\frac{\partial R_{LP}}{\partial Q_{FG}} = P_{LPP} \cdot \frac{\partial Q_{LPP}}{\partial Q_{FG}} - P_{FG} = 0 \tag{4.9}$$

$$\frac{\partial R_{LP}}{\partial Q_{R}} = P_{LPP} \cdot \frac{\partial Q_{LPP}}{\partial Q_{R}} - P_{R} = 0 \tag{4.10}$$

$$\frac{\partial R_{LPP}}{\partial Q_{L}} = P_{LP} \cdot \frac{\partial Q_{LPP}}{\partial Q_{L}} - P_{L} = 0 \tag{4.11}$$

$$\frac{\partial R_{LPP}}{\partial Q_{K}} = P_{LP} \cdot \frac{\partial Q_{LPP}}{\partial Q_{K}} - P_{K} = 0 \tag{4.12}$$

$$\frac{\partial R_{LPP}}{\partial \lambda_1} = Q_{LPP} - f\,(Q_{FG}\,,\, Q_R\,,\, Q_L,\, Q_K) = 0 \tag{4.13}$$

The system contains five functions and five unknown quantities, since prices are assumed to be given and known at the micro-level. This system of equations can be rewritten in reduced form making all endogenous variables a function of exogenous prices. When this is done the general form of the functions will appear as follows:

$$Q_{LPP} = f\,(P_{LP},\, P_{FG}\,,\, P_R\,,\, P_L,\, P_K) \tag{4.14}$$

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*Within the context of static theory.

$$Q_{FG} = f\,(P_{LP},\ P_{FG},\ P_R,\ P_L,\ P_K) \tag{4.15}$$

$$Q_R = f\,(P_{LP},\ P_{FG},\ P_R,\ P_L,\ P_K) \tag{4.16}$$

$$Q_L = f\,(P_{LP},\ P_{FG},\ P_R,\ P_L,\ P_K) \tag{4.17}$$

$$Q_K = f\,(P_{LP},\ P_{FG},\ P_R,\ P_L,\ P_K) \tag{4.18}$$

Equations (4.9) - (4.18) represent the supply response and derived demand functions theoretically generated by the static micro-level conditions specified.

The term Q_K is taken to denote capital used in a general sense in the productive process. This includes both the variable capital and the fixed capital (fixed assets) and the assumptions concerning the existence of fixed assets (inputs) specialized to the enterprise lead to the appearance of a separate quantity term chosen as a proxy for these fixed assets in the macro supply and derived demand functions. Here the fixed assets are viewed as an input into the livestock and feed grains and roughage producing activities which become variable over a longer time span and hence the same factors are assumed to generate the demand for inputs. The assumption that a fixed asset is fixed only for one production year changes only the nature of the economic theory involved in specifying the derived demand relations for the productive resources. Over the sample time period what is classified as a fixed asset and sets constraints to profit maximization of a producer becomes variable and is not a constraint to this goal achivement any more. But to understand producer's investment behavior and his decision making each year, the notion of the fixed asset theory seems to be very crucial. Thus, to have a clear picture of the system the quantity of breeding stock demanded in a static sense can be specified as follows:

$$(NBC, NVC, NMC) = f\,(P_{LPP}, P_{FG}, P_{R}, P_{L}, P_{K}, P_{IMPBV}, NBC_{t-1}, NVC_{t-1}, NMC_{t-1}) \qquad (4.19)$$

where:

NBC, NVC, NMC = Number of beef and veal cows and number of milk cows respectively

P_{LPP} = Price of livestock products produced, i.e., price of beef and veal and price of milk

P_{FG} = Price of feed grains

P_{R} = Price of roughage

P_{L} = Cost of labor

P_{K} = Capital cost

P_{IMPBV} = Price of imported beef and veal

NBC_{t-1}, NVC_{t-1}, NMC_{t-1} = Number of beef, veal and milk cows respectively in t-1 year.

The beef and veal industries are viewed in this study in relation with the feed grain economy and the import economy for the two livestock products, i.e., beef and veal. The derived demand for feed grain and roughage generated in the livestock sector are a major source of demand for these grains as this is shown by the variables which are used in the feed grain demand equation(s). Thus, the interaction of the livestock sector's (here only the beef and veal industries) derived demand for feed-grain and the supply of feed-grain form the market price generating process for feeds.

Supply and Derived Input Demand for Feed-Grain and Roughage

The economic theory behind the specification of feed supply response functions is the same with the theory used in specifying livestock supply response functions. However, a different set of assumptions have to be made for the specification of the feed supply response functions and hence, different empirical specifications must be derived.

Due to the small farm enterprise in Greece the feed-grain grower cannot achieve a farm income to live upon and he is taken here to have a multiple enterprise objective function which is maximized thus giving him the appropriate level of income. His assets are not so specialized and he is not constrained that much to shift his assets from one enterprise to another. Under the Greek conditions quite a few farmers in the plain of Thessaly are specialized as grain producers. Most of them consider these activities as complementary since the only requirements specified by the grains are not that much labor and/or capital.

Since Greece has been a net importer of grains, she subsidized them most of the time andin different ways. These conditions and these factors lead to the specification of the following production relations and associated objective function always within the general micro-static level.

$$Q_{C1} = f\ (L,\ LB,\ K) \tag{4.20}$$

$$\begin{aligned} R_C = {} & (P_{C1} + SP_{C1}) \cdot Q_{C1} + (P_{C2} + SP_{C2}) \cdot Q_{C2} \\ & - (P_L \cdot Q_L) - (P_{LB} \cdot Q_{LB}) - (P_K \cdot Q_K) \\ & + \lambda_1\ (Q_{LC1} + Q_{LC2} - GI) \\ & + \lambda_2 [Q_{FG1} - f\ (Q_{L1},\ Q_{LB2},\ Q_{K2})] \\ & + \lambda_3 [Q_{FG2} - f\ (Q_{L2},\ Q_{LB2},\ Q_{K2})] \end{aligned} \tag{4.21}$$

where:

Q_C = Quantity of crop

L = Land

LB = Labor

K = Capital

R_C = Objective function for a crop producer; the same as in livestock production

SP = Support price or subsidy price

λ = Lagrangian operator

WI = Weather index

1 = Crop enterprise number 1

2 = Crop enterprise number 2

GI = Government intervention program(s).

It can be seen from (4.20) that given weather conditions feed grains and/or roughage production is a function of land, labor and capital - in all its forms - used in each crop enterprise.

All inputs are assumed to be variable to the industry but not to the firm. The objective function of a typical Greek feed grain and/or roughage producer indicates that his revenue is realized (generated) either by selling his product to the market or by selling his product to the government agencies responsible for the grain storage program. The constraints of his objective function are set from the fact that his land input devoted to the grains production is limited (given). The physical input-output relationships existing for each activity and the technology included are given as well. To determine the conditions necessary to maximize the constrained objective function of a typical producer and in order to set up this set of functions in the form of supply response and derived demand functions one proceeds mathematically as follows:

$$Q_{C1} = f\ (P_{C1},\ SPC_1,\ P_{C2},\ SP_{C2},\ P_L,\ P_{LB},\ P_K) \tag{4.22}$$

$$Q_{C2} = f\ (P_{C1},\ SP_{C1},\ P_{C2},\ SP_{C2},\ P_L,\ P_{LB},\ P_K) \tag{4.23}$$

$$Q_L^{C1} = f\ (P_{C1},\ SP_{C1},\ P_{C2},\ SP_{C2},\ P_L,\ P_{LB},\ P_K) \tag{4.24}$$

$$Q_L^{C2} = f\ (P_{C1},\ SP_{C1},\ P_{C2},\ SP_{C2},\ P_L,\ P_{LB},\ P_K) \tag{4.25}$$

$$Q_{LB}^{C1} = f\ (P_{C1},\ SP_{C2},\ P_{C2},\ SP_{C2},\ P_L,\ P_{LB},\ P_K) \tag{4.26}$$

$$Q_{LB}^{C2} = f\ (P_{C1},\ SP_{C1},\ P_{C2},\ SP_{C2},\ P_L,\ P_{LB},\ P_K) \tag{4.27}$$

$$Q_K^{C1} = f\ (P_{C1},\ SP_{C1},\ P_{C2},\ SP_{C2},\ P_L,\ P_{LB},\ P_K) \tag{4.28}$$

$$Q_K^{C2} = f\ (P_{C1},\ SP_{C1},\ P_{C2},\ SP_{C2},\ P_L,\ P_{LB},\ P_K) \tag{4.29}$$

If the equations (4.22) - (4.29) in this section are compared with the ones in the section dealing with the empirical equations adopted to explain what was intended to be done, it will be seen that supply of crops is generally thought of as consisting of units (head of cattle, acres, etc.) times yield (pounds, kilograms, etc.). The abstract theoretical relations presented here includes no such distinction. The question is a simple one of the nature of the resource(s) used; how many resources are needed to generate that much (say Q) quantity of output.

The decision to be made by farmers is to choose alternative policies which lead to the same result but with different sets of costs. Such a decision can be: Should a farmer increase acreage or yields in order to arrive at the production of the same output Q? These two simple alternatives dictate different response to different producers and this finally depends on the marginal value product of each factor considered. Given the Greek conditions under which land is a scarce factor the dynamic response pattern may differ from that of an American farmer since resources associated with altering yield are more variable in nature than those associated with land use in the case of a Greek farmer. The opposite could be true for his American colleague.

Policy constraints may be acreage or yield specific in regard to the type of inputs or activities constrained as is the case with tobacco in Greece during recent years. In this study yields and unit functions are used along with a single supply response function.[1] The primary reasons for estimating yield and unit functions separately is the fact that it is believed that the dynamics of the two relations are different and different variables come into play in each relationship. This, however, has been done for the livestock products and for feed grains and roughage as well.

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[1]For a theoretical discussion on this topic see: Gordon Gemmill, "The World Sugar Economy: An Econometric Analysis of Production and Policies." Unpublished Ph.D. thesis, M.S.U., 1975.

The Econometric Model

The General Linear Model [2]

The General Linear Model can be regarded as follows:

$$Y_j = \sum_{i=1}^{k} \beta_i X_{ij} + U_j \qquad j = 1,2,\ldots,n \qquad (4.1)$$

where:

Y_j: the dependent (endogenous) variable or predictant;

X_i: The independent (exogenous) variable or predictor(s);

β_i: Unknown parameter that depicts the influence of independent variable(s) upon Y_j;

U_j: random disturbance term on the jth observation representing the influence of the predetermined variables X_i left out of the equation or errors in the measurement of the dependent variable Y.

The endogenous variables X_i can be fixed or random variates. It was generally assumed that these variables are of the first case (type of endogenous variables) since such an assumption simplifies the analysis. However, when the exogenous variables are assumed to be random variates, they can be assumed to have a probability distribution independent of the disturbances. It is further possible to consider errors of measurement in the independent variables, errors which complicate the analysis considerably. Thus, it was always assumed that the independent variables are measured without error.

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[2] The present exposition heavily draws from H. Theil's work, Principles of Econometrics (New York: John Wiley and Son Inc., 1971).

Many assumtions could be made about the first and second moments of the disturbances. However, for the purpose of this analysis here it will be assumed that they have expected values of zero (normality), constant variances (homoscedasticity) and zero covariances (non-autoregression). These assumptions imply that the expected value of Y_j equals

$$E(Y_j) = \sum_{i=1}^{k} \beta_i X_{ij} \qquad j = 1,2,\ldots,n$$

i.e., the variance of the dependent variable is constant for all observations (this is called homoscedasticity), and the disturbance terms are pairwise uncorrelated for all observations.

The model becomes unduly complicated if any one of the Xs is linearly related to any other Xs in the model. Furthermore, no statistical problems are involved when the number of observations is equal to the number of regression coefficients in the model. Thus, the following assumptions are made which rule out these possibilities: a) no linear relationships exist among the observations on the independent variables, the Xs, and b) the number of regression coefficients is less than the number of observations.

Because matrix notation aids in conciseness and brevity, it is adopted here for this short discussion about the linear regression model employed in this research effort.

Letting

$$Y = \underset{(n\times 1)}{\begin{bmatrix} Y_1 \\ Y_2 \\ \cdot \\ \cdot \\ \cdot \\ Y_n \end{bmatrix}}, \quad X = \underset{(n\times k)}{\begin{bmatrix} 1, X_{12}, \ldots, X_{1k} \\ 1, X_{22}, \ldots, X_{2k} \\ \cdot \;\; \cdot \\ \cdot \;\; \cdot \\ \cdot \;\; \cdot \\ 1, X_{n2}, \ldots, X_{nk} \end{bmatrix}}, \quad = \underset{(k\times 1)}{\begin{bmatrix} 1 \\ 2 \\ \cdot \\ \cdot \\ \cdot \\ k \end{bmatrix}}$$

$$\text{and } U = \underset{(n\times 1)}{\begin{bmatrix} U_1 \\ U_2 \\ \cdot \\ \cdot \\ \cdot \\ U_n \end{bmatrix}}$$

then the general linear regression model can be written succinctly as follows:

$$Y = X\beta + U \tag{4-2}$$

Single Equations vs. Simultaneous Equation System

A first economic system which was thought to describe the feed-cattle economy of Greece consisted of nine equations for the beef segment with nine dependent variables, of which four were in an identity form.

The veal segment employed the same equations and the same number of both endogenous variables to be estimated and exogenous variables appearing in an equal number of identities.

The milk segment employed eight equations, of which three were in the form of an identity. Imports of fluid cow milk are not included in this model since there are almost none.

The feed-grains segment also included nine equations, of which four were in the form of identities, while the pastures (roughage) segment of the model included eight equations, of which four were in the form of identities.

Thus, 19 endogenous variables remained to be estimated with 22 degrees of freedom. The overall system was overidentified since in a complete model the number of structural equations must be equal to the number of endogenous variables. And it was expected that this would be the case here since, according to economic theory, to manage to construct an exactly-identified system for such a large part of the agricultural sector would necessitate the insertion of variables which contribute very little or at all to the explanation of the variation of each independent variable. Apparently, these variables are not backed by the economic theory itself.

The structural form of the equations which was set up to model the feed-cattle economy of the Greek agricultural sector called for both "recursive" and "simultaneous" relations to be specified and estimated. A recursive relation is defined as a structural function containing at least one lagged endogenous variable (and thus exogenous to the period in question) as an independent variable but no current period endogenous variables as independent variables. On the contrary, a simultaneous relation is defined as a function containing at least one current period endogenous variable as an independent variable. This study did not enter into the historical debate about the nature of the "economic world." In other words, it did not address itself to the question: are economic phenomena taking place in an interdependent way (in a Haavelmosian approach) or in a recursive (Causal-chain Woldian approach) way? There are excellent references on this issue and the reader should consult them if interested.[3]

The statistical estimation of the parameters of simultaneous equations is confined to identifiable equations, but this is not the serious problem it may seem since structural equations are usually

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[3]Karl Brunner (ed), Problems and Issues in Current Econometric Practice (Columbus: The Ohio State University, College of Administrative Science, 1972)

overidentified; and the reason for this is that in a system like the one under examination the number of predetermined variables tends to increase with the number of equations, whereas the number of the endogenous unknown parameters to be estimated in any particular equation is rather small.

Two-stage least squares technique produces an instrumental variable for independent endogenous variables in the function. And, ideally speaking, an instrumental variable is nearly independent of the function's error term but highly correlated with the independent variable for which it is an instrument.

To the extent that the instrumental variable achieves its desired properties, the bias of the estimate of the parameter for the endogenous independent variable is reduced. But this reduction of bias occurs at the expense of some efficiency. The instrumental variable never perfectly matches the variation of the endogenous independent variable it represents; and, due to that reason, it is obvious that some information is lost. In problem solving research the decision whether to use simultaneous equations estimators, such as the ones coming from the use of 2SLS, must take into account whether the elimination of bias achieved is worth the efficiency lost.

In this study, following Karl Fox's approach, single equations were tried, since it was believed that an equation which expresses the price of the commodity (or, what is the same for that matter, the quantity) as a linear function of its supply (price) and consumer income would contain only one endogenous variable as a function of the other two predetermined variables. This is also a true "structural" demand equation, and, if it is assumed that the disturbances (residuals) from this equation are random and normally distributed, then this equation fitted by the method of least-squares with price as the dependent variable is identical to the Maximum Likelihood Estimate (MLE) indicated by the commission approach. Thus, the single equation approach was fully justified in this case (Koopmans, 1945).[4]

Model Design and Identification

The econometric modeling approach aims at specifying the model according to the existing body of knowledge of economic theory at the time of model specification. The estimation of the model's parameters came from a rather general knowledge of the population from which the study sample was drawn and, hence, was based upon statistical inference techniques which used samples of data describing the population for which generalizations are made. This leads to the econometric modeling approach which depends on time series data and various forms of regression analysis. It is of course implicitly assumed in all these kinds of studies that relationships and parameters estimated from these time series data can adequately be described by the relationships modeled.

The task of a researcher who uses time-series data like those used in this study is to know the structure and behavior of the sector or sub-sector that is under investigation and thus be able to formulate a model which more or less explains the economic relationships which are tied together. The explanations are found in the parameter estimates which are estimated (or considered) either from an original economic relationship or from data transformed to describe relationships which exist in a population.

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[4]T. Koopmans, "Identification Problems in Economic Model Construction," Cowless Commission Monograph No. 14, 1945.

In specifying or identifying a model one must explicitly make decisions defining which variables represent exogenous variables (given) and which represent endogenous variables to be estimated by the model. In fact, specification of variables as exogenous or endogenous is a key decision in building a model. As a result of this decision the scope of the model and its capabilities are essentially set. A specification which is too broad can lead, for example, to a system too complex to manage with regards to certain time and material (money) and/or human resources constraints. Thus, the original model was intended to include a Common Market interface to observe supply response under E.E.C. prevailing (market) price structure. But due to data constraint the idea was postponed for testing in other than this dissertation research effort.

On the other hand, too narrow a specification will force one to omit important factors and interactions important to determining system behavior.

Generally speaking, the limits of a model specification are established by the purpose which the model is built to serve. The general assumption that the Greek feed-cattle economy is a stable system holds, but at any point in time it is generally believed that this particular economy is not at an equilibrium because of external influences (shocks) which are operating.

The economic model which represents the feed-cattle economy would eventually converge to an equilibrium point (value) if all exogenous variables were held constant. But of crucial importance in the case under consideration is the speed with which the system is moving towards that point. And this speed depends on the rate of adjustment of each activity within the model which in turn depends on structural and other characteristics representing the initial starting point of reference of the system as well as on the interrelationships among activities.

Thus the model was first specified with the help of the knowledge of the sub-systems studied, and the characterization of the variables as exogenous and/or endogenous was based upon the author's knowledge of the economy studied and upon the existing body of knowledge of economic theory.

Needless to say, such a characterization is not an easy and brief task. On the contrary, it is a difficult and time-consuming job and sometimes the researcher has to refer continually to the study to make careful analytical observations of each subsystem and then to the data at hand in order to develop simple, but helpful diagrams, correlations and graphs. After performing this task, the researcher undertakes a kind of "trial and error" process through the use of a computer device in order to come up with--within a reasonab-le time span--the final decision about what variables were going to be included in the model to satisfy economic theory's constraints and the subsector's and model's (system's) requirements.

These last two sets of constraints and, particularly, the very last one, affect or influence, the accuracy of the system. And if the accuracy of the system is of primary concern, then it probably means that the scope of the system has to be restricted. For this to be done, of course, the researcher must have the ability to distinguish among all factors the ones that are the most important. Also, judgments regarding factors such as the additional "benefits" and "costs" resulting from such a specification have to be executed by the researcher himself.

A criterion for selecting exogenous variables for use in forecasting models is that they must be more readily forecast outside the model than the endogenous variables. Otherwise, it is hopeless to use them to estimate the endogenous variables. In explaining, for example, how many acres are planted under feedstuffs, the weather variable concerning the planting period should not be left out since, being truly an exogenous variable to the economy at hand, it greatly affects farmers' decisions to plant or not plant feedstuffs acreage. The same is true for time with regards to explaining average yield per cow. The "technology" variable should also not be omitted.

CHAPTER V

DEMAND

Consumption

The final purpose of all farming (agri-) business is consumption. Indeed, the attitudes of consumers toward farm-produced food play a crucial role in the operation of the complex system of interrelated industries that compose the feed-grain-cattle economy.

It is appropriate, then, to begin by looking at what and how much of these products consumers buy, how their eating habits have changed over time and the economic decision-making process that underlies their decisions and behavior. The economic rational behavior of people is expressed in demand theory which is used to explain why consumption behavior and patterns (trends) are what they are.

In this chapter it will be shown how consumers make their choices about food consumption (particularly about beef, veal and milk). In a separate section the general theory of demand as it is usually formulated will be given. Later in subsequent sections empirical demand estimates are provided with elasticities of demand (own, income, cross-demand) for the products included. Still later a few words on the derived demand of feed-grains will be presented. But first in the immediately following section some general considerations about demand are given.

Consumer Choice

Consumer choice, in general, is based upon the utility theory, and, particularly, in economics upon the marginal utility theory. The total utility someone gets from consuming a food product increases rapidly with the first bite and then slows down (but continues to increase) until he has eaten that food which satisfies him (or his stomach). If he eats more, he will experience dissatisfaction and his total utility will start to decrease.

The marginal utility, which relates to the utility of each succeeding bite, decreases as more and more food is consumed. This is called the law of diminishing marginal utility, and it has a physiological and psychological basis.

These are the very general foundations upon which the demand theory has been built by economists.

The Theory of Demand

Definitions and Demand Relationships

Demand is a behavioral relationship that describes how much product will be demanded at different prices under a certain set of conditions.

Consumer demand refers to the purchasing behavior of one or more buyers who consume a product.

Intermediate demand refers to price-quantity purchasing behavior of buyers who demand the product for resale or use it as an input into a production process in order to produce a new product. When the individual demands of buyers at any one market level and at any point in time are added together, the aggregate demand is derived, which is called the market demand.

Equi-marginal rule is the general rule guiding maximization of satisfaction which says that, given a level of income, it should be allocated among all possible choices such that the marginal utility per money unit of expenditure on each good and service is equal to the marginal utility per money unit of expenditure in every other use.

The price-quantity relationship is generally formulated under the assumption of ceteris paribus condition, i.e., under the condition that all other factors (things, conditions) affecting consumption remain constant at the time when this relationship is specified. Among these factors are: price expectations, availability of the product(s), income, etc.

With this sort of exposition as background, the general form of consumer demand can be expressed as the relationship between price and quantity (demanded) purchased (1) of a well-defined product, (2) at or during a particular time and (3) at a specified place or area. This relationship assumes that factors such as consumer disposable income, prices of substitute products, prices of complementary products, expectations of future prices and income, and tastes and preferences (technology) remain constant.

Thus, the general form of consumer demand can be expressed as follows:

$$Q^d = -f(P_i/Y, P_s, P_c, E_{PY}, T, \pi) \qquad (5\text{-}1)$$

where: Q^d: quantity demanded;

f : function of;

P_i: price of the good examined;

/ : holding following things (variables) constant;

Y : income;

P_s: price(s) of substitutes;

P_c: price(s) of complements;

E_{PY}: price and income expectations;

T : tastes and preferences;

π : population.

Because of the principle of diminishing marginal utility, the price-quantity relationship is always negative. That justifies the negative sign before the demand function in (5-1). This is a point to be remembered later in the empirical estimation of the demand function. Expressed geometrically, it means that the demand curve slopes downward.

From the basic demand function in (5-1) some other interesting functions can be derived which are empirically estimated later on in this chapter. However, it is of great convenience that they also be explicitly (but in general terms) expressed here. Thus, the expression

$$Q^d = -f(P_i/Y, P_s, P_c, E_{PY}, T) \tag{5-2}$$

is called own-price relation of demand. The expression

$$Q^d = \pm f(Y/P_i, P_s, P_c, E_{PY}, T) \tag{5-3}$$

is called income relationship of demand. The expression

$$Q^d = \underline{+}f(P_s, P_c/P_i, Y, E_{PY}, T) \tag{5-4}$$

is called cross-demand relationship expressing that as the price of one product increases or decreases, the quantity demanded of a related product will increase or decrease, depending upon how these products are related in consumer decision making behavior.

Now, as far as (5-3) is concerned, it has been a common habit in demand theory for a good to be called normal or superior when an income increase results in an increase in quantity demanded of that good. If the increase of income calls forth a decrease in the product purchases, the good is usually called an inferior good.

From (5-4) it is a custom to derive two definitions (or actually relationships). If the price of a product X decreases, this may result in a lesser quantity of product Y being demanded. If this is so, then products X and Y are substitutes. However, if the price of X decreases, this may result in a greater quantity of the product Y being demanded. Then, if that is the situation, the products X and Y are called complements. (Here, $H \equiv i$, $Y \equiv s,c$).

Demand Elasticities (own-price, income, cross)

From (5-2), (5-3) and(5-4) the own-price elasticity of demand, the income elasticity of demand and the cross elasticity of demand can be obtained, respectively, if the corresponding relationships are expressed in their first-order derivatives with respect to: own-price, income and price of other goods, and multiplied by their respective ratio of quantities at their means.

$$\frac{\partial Q^d}{\partial p} \cdot \frac{\bar{P}}{\bar{Q}^d} = E_p = \text{own-price elasticity of demand} \qquad (5\text{-}5)$$

$$\frac{\partial Q^d}{\partial Y} \cdot \frac{\bar{Y}}{\bar{Q}^d} = E_y = \text{income elasticity of demand} \qquad (5\text{-}6)$$

$$\frac{\partial Q^d}{\partial (P_s, P_c)} \cdot \frac{(\bar{P}_s, P_c)}{\bar{Q}^d} = E_c = \text{cross-elasticity of demand} \qquad (5\text{-}7)$$

where: $\bar{P}$, $\bar{Q}^d$, $\bar{P}_s$, $\bar{P}_c$ are expressed at the values of their means;

a) If $E_p = -1$, it is said that the product has a unit elasticity or it is called unitary elastic.

b) If $E_p < -1$, the product is called price elastic.

c) If $-1 < E_p < 0$, the product is called price inelastic.

d) If $E_y > 0$, the product is called superior or normal.

e) If $E_y < 0$, the product is considered to be an inferior good.

f) If $E_c > 0$, the goods compared are substitutes.

g) If $E_c < 0$, the products compared are complements.

Under special, but not unusual circumstances, the three elasticities (own-price elasticity, income elasticity and cross-product elasticity) will sum up to zero for a given product. In other words,

$$E_p + E_y + E_c = 0 \qquad (5\text{-}8)$$

This suggests that products which have many or close substitutes also have more price elastic demands, and those products that are highly superior when income increases, even if they have few substitutes, may be price elastic.

Sometimes the concept of total price elasticity is used. Whereas own-price elasticity is a measurement of changes in quantity demanded when price changes, other things remaining unchanged (ceteris paribus), total price elasticity is a measure of quantity change in relation to price change, allowing other factors to change (mutatis mutandis). The total elasticity for a given product will be less elastic than the more standard ceteris paribus elasticity.

Demand Estimation

With the previous chapters and the static theory of demand explained in the theory of demand section as background, one first big step has been completed toward the demand estimation. As stated by Waugh:

> The first step in any statistical analysis should be to set up some sort of theoretical model describing how the markets for a commodity work. The model generally starts with a listing of factors that are believed to affect the supply, demand, and price of the commodity. Diagrams are often helpful in portraying various interrelationships.[1]

The model may be complex, with several equations representing a number of supply-demand equations and constituting what is called a simultaneous equations system, or it may be rather simple, with one equation representing demand. The second approach was followed in this research effort while the first approach remained for use in a further investigation of the feed-cattle economy.

The model finally

> ...should be put into a form that can be fitted by statistical techniques to determine if it is

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[1] Frederik Waugh, Demand and Price Analysis, U.S.D.A., Technical Bulletin 1316, Nov. 1964, pp. 6-7.

> consistent with the observed data. To set up a good model for measuring the demand for any commodity, the researcher must have an intimate understanding of the markets for that particular commodity. The routine fitting of the same model to cotton, beef cattle, and canned peas is poor research method.[2]

Once the variables that determine demand for a given product and the mathematical form of the relationship among the variables have been selected, the researcher is in a position to use observed data to fit the relationship.

Of the two types of data, the cross-section data and the time-series data, the second type of data was used in this thesis since it was more easily available. The quantity data for annual consumption were computed by dividing the total annual domestic disappearance (consumption) of the products examined by the population (both humans and/or animal population). The resulting figure represented the average annual consumption for an average consumer (human and/or animal). The prices used were annual weighted prices published in various sources, and the method utilized was multiple regression analysis which was briefly discussed in the chapter on methodology.

In the section on theory of demand the variables which enter into the demand function were provided. In this section the a priori knowledge of the variables which enter into the demand function in the empirical analysis will be given for each product separately.

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[2]S.P. George and G.A. King, "Consumer Demand for Food Commodities in the United States with Projections for 1980," Giannini Foundation Monograph 26, California Agric. Exp. Station, March 1971, pp. 1-2.

Factors Associated with Demand for Feed-Grain and Roughage

Price Factor

Certainly, it would be expected that a change in price will result in a change in the quantity of feed-grain demanded. The impact of feed-grain prices on the demand for it is different under the various uses, availability of substitutes, level of per animal consumption and the kind and size of livestock population existing in Greece over the sample period.

In Greece it is difficult to determine the relationship between changes in prices of feed-grain and demand, due to the lack of complete and reliable data either of a time-series or cross-sectional nature for consumption per animal. But it is logical to expect that the proportional change in the quantity of feed-grain and roughage consumed by cattle and, for that matter, used by cattle growers will be less than a proportional change in price since these feed-stuffs are the most prevalent stuffs in cattle feeding. This means that the demand for feed-grain and roughage is expected to be inelastic with respect to the change in price.

Cattle Population

Cattle population is an important factor in determining the general level of demand for feed-grain and roughage. Thus, with an increase in cattle population, it is in general expected that the demand for feedstuffs would increase.

The Price of Related Goods

Cattle population is usually fed with feed-grain and fodder plants; and roughage should be considered as a related good to feed-grain and vice-versa. Pasture condition and quality should have been other factors if there were data available on them since, if pasture conditions and quality were improved, then it should be expected that cattle would consume less feed-grain.

Cattle Feeding Practices and Management

Cattle feeding practices and management also cause demand for feedstuffs to change from time to time. These practices involve not only the feedstuffs being considered here, but also other feedstuffs as well which may be substituted for those under consideration. Since cattle population was not fed with other feedstuffs over the sample period considered (but only late in the 1960s), it can safely be concluded that there was no other product that could replace feed-grain and roughage in the cattle feeding practices in Greece for that period.

Farm Income

Changes in farm income often lead to major changes in demand for feedstuffs. The degree of impact will depend largely on the existing level of farm income and income elasticity of demand for feed-grain and roughage.

The Availability of Feed-Grain and Roughage

The quantity of feed-grain and roughage available to the cattle growers always has had a positive impact on their quantity demanded. The imports of these feedstuffs and the positive effect on the growth of the livestock industry which the P.L. 480 program has had, is a sign that, up to a certain extent, the larger the quantity available, the greater the demand.

The Prices of Livestock Products

Prices of livestock products is an important factor in determining the level of demand for feedstuffs since the demand for these stuffs is an (immediate) derived demand because it is derived from primary or consumer demand for livestock products. Generally speaking, it is expected that the higher the prices of livestock products are, the higher the quantity demanded for feed-grain and roughage will be.

Empirical Estimation of Demand

The Variables Used

In this section the empirical results are obtained by solving the various equations of the feed-grain and roughage model by means of OLS. Here all the variables used in the entire study are presented in order to have tham all together in one place for easy reference.

Endogenous Variables

QBD : Quantity of beef demanded at the farm level divided by Greek population, in kg/head.

BCSL : Number of beef cows slaughtered, in thousand head.

$\bar{Y}BC$: Average yield per animal unit, i.e., per beef cow, in kilograms.

QBIMP: Quantity of beef imported divided by Greek population, in kg/head.

QBS : Quantity of beef supplied which is the result of quantity of beef produced plus the quantity of beef imported, in thousand tons. The quantity of beef produced is the result of BCSL × $\bar{Y}BC$. Identity.

QVD : Quantity of veal demanded at the farm level divided by Greek population, in kg/head.

VCSL : Number of veal-cows slaughtered, in thousand heads.

$\hat{Y}$VC : Average yield per animal unit, i.e., per veal cow, in kilograms.

QVIMP: Quantity of veal imported divided by Greek population, in kg/head.

QVS : Quantity of veal supplied = quantity of veal produced plus quantity of veal imported, in thousand tons. Identity.

QMKD : Quantity of milk demanded at the farm level divided by Greek population, in kg/head.

NCM : Number of cows milked, in thousand head.

$\hat{Y}$CM : Average yield per animal unit, i.e., per milk cow, in kilograms.

QMKS : Quantity of milk supplied, in thousand tons. Identity.

QFGD : Quantity of feed-grain demanded at farm level divided by the animal population, in kg of TDN.

QFGP : Quantity of feed-grain produced, in thousand tons of TDN.

QFGIMP: Quantity of feed-grain imported, in thousand tons of TDN.

QFGS : Quantity of feed-grain supplied = QFGP + QFGIMP, in thousand tons TDN. Identity.

QRD : Quantity of roughage demanded divided by the cattle population in Greece, in kg of TDN.

QRS : Quantity of roughage supplied which is equivalent to quantity of roughage produced since no imports of roughage are assumed here, in thousand tons of TDN.

FPFS : Farm price of feed stuff deflated by the CPI, in drs/kg.

<u>Exogenous Variables</u>

GNP : Gross National Product divided by the Greek population and deflated by the CPI, in drs/head.

T : Time variable.

FP(L+M) : Farm price of lamb and mutton deflated by the CPI, in drs/kg.

QBC : Quantity of beef consumed at the retail level divided by the Greek population, in kg/head.

$BCSL_{t-1}$: Beef cows slaughtered in t-1 period, in thousand head.

(FPB/FPFG)t-1: Ratio of farm price of beef over farm price of feed-grain deflated by CPI in period t-1.

DV_b : Dummy variable for subsidy of 2 drs/kg liveweight paid for animals weighing more than 250 kgs liveweight for the years 1963-1968.

RPB : Retail price of beef deflated by the CPI, in drs/kg.

QVC : Quantity of veal consumed at the retail level divided by the Greek population, in kg/head.

NTC_{t-1} : Number of total cows in t-1 period, in thousand head.

FPV_{t-1} : Farm price of veal in t-1 period deflated by the CPI, in drs/kg.

DV_v : Dummy variable for subsidy given in the years 1965-1972 in order to promote increase of veal production, in drs/kg.

RPV : Retail price of veal deflated by the CPI, in drs/kg.

RP(L+M) : Retail price of lamb and mutton deflated by the CPI, in drs/kg.

QMC : Quantity of milk consumed at retail level divided by the CPI, in kg/head.

$FPCH$: Farm price of cheese deflated by the CPI, in drs/kg.

NCM_{t-1} : Number of cows milked in t-1 period, in thousand head.

$FPMK_{t-1}$: Farm price of milk in t-1 period deflated by the CPI, in drs/kg.

DV_m : Dummy variable for milk subsidy given to the farmers during the years 1965-1972 to promote increase in milk production, in drs/kg.

AUF : Animal units fed. Here total carcass meat production of all categories of meat is taken and divided by 100 kgs of carcass weight; the result is taken as animal units; in thousand units.

$FPFG_{t-1}$: Farm price of feed-grain in t-1 period and deflated by the CPI, in drs/kg.

$PCORN_{USA}$: Wholesale price of corn in USA, in cents/kg.

AUF_{t-1} : Animal units fed in t-1 period, in thousand units.

FPR_{t-1} : Farm price of roughage in t-1 period deflated by the CPI, in drs/kg.

DV_r : Dummy variable for subsidy given to the alfalfa growers during the years 1965-1972, in drs/stremma.

$BCSL_{t-i}$: Beef cows slaughtered in t-i period, in thousand head.

$VCSL_{t-i}$: Veal cows slaughtered in t-i period, in thousand head.

NCM_{t-i} : Number of milk cows in t-i period, in thousand head.

FPB_{t-i} : Farm price of beef in t-i period deflated by the CPI, in drs/kg.

(FPMK/FPFG) : Farm price of milk over the farm price of feed-grain; this variable proxies the profitability of the milk enterprise and is generated by dividing the two variables.

(FPMK/FPFS) : Farm price of milk over the farm price of feed-stuffs; the last variable includes both feed-grain and roughage as well.

$FPMK_{t-i}$: Farm price of milk lagged i periods and deflated by the CPI.

(FPB/FPFG) : Farm price of beef divided by the farm price of feed-grain; this proxy variable is taken to give the profitability of the beef production enterprise.

(FPMK/FPFG)t-i: The same variable as above lagged i periods.

(FPB/FPFG)t-i : The same variable as above lagged i periods.

FPB/FPR : Farm price of beef divided by the farm price of the roughage variable to proxy the cost relation of the beef production enterprise with respect to roughage.

CPI : Consumer Price Index.

POPN : Population of Greece in thousand head.

$FPFS_{t-1}$: Farm price of feedstuff divided by the CPI, lagged i periods, in drs/kg.

The Demand for Feed-Grain* and Roughage**

From the factors listed in the section before the previous one which seem to be associated with the demand of feed-grain and roughage, the most important one is the factor animal population. The two equations fitted to explain the variation in the quantity of feed-grain demand and roughage demand, respectively, were as follows.

$$(FG_1) \quad QFGD_t = \underset{(200.2921)}{611.2921} + \underset{(.0912)}{0.5599}AUF_t$$

$$\bar{R}^2 = 0.80 \qquad d^* = 1.34 \text{ (i)} \qquad (5\text{-}9)^{***}$$

$$(R_1) \quad QRD_t = \underset{(76.0652)}{68.7566} + \underset{(.0346)}{0.5606}AUF_t$$

$$\bar{R}^2 = 0.96 \qquad (5\text{-}10)$$

Equation (5-9) is the most promising one among many others tried. It seems to support the a priori knowledge since 80 percent of the variation of the demand for feed grain is explained by the number of animal units fed (AUF_t).

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*Feed-grain refers to feeds which belong to the category of concentrates and include the various grains (wheat, corn, oats, barley, rye, etc.) and the high-grade by-products, such as wheat bran, cotton seed meal, linseed meal, corn gluten feed, sugar beet pulp, etc. They can be either low in protein or rich in protein.

**Roughage refers to feeds that are high in fiber and therefore low in total digestible nutrients. Such feeds as hay, corn fodder, alfalfa, glovers, straw and silage belong to this class of feedstuffs.

***In all equations in this study the standard errors of the coefficients are given in parentheses, and

d^*: Durbin-Watson Statistic: i: inconclusive. na: negative serial correlation. 2a: Zero serial correlation and

$\bar{R}^2$: coefficient of determination corrected for the degrees of freedom.

The variable carries a positive regression coefficient, meaning that the greater the number of animal units fed, the higher the quantity of feed-grain demanded will be. Also, the variable is statistically significant, thus giving more faith to reliance on this relationship. The model shows that for a unit change in the animal units fed a 0.5 unit of change appears to take place in the quantity of feed-grain demanded.

The same holds true for roughage. Here, again, the most important factor seems to be the number of animal units fed. The variable AUF is positively correlated to the QRD, meaning that the greater the number of animal units fed with roughage, the larger the quantity of roughage demanded will be. The variable is statistically significant, and the explanation power of the equation is 0.96 which means that 96 percent of the variation of the roughage observed is explained by the number of animal units fed. There is a 96 percent probability - out of 100 - that the two variables move together.

The quantitative relation between the two variables is such that for a one unit change in the variable AUF a 0.5 unit change corresponds to the variable QRD.

Imports of Feed-Grain

It was thought that after an examination of the demand for feed-grain in the previous section the imports of feed-grain should be given in a subsequent (successive) section to provide a more complete picture of the demand for feed-grain.

Feed-grain imports expressed in TDN showed an upward movement during the sample period, starting from 83,000 tons of TDN in 1951, reaching a peak of 770,000 tons of TDN in 1970 and 1971 and then declining to a level of 128,000 tons of TDN in 1972. A brief comment is in order here.

Prior to World War II, the world feed-grain economy experienced increasing world surpluses, declining trade and falling world prices. Since World War II, significant developments have taken place in the world feed-grain economy. Thus, in 1953-1954 the United States Congress enacted P.L. 480 in order to provide for the distribution of U.S. wheat on a concessional or noncash basis. The world's two largest feed-grain exporters, the United States and Canada, experienced their largest accumulation of feed-grain stocks in history, and Canada sold sizable quantities of wheat to Communist China and the U.S.S.R., and, for the first time in history, Canadian farmers were paid to take land out of feed-grain production. The European Economic Community (EEC) was formed, and, because of increased price supports, caused cereal production to increase substantially. Up to that point, there was a rather economically favored world environment for Greece's imports and the only problem Greece had to face was that of her balance of payments.

Since 1972, however, conditions have begun to change in the world market. During the last two years the U.S.S.R. imported large quantities of wheat from the U.S. A drought in South East Asia and in Central Latin America caused some more severe problems in feeding not only the animal population but the human population as well. The question has been raised in recent years as to whether this feed-grain world deficit is a permanent one and how long will it take to be over.

Today's world picture is highlighted by the extreme swings in exports, commodity prices and wide areas of starvation occurring over the last few years. These problems were emphasized in the Rome Food Conference supported by the United Nations.[3]

In 1973 world grain reserves fell to the lowest level since 1953; the Yom Kippur War initiated a five-fold increase in oil prices, affecting fertilizer prices and production and transportation costs, and induced world-wide inflation which reached the level of 33 percent in Greece in that year, the highest rate of inflation the world over. To these dire circumstances add the uncertainty of knowing whether the U.S.S.R. and Communist China would enter the market and buy sizable quantities of grains as they did in 1960 and the picture becomes even more gloomy. At this point it is necessary to mention this fact as necessary background information to an understanding of Greece's open scenarios from now on.

Greece has three general options open to her. The first is to buy feed-grains from the world feed-grain market, thus keeping her status with EEC as it stands today. The second option is to pursue a self-sufficiency policy by subsidizing her feed-grain production and the third scenario is to join the EEC as a full member and follow EEC's Common Agricultural Policy (CAP).

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[3] United Nations Economic and Social Council, World Food Conference, Notes by the Secretary General, November 22, 1974, "Hunger and Diplomacy: A perspective on the U.S. Role at the World Food Conference," Submitted to the Subcommittee on Foreign Agriculture, Committee on Agriculture and Forestry, United States Senate. (Washington, D.C.: U.S. Government Printing Office, 1975).

The equations explaining the variations of feed-grain coming into Greece were the following:

$$QFGIMP_t = \underset{(00.9451)}{30.7171} - \underset{(0.089)}{0.17480}QFGP_{t-1} + \underset{(0.0590)}{0.2679}AUF_t$$

$$\bar{R}^2 = 0.54 \qquad d^* = 2.11 \text{ (za)} \qquad (5\text{-}11)$$

$$QFGIMP_t = \underset{(651.5595)}{60.4664} - \underset{(15\ 455.5335)}{3\ 561.2153}PCORN_{USA} + \underset{(.0701)}{0.1681}AUF_{t-1}$$

$$\bar{R}^2 = 0.43 \qquad d^* = 1.76 \text{ (za)} \qquad (5\text{-}12)$$

From these two equations it can be seen that the number of animal units fed this year and the year previous constitute a major factor in determining feed-grain imports into Greece. The variable appears to be statistically significant in both equations and bears the right positive sign, meaning that the greater the number of animal units fed, the greater the quantity of imported feed-grain.

The variable quantity of feed-grain domestically produced bears the right sign in the first equation meaning that the lesser the quantity of feed-grains produced in year t-1, the greater the quantity of imported feed-grain. The variable seems to be statisically significant, and its estimator bears significant economic weight.

Both models give a rather low $\bar{R}^2$, meaning that some other economically relevant factors have been left out. The import elasticity of demand for feed-grain with respect to animal units fed is found to be +0.3 in equation (5-11) and +0.2 in equation (5-12).

This, again, shows that the import elasticity of demand for feed-grain with respect to AUF is very low, verifying the fact that feed-grain had "been pulled" into Greece because it was needed to feed and keep the cattle herd going. Furthermore, this means that feed-grain produced in Greece is not enough to even feed the cattle herd over the time considered.

The low import elasticity of demand for feed-grain lends support to structural changes in the feed-grain industry to increase yield.

Factors Associated with Demand for Beef, Veal and Milk

Factors associated with the demand for these livestock products are discussed in this section in order to give a concise and clear account of what factors to expect in the empirical analysis of demand for these products.

Product Price

Certainly, it would be expected that a change in price will result in a change in consumption of these livestock products. The impact of livestock prices on the demand for them is different under the various uses, level of incomes, availability of substitutes and level of per capita consumption. It is logical to expect that as the price of these livestock products increases, the quantity demanded will decrease.

Consumer Personal Disposable Income

Changes in consumer personal disposable income led to major changes in demand for the livestock products at hand over the sample period examined. The degree of impact depends largely on the existing level of per capita income and income elasticity of demand. Generally speaking, a positive relationship between income and quantity of beef, veal and milk is expected to hold as income rises.

Population

Population is an important factor in determining the general level of demand. With an increase in population, it is expected that the demand for beef, veal and milk would increase.

The population increase which Greece experienced over the period 1951-1971 was in absolute numbers equal to 1,135,840; i.e., 56,792 persons per year. In percentage terms this means that the population increase amounted to 14.88 percent over this twenty year period which corresponds to an annual increase of 0.74 percent.[4]

The population parameter enters indirectly into the empirical functions fitted, since consumption of livestock products is given in annual per capita form.

The Price of Related Goods

Other than beef and veal, people in Greece eat fish, vegetables, fruits, lamb and mutton, poultry meat, pork and other dairy products in addition to fresh milk. It is generally expected that as the prices of (other) related products go up, the quantity of livestock products at hand will increase. This can be seen in the

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[4]N.S.S.G., Statistical Yearbook of Greece (Athens, 1971), p. 18.

relationship called cross-demand elasticity and/or under the labels of complements and substitute products.

The Range of Foods Available to Consumers

Certainly, if Greek people have a greater variety of foods to eat, they will probably consume less livestock products of this kind and vice-versa.

Consumer Tastes and Preferences

Consumer tastes and preferences also cause demand to change from time to time. These preferences involve not only the food products being considered, but also other products which may be substituted for those under consideration. And since Greek people consume products other than beef, veal and milk, it can be concluded that there are other products that can replace beef, veal and milk in their diet.

In Greece, it is difficult to determine the relationship between changes in prices and demand because of the lack of complete and reliable data in the form of time-series data on consumption. This is why the models here were kept simple; but, nevertheless, they include the factors that seem to play a crucial role in explaining the variations in demand for the livestock products considered in this analysis.

Both retail and farm demand relationships have empirically been tested here.

The Demand for Beef

Retail Level

A considerable amount of research has been devoted to estimation of demand relationships for food products in the developed countries and in the United States in particular. One of the more recent and comprehensive studies of demand was carried out by P.S. George and G.A. King at the University of California.[5] They estimated price elasticities, all cross-demand elasticities and income elasticities for 49 foods.

Retail Demand for Beef

The equation tried for the estimation of the retail demand of beef was as follows:

$$QBD = \underset{(1.5218)}{6.00492} - \underset{(10.3756)}{20.5973RPB} - \underset{(.0477)}{0.3270RP(L+M)} + \underset{(.0157)}{0.1975GNP}$$

$$\bar{R}^2 = 0.90 \qquad d^* = 1.94 \text{ (za)} \qquad (5\text{-}13)$$

Equation (5-13) gives the retail demand for beef in Greece in terms of its own price (retail price of beef), the retail price of lamb and mutton and the per capita Gross National Product which is taken to proxy the personal disposable income variable. The equation seems to be quite promising since it gives the right signs for the regression coefficient and a rather satisfactory coefficient of

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[5] P.S. George and G.A. King, "Consumer Demand for Food Commodities in the United States with Projections for 1980," Giannini Foundation Monograph 26, California Agricultural Experiment Station, March 1971.

determination.

In terms of its own price, the retail price variable seems to be statistically significant since the magnitude of the estimated regression coefficient is almost two times its standard error. This then means that there is a fairly high probability (about .95) that the true parameter is not zero.

The sign in front of the estimated regression coefficeint of retail price of beef is what one should expect from economic theory. Since this is a demand relationship the quantity of a product demanded and its price are inversely associated. The minus sign verifies the downward sloping demand curve for a livestock product.

The corrected coefficient of multiple determination, $\overline{R}^2$, was found to be equal to 0.90. All this means is that there is a high degree of linear association between the variables included in the model and the quantity of beef demanded (QBD) for consumption. In other words, 90 percent of the variation in the per capita quantity of beef demanded for consumption in Greece is associated with the variables appearing in the empirical estimation.

The variable retail price of lamb and mutton seems to play an important role in explaining the demand variation for beef. The per capita consumption of lamb and mutton moved in a parallel way and at higher levels of consumption than that of beef over the entire period of the sample (see Table B-4 in the Appendix).

The sign of the regression coefficient is consistent with the logic of the model and of the economic theory according to which a negative sign was expected since beef and lamb and mutton (taken together) are complementary products in the diet of Greek consumers. The magnitude of the estimated regression coefficeint seems to be reasonable since a unit change in the retail price of beef is associated with a 0.3 unit change in its quantity demanded per year and per capita, which seems to be logical.

The variable RP(L+M) is statistically significant since the magnitude of the estimated regression coefficient is well above two times its standard error which makes using this variable in the model more reliable in explaining the variation in the demand for beef in Greece over the period 1951-1972.

The other striking point about the model (5-13) is that no autocorrelation appears to hold following the standard Durbin-Watson criterion for autocorrelation.

The GNP variable appears to play its role in the explanation of the variation of demand for beef in Greece for the time period examined. GNP almost doubled at the end of the sample period. This variable is positively associated with the dependent variable QBD, meaning that as income (or, for that matter, the GNP) increased, the quantity of beef demanded increased, too.

The magnitude of the coefficient seems to be reasonable since it means that whenever the GNP changes by 1,000 drachmae per year, the per capita quantity of beef demanded changes by 0.198 kg per year.

Retail Elasticities for Beef

The three demand elasticities for beef at the retail level are shown in Table 10 below.

TABLE 10

RETAIL DEMAND ELASTICITIES FOR BEEF*

Dependent Variable	Independent Variables		
	RPB	RP(L+M)	GNP
QBD	-1.41	-0.02	+ 5.90

In Table 10 the three elasticities of demand for beef are given. The own-price elasticity was found to be -1.41 and reveals that beef demand was price elastic in Greece over the sample period. The cross-price elasticity of demand for beef with respect to lamb and mutton (taken together) is negative, indicating that the two products are complementary commodities. The income elasticity of demand for beef at the retail level was found to be +5.90, revealing that the beef is considered a normal good in Greece.

Empirical estimates of price elasticities of demand vary, depending upon the price and quantity series used in the analysis. In addition, they are also influenced by the kind of shift variables included in the equation. Furthermore, they are also affected by the kind of shift variables included in the regression equation, i.e., the factors that are held constant. In this respect Working's discussion of what happens to demand price elasticities when quantities rather than prices are used as measures of substitutions in a

*All elasticities have been calculated at the mean value.

regression analysis is relevant. He states that "if prices of other meats are held constant, the elasticity of demand is somewhat greater than if supplies are held constant."[6]

The Relationship Between Farm and Retail Demand for Beef

The farm price and the retail price of beef are connected by the marketing margins. If retail and farm prices have the same percentage relationship to each other, the elasticity of demand at the two levels will be identical. A one percent change in price will result in equal percentage quantity changes at the two levels. But if the marketing margins tend to be constant in drachma terms and not in percentage terms, then the elasticity at the retail level will be greater than at the farm level. Unfortunately, there are no data available for marketing margins in this case in order to observe their behavior and their relationship to both farm and retail prices. Still, it is expected that margins may gradually have widened due to provision of better marketing services provided over time, including use of better equipment such as vehicle refrigerators for transportation, freezing facilities at the retail level, etc.

The relationship between farm and retail demand in the mathematical language of economics is based upon Harlow's work on hogs (1962).[7] A formula which combines the above statements is derived in order to compare the farm and the retail price elasticity.

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[6]Wlmer J. Working, Demand for Meat (Chicago: University Press, 1954), p. 69.

[7]A.A. Harlow, Factors Affecting the Price and Supply of Hogs, USDA Technical Bulletin, No. 4, 1962.

The elasticity of demand at the retail level is indicated by the formula:

$$e_r = \frac{dQBD}{dRPB} \cdot \frac{R\bar{P}B}{Q\bar{B}D}$$

where $R\bar{P}B$ is retail price of beef and $Q\bar{B}D$ is quantity of beef consumed at the retail level. By the same token, the elasticity at the farm level is indicated by the formula:

$$e_f = \frac{dQBD}{dFPB} \cdot \frac{F\bar{P}B}{Q\bar{B}D}$$

where $F\bar{P}B$ is the farm price of beef. From calculus it is known that

$$\frac{dQBD}{dFPB} = \frac{dQBD}{dRPB} \cdot \frac{dRPB}{dFPB}$$

By substituting this latter expression in the equation for farm level elasticity and by multiplying by $\frac{RPB}{RPB}$, the following two relationships are derived:

$$e_f = \frac{dQBD}{dRPB} \cdot \frac{RPB}{QBD} \cdot \frac{FPB}{RPB} \cdot \frac{dRPB}{dFPB}$$

$$e_r$$

or

$$e_f = e_r \cdot \frac{dRPB}{dFPB} \cdot \frac{FPB}{RDB} \quad .$$

The relation $\frac{dRPB}{dFPB}$, which is a ratio of changes between retail and farm prices of beef, depends upon the behavior of marketing margins.

a) If retail and farm prices always move in a parallel way bearing the same percentage relationship, RPB = a.FPB, and $\frac{dRPF}{dFPB} = a - \frac{RPB}{FPB}$, then, $e_f = e_r$, i.e., the two elasticities are equal.

b) If margins, however, are constant in drachma terms, RPB = FPB + b and the ratio $\frac{dRPB}{dFPB} = 1$. Hence, the e_f taken from the above given relationship becomes $e_f = e_r \cdot \frac{FPB}{RPB}$. Since farm prices are usually lower than retail prices, $\frac{FPB}{RPB} < 1$, and, hence, it is proven that the farm price elasticity is less than the retail elasticity.

These findings are similar to those of Brandow[8] who states that farm prices are lower than retail prices by the amount of marketing margins, and, hence, a one percent change in the farm price has less effect on the volume moving through the marketing system into consumption than does a one percent change in the retail price. This has serious policy implications since the results are different if farm price is raised and given to the farmer or retail price is lowered and given to the consumer.

Generally speaking, farm-level demand for domestic agricultural products is less elastic than the retail demand, another reason why small changes in the production level of farm products cause large changes in farm prices. Waugh concludes also that with percentage price spreads, both "price flexibilities", i.e., that of retail price with respect to quantity and income held constant and that of retail price with respect to income with quantity held constant, are the same at retail and at farm level. Prices are more elastic (more flexible)

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[8]G. Brandow, Interrelations Among Demands for Farm Products and Implications for Control of Market Supply. Penn. State Univ. Ag. Exp. Sta. Bul. 680, 1961.

at the farm level than at the retail, both with respect to quantity and income, if the price spread is a constant number of drachmas and its divisions.[9]

The Equations Fitted

The equations fitted to explain the variation in the quantity of beef demanded at the farm level were as follows:

$$QBD = \underset{(1.9040)}{6.2992} - \underset{(12.8666)}{30.9965}FPB + \underset{(.0419)}{0.1996}COM_{t-1} - \underset{(.0193)}{0.0276}GNP$$

$$\bar{R}^2 = 0.70 \qquad d^* = 1.96 \text{ (za)} \qquad (5\text{-}14)$$

$$QBD = \underset{(2.1009)}{0.3582} - \underset{(17.6515)}{9.8771}FPB + \underset{(.0162)}{0.0473}GNP$$

$$\bar{R}^2 = 0.36 \qquad d^* = 1.84 \text{ (za)} \qquad (5\text{-}15)$$

$$QBD = \underset{(2.8543)}{5.6978} - \underset{(12.2457)}{8.0644}FPB + \underset{(.0277)}{0.0321}GNP - \underset{(16.7250)}{18.7108}FP(L+M)$$

$$\bar{R}^2 = 0.76 \qquad d^* = 2.44 \text{ (za)} \qquad (5\text{-}16)$$

The first of the above equations is given as a function of three independent variables: the farm price of beef (FPB), the consumption of all other meats in the previous year (COM_{t-1}) and the GNP variable.

The general observation related to the first equation is that the income variable takes the wrong sign since it is expected that the general upward movement of GNP should result in an upward trend of demand

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[9]F. Waugh, Demand Price Analysis: Some Examples from Agriculture, USDA, ERS, Technical Bulletin, 1964.

for beef at the farm level, given the fact that beef has been found to be a normal good at the retail level. The variable is not, of course, statistically significant, and one may drop it from the model. Nor is the economic weight which the variable carries that significant. This finding leads one to think that beef consumption in Greece has reached such levels that further consumption should occur only if the product takes other forms of appearance (i.e., ready meals, hamburgers, etc.).

The variable COM_{t-1} enters with a positive sign, which means that, as the consumption of all other meats increases, the quantity of beef demanded at the farm level is increased, too. This is somewhat puzzling, but since nothing is known about the behavior of margins in the retail-wholesale business of beef, nothing more can be said about it. The variable appears to be statistically significant. For a one unit change in the per capita consumption of all other meats, which occurred the prior year, the quantity of beef demanded in this year and at the farm level is increasing by only 0.2 unit per capita per year. In other words, if the consumption of all other meats increases by 1.0 kg per head per year, the per capita farm level demand increases by 200 gr. per head per year.

The price of its own, i.e., the farm price of beef, carries a minus sign which means that as the farm price of beef goes up, the quantity of beef demanded at the farm level is expected to go down. This is in accord with the *ceteris paribus* condition and with economic theory. The variable is statistically significant, and its economic weight seems to be rather great since for a one unit change in FPB, a 31 unit change in the quantity of beef demanded is expected. This is an overestimation of the estimated regression coefficient of the FPB variable, and it is believed that is so due to OLS method adopted for estimation.

The income variable appears to have a wrong sign and it not statistically significant. It is better to drop it from the equation.

The second equation (5-15) fitted to explain the variation of the demand at the farm level is a function of the FPB and of the GNP. In such a formulation the GNP variable takes the positive sign and is statistically significant, while the FPB variable keeps it minus sign, but becomes statistically non-significant. The magnitude of the estimated regression coefficient is still large. Apparently, the $\overline{R}^2$ is significantly reduced from 0.70 in the first model to 0.36 in this second formulation.

Finally, the third formulation (5-16) seems to be the most promising one since the signs of all the independent variables are in accord with economic theory, though almost all of them could not be considered as statistically significant.

Analytically, under the (5-16) formulation the FPB variable carries a minus sign, meaning that whenever the farm price of beef is increasing the quantity demanded at the farm level is expected to decrease. The variable is not statistically significant in this kind of formulation, but it still carries a large estimated coefficient.

The GNP variable carries a positive regression coefficient, meaning that as the per capita income increases, the quantity of beef demanded at the farm level is expected to increase.

The farm price of lamb and mutton variable FP(L+M) seems to be in line with what was found at the retail level. The variable carries a minus sign, meaning that beef and lamb and mutton are complements in the diet of Greeks. As the farm price of lamb and mutton increases, the quantity of beef demanded at the farm level is expected to decrease.

That lamb and mutton are seasonally consumed means that within the time limits of lamb and mutton consumption the quantity of beef consumed is really reduced. During the period between Christmas and Easter time the consumption of lamb and mutton reaches its highest peak. At this time the quantity of beef consumed is reduced which is reflected at the farm level. This is the meaning of the minus sign of the estimated regression coefficient of the FP(L+M) variable. Over the other time period the two goods are substitutes.

The estimated regression coefficient seems to have been overestimated since for one unit of change in the farm price of lamb and mutton 18 units of change correspond to the quantity of beef demanded at the farm level, which seems to be a rather great change.

Elasticities of Demand for Beef at the Farm Level

The elasticity of demand for beef at the farm level was calculated from the (5-15) model and was found to be equal to $E_{PF} = -0.506$, which verifies the theory exposed at the beginning of this section which says that the farm-level demand is less elastic than the retail one.*

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*The E_{PB} calculated from the other two models was found to be -1.58 and -0.413, respectively, from (5-14) and (5-16).

The cross-product elasticity of beef demand at the farm level with respect to the farm price of lamb and mutton at the same level was found to be $EC_{BF} = -1.0918$, which is obviously less than zero, meaning that the two products are considered to be substitutes.

Thus, in concluding this section it can be observed that the two cross-product elasticities (at the retail and at the farm level) support the view that beef and lamb and mutton could be considered as being substitute products. For this to be further verified, however, more data on seasonal consumption patterns are needed.

Imports of Beef

Imports of meat in Greece are subject to: (1) an import duty ranging from 15 to 18 percent of the imports value and (2) a "floor price" system introduced in 1964, according to which imports are banned altogether if price of meat at home is at, or lower than the floor price. In the world market meat prices are lower than the domestic ones. And some prices (in Greece) are too high due to the protection of the industry expressed in the form of the import levy and to the preferences of Greek consumers for "fresh," locally produced meat.

The reasons for the protection of the industry are to save foreign currency and to support domestic meat production through its further development, thus maintaining a reasonable level of income for Greek meat producers. Another point is worth mentioning here. Greece imports a lot of meat and sets her imports free of levy deliberately in seasons of high consumption of meat which coincide with certain religious feasts (Christmas and Easter time). But this does not mean that meat imports are not realized during other times of the year. It simply means that at these religious feast times imports of meat reach their peaks.

The beef import regression equation is a part of the beef sub-system model. The following equations were tried:

$$QBIMP_t = \underset{(.7634)}{-1.6972} + \underset{(4.9375)}{3.5514}FPB_t + \underset{(.0758)}{0.7801}GNP_t$$

$$\bar{R}^2 = .87 \qquad d^* = .47 \qquad (5\text{-}17)$$

$$QBIMP_t = \underset{(.5578)}{-1.0550} - \underset{(4.7101)}{10.3551}FPB_t + \underset{(.0645)}{0.6215}QBC + \underset{(.0052)}{0.2281}GNP_t$$

$$\bar{R}^2 = .94 \qquad d^* = 1.23\ (i) \qquad (5\text{-}18)$$

$$QBIMP_t = \underset{(.9879)}{1.0265} - \underset{(6.3611)}{13.9404}FPB_t + \underset{(.1211)}{0.4141}QBC + \underset{(.0345)}{0.1200}T$$

$$\bar{R}^2 = .92 \qquad d^* = 1.49\ (i)^* \qquad (5\text{-}19)$$

From the equations above it can be observed that in the first one the variable FPB_t is statistically significant but does not bear the right sign, although seems to have a rather fair economic weight. In the other two equations this variable bears the right sign as one would expect from a priori reasoning of economic theory, and in both equations it is not statistically significant but economically very important. FPB_t and QBC_t are serially correlated. Indeed, the partial correlation coefficients are particularly high, and the d^* statistic gives an indeterminant Durbin-Watson test for serial

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*In equation (5-19) the d^* statistic with the value 1.49 rejects the null hypothesis only at 1% level of significance.

correlation. When serial correlation is not present, as in equation (5-17), the sign is not corrected, but its statistical significance becomes questionable.

The variable QBC_t seems to verify the a priori knowledge of the beef import industry and its seasonality in character since this variable is statistically significant, bears the right sign and is economically important. The GNP_t variable is also significant, bears the right sign and has important economic significance. A time trend used in equation (5-19) in place of the GNP_t variable did not improve the equation, although it is statistically significant. The best equation seems to be (5-18) for it carries lower standard errors for each of its coefficients and higher explanatory power ($\bar{R}^2$ = .94), and the signs of the variables used are in accordance with the reasoning of economic theory.

Imports are mainly influenced by the retail prices of meat (beef here) prevailing in the domestic market; thus, the retail price of beef should have been used instead. Such a formulation was tried by using the variables RPB_t and QBP_{t-1} (quantity of beef produced in the t-1 period).

$$QBIMP_t = \underset{(1.2093)}{-4.2863} + \underset{(5.5559)}{21.2586}RBP_t + \underset{(.0360)}{0.0689}QBP_{t-1}$$

$$\bar{R}^2 = .52 \qquad\qquad d^* = 1.16\ (i) \qquad\qquad (5\text{-}20)$$

In this formulation the retail price of beef in year t seems to play a role on the quantity of beef imported since, other things being equal, a unit change in the RPB_t causes 21.26 units of change in $QBIMP_t$. The standard error of the regular regression coefficient of RPB_t is rather small, and the variable seems to be statistically significant and to carry the right sign and has important economic meaning. The Durbin-Watson statistic d^* with a value of 1.16 becomes inconclusive at significant levels 5 percent and 2.5 percent, and it just coincides with the value of the upper limit $d_u = 1.16$ at 1 percent level of significance, i.e., it is on the border of accepting or not accepting the H_0 hypothesis of non-existence of serial correlation. The second variable QBP_{t-1} seems at a first glance to play a role in imports since it carries the right sign expected from a priori reasoning, but its standard error of the regular regression coefficient is not even half of the value of the coefficient and its economic meaning seems not to be that important since a one unit change in QBP_{t-1} corresponds to a 0.06 unit change in the dependent variable $QBIMP_t$. The overall explanatory power of this equation is rather poor ($\overline{R}^2 = .52$).

Thus, from the empirical analysis presented in this section it seems rather safe to conclude that imports have been substantial and have rather heavily contributed to Greece's balance of payments problem. On the other hand, imports have been a source of uncertainty to domestic producers.

It seems that the most important factors affecting beef imports are the domestic farm price for beef, which indirectly influences both the supply of beef and the demand for beef, the increasing per capita income and the level of meat consumption already reached through habitual and income effects. Given the fact that per capita consumption of beef was 16.9 kilograms per year in 1972 and that of EEC-9 was 24.3 kg, it is reasonable to expect that beef imports will continue to be a problem to be tackled in the future.

Import Elasticities of Beef

Table 11 reveals that retail price elasticity of imported beef is rather high (+3.08), which means that whenever the domestic retail price of beef changes by one percent the quantity of beef imported changes by almost 3 percent.

TABLE 11

IMPORT ELASTICITIES OF BEEF

Equation	Dependent Variable	Explanatory Variables			
		FPB_t	GNP_t	RPB_t	QBP_{t-1}
5-17	QBIMP	-	2.21	-	-
5-18	QBIMP	-1.13	+5.19	-	-
5-19	QBIMP	-1.52	-	-	-
5-20	QBIMP	-2.31	-	+3.08	+0.69
Average		-1.44	+3.75	+3.08	+0.69

It is also extremely important to know how demand responds to changes in income. The responsiveness of demand to changes in income is termed income elasticity of demand and is defined as the percentage change in quantity of beef imported (demanded) over the percentage change in income (consumer's income). For most goods, increases in income lead to increases in demand, and income elasticity will be positive. Obviously, here the income elasticity of demand is positive, ranging from +8.21 to +5.14 in the two equations (5-17) and (5-18). The reason for knowing the income elasticity of demand is that industries with low income elasticities will find the demands for their products expanding only slowly, while industries with high income elasticities find the demand for their products expanding rapidly. This may be taken to mean here that with further income increases, other things being equal, beef imports will be still coming into the country.

As far as the relationship between the percentage change in the quantity of beef imported and the percentage change of retail price of beef is concerned, it can be observed that, under the ceteris paribus condition, as the domestic retail price of beef rises by one unit the quantity of beef imported rises by 3 units. The retail price of beef in the domestic market is higher than in the world market, and the difference is leveled off by the import levy. Nevertheless, the price import elasticity of demand for beef shows that, even with higher retail prices of beef, beef will still be demanded due to the strong income effect.

Another striking result of the empirical analysis is that the price elasticity of beef imports with respect to farm price of beef which, in equation (5-17), comes out to be positive and rather small and is not statistically significant, should be used with caution. The explanation lies in the fact that whenever the farm price increases by a small percentage farmers form positive price expectations and hold beef cows from being slaughtered. The short-run result would be a shortage of beef supplies in the market and, hence, an increase in the quantities of beef imported.

The Demand for Veal

Retail Demand for Veal

Veal was consumed at a rate of 4.96 kg. per capita per year in Greece, almost double the quantity compared with beef consumption. In fact, the EEC-9 average per capita consumption of veal was 2.5 kgs per year while that in Greece was 8.9 kg. in 1973. There is, of course, a difference in the definitions of the product "veal," but, nevertheless, habitual reasons explain why consumption of veal is higher in Greece.

The higher consumption of veal in Greece is due: 1) to low per capita income over the first decade of the sample period, 2) to the freshness and flavor which constitute an important factor in veal purchases, 3) to better nutritional aspects and, finally, 4) to a "demonstration effect" which is well developed in the consumption pattern of the Greek people. These are the explanations for the income elasticity of demand for veal at the retail level which was found to be +1.86. It seems that, on the average, the typical consumer has already spent enough of his budget on veal purchases so that, inevitably, the income elasticity of demand for veal will be rather high.

The Equations Fitted

Two equations were tried to explain the variations in the quantity of veal demanded at the retail level. The two equations were as follows:

$$(RV_1)\ QVD = \underset{(5.9696)}{0.7236} - \underset{(14.9915)}{1.8239RPV} + \underset{(.2414)}{0.6553RP(L+M)}$$

$$+ \underset{(.0393)}{0.5981GNP} - \underset{(.0492)}{0.0630CPI}$$

$$\bar{R}^2 = 0.96 \qquad d^* = 1.32\ (i) \qquad (5\text{-}21)$$

$$(RV_2)\ QVD = \underset{(1.8505)}{-6.5543} + \underset{(14.3973)}{4.5107RPV} + \underset{(.0934)}{0.3689RP(L+M)} + \underset{(.0399)}{0.0632GNP}$$

$$\bar{R}^2 = 0.96 \qquad d^* = 1.32\ (za) \qquad (5\text{-}22)$$

Equation (5-21) reveals that the quantity of veal demanded is influenced by the retail price prevailing at the retail level. The retail price variable, of course, is not statistically significant. The variable bears the right sign since the dearer the veal becomes at the retail level, the less it is demanded by Greek consumers.

The retail price of lamb and mutton bears a positive regression coefficient which is what one should expect from economic reality in Greece. The dearer the veal becomes, the more lamb and mutton is demanded and vice versa. The variable seems to be statistically significant and to carry some economic validity since for one unit of change in the RP(L+M) a 0.6 unit change in QVD is caused which illustrates the competitiveness of the two kinds of meats. Lamb and mutton are more seasonally consumed, and the empirical evidence is more valid when the issue is looked at from a seasonal consumption point of view.

The GNP variable carries a positive sign which means that as the GNP increases, the quantity of veal demanded at the retail level will also increase. The GNP variable is almost statistically significant in every equation tried, and in the first equation (5-21) bears a rather fair economic significance since a one unit change in GNP causes a 0.6 unit change in the dependent variable. The inclusion of the GNP variable together with the CPI variable may be the cause for the indeterminancy of d^* statistic for serial autocorrelation. There is, of course, a problem here, and that is, when one talks of the CPI he at the same time talks about retail veal price which is included as one of the items used to construct the consumer price index in Greece. The association between RPV and CPI is high and that is another reason for the d^* statistic to be indeterminant.

The overall explanatory power of the (5-21) model is rather high, but the indeterminancy of the d^* statistic for serial autocorrelation and the fact that the variable RPV is not statistically significant should be kept in mind when using this model.

The (5-22) model is almost the same as the (5-21) model, the only difference being that the CPI variable is excluded from the second one. This exclusion makes the variable RPV carry a wrong sign, although its economic significance increases quite a bit. When the indeterminancy of the d^* statistic disappears, the RP(L+M) is almost not affected and the GNP variable loses some of its economic significance. The overall explanatory power of the equation remains exactly the same.

Elasticities of Demand for Veal at Retail Level

Equations (5-21) and (5-22) are used to calculate the short-run retail price elasticities which are shown in Table 12 below.

TABLE 12

SHORT-RUN PRICE ELASTICITIES OF VEAL AT RETAIL LEVEL

Dependent Variable	Independent Variables			
	RPV	RP(L+M)	GNP	CPI
QVD_t	-0.09	+0.03	+1.18	-1.69
QVD_t	-0.22	+0.01	+1.18	-
Average	-0.15	+0.02	+1.18	-1.69

Table 10 shows the short-run price elasticities of veal at the retail level with respect to certain variables. It can be observed that the direct own-price elasticity of demand for veal is -0.15, while that estimated by Papaioannou is -0.61.[10] The difference may be due to (1) the fact that Papaioannou uses the retail price of salted fish as one of the explanatory variables, while the RP(L+M) was utilized in this study and (2) different time-series were used in the two studies.

The cross elasticity with respect to retail price of lamb and mutton did not exceed the direct own-price elasticity of demand for veal which means that the model specifications are the correct

[10]M. Papaioannou, "An Analysis of the Supply and Demand Condition in the Animal Breeding Industry in Greece," Unpublished Ph.D. Thesis, Oxford University, 1970.

ones. In Papaioannou's study the own-price elasticity of demand for veal exceeds that of (the) cross elasticity only in TSLS formulation.

The income elasticity in this study was found to be equal to +1.18, while it is 2.71 in Papaioannou's study. But the elasticity found here is plausible since the income elasticity for the USA is 0.60.[11]

The demand elasticity for veal with respect to CPI was found to be -1.69 which also seems to be reasonable considering that Greeks spend a lot on veal consumption.

Farm Demand for Veal

Substantial research has been done in agricultural economics on questions related to price differences between the farm level and the retail level of farm products everywhere in the world. Nonetheless unanswered questions remain.

The difference between the price received by producers and that paid by consumers is a marketing margin. Both producers and consumers are greatly concerned about the size of marketing margins, their changes and their incidence of changes for both these categories of people. This section will not, however, deal with marketing margin behavior in the veal market in Greece because there were no data available to the author about these margins. Only the two elasticities will be discussed here.

The Equations Fitted

In order to compute the farm demand for veal two equations were tried. They were as follows:

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[11] Brandow, p. 19.

$$QVD = -12.6407 - 4.1808FPV + 0.1601GNP + 15.3368FP(L+M)$$
$$(2.5992)(25.8933) \quad (.0503) \quad (41.6885)$$

$$\bar{R}^2 = .83 \qquad d^* = .88\ (na)(i1\%) \qquad (5\text{-}23)$$

$$QVD = -6.8720 - 12.7200FPV + 0.0731GNP + 15.0941FP(L+M)$$
$$(2.2874)\ (18.7886) \quad (.0418) \quad (30.0717)$$

$$+ 0.3838T$$
$$(.0915)$$

$$\bar{R}^2 = .91 \qquad d^* = 1.43(i) \qquad (5\text{-}24)$$

The two equations fitted here are the same, the only difference between them being that a time trend was allowed to enter in the second equation. But this entrance of the time variable increased the $\bar{R}^2$ by only 8 points and left almost everything else unaltered, although a slight improvement in the standard error of estimates appeared in the second model.

The own-price variable, i.e., the farm price of veal (FPV), appears to have the right sign since a negative estimated regression coefficient in front of it means that quantity of veal demanded at the farm level and the price of veal are inversely related. The variable appears not to be statistically significant, and this could probably be attributed to the assumption made about the random error, i.e., that random errors are independent of one another may not be true.

The income variable and the QVD at the farm level are positively related which is what one should expect from economic theory and based on certain assumptions about the behavior of marketing margins. The variable is statistically significant in both models.

The farm price of lamb and mutton is positively related, meaning that the two products are complements since an increase in the price of lamb and mutton is associated with an increase in the quantity of veal demanded at the farm level. This complementarity is also supported by the fact that Ec was found less than zero, i.e., Ec = 0.56 < 0.

There is a consistency in the findings of the empirical analysis as far as the complementarity of lamb and mutton (taken together) and beef and veal is concerned. Lamb and mutton are complementary to both beef and veal.

The variable (FP(L+M)) is not, of course, statistically significant, but it does contribute to the explanation of the variation in the quantity of veal demanded at the farm level.

The time element is statistically significant and positively associated with the quantity of veal demanded at the farm level which is really what happened over the sample period examined.

The average cross elasticity of veal with respect to the farm price of lamb and mutton seems to be sufficiently good since it agrees with other analyses (see Table 13 below). Papaioannou, using salted fish as a substitute for veal, has found a cross-elasticity of 0.70 with OLS and 0.56 with TSLS.[12] This elasticity was found to be 0.56 here or fell within the range of 0.56-0.58, using OLS and seems to be reliable. The sign and the magnitude of its coefficient is reasonable even when OLS is used. Its positive sign with respect to per capita veal consumption indicates that the dearer the lamb and mutton become, the greater the quantity of veal demanded and vice versa.

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[12]Papaioannou, p. 156.

TABLE 13

VEAL DEMAND ELASTICITIES AT FARM LEVEL

Dependent Variable	Explanatory Variables		
	FPV	GNP	FP(L+M)
QVD	-0.16	+3.01	+0.56
QVD	-0.49	+1.37	+0.56
Average	-0.32	+2.19	+0.56

Imports of Veal

Because veal like beef, is regulated by the same import rules to which reference is made in the section dealing with imports of beef, these rules are not repeated here. What is not considered in that section is some theoretical reasoning as to how imports of both live cows and/or calves or imports of meat (beef and veal) influence farmers in formulating their price expectations and their foresight for the market.

The government usually sets domestic prices at no regular times and decides about the special import policy of meats one or two months before religious feasts when it estimates that domestic production will not cover consumption needs. This policy, along with institutional rigidities inherent in the whole system of import policy, creates uncertainties with regard to the duration of the new domestic price level for veal and the price of the imported veal. To this add the duration of imports and the perception of the two veal prices in farmers' minds.

Once the decision is made by farmers and once they have formed their price expectations it must be put forward for approval and support, if any, by the state. All this needs time to be executed, and the length of time depends on the policy followed by the government and its agencies and institutions.

Due to this difference in price and/or production perception by farmers and by the government, inconsistencies in individual and collective aims come into the picture, inconsistencies which are multiplied by domestic and international market uncertainties, weather uncertainties for feed-grain, etc. and make the whole situation very complex.

The equations tried for an explanation of veal imports were:

$$QVIMP_t = \underset{(1.0546)}{-3.0645} + \underset{(10.1287)}{2.4357}RPV_t + \underset{(.2983)}{8.1179}QVD_t + \underset{(.0005)}{0.0005}GNP$$

$$\bar{R}^2 = 0.88 \qquad d^* = 0.70 \text{ (za)} \qquad (5\text{-}25)$$

$$QVIMP_t = \underset{(.8334)}{1.1756} + \underset{(.0616)}{0.3270}QVD_t - \underset{(4.8585)}{4.4270}FPV_t - \underset{(.0146)}{0.0045}GNP_t$$

$$\bar{R}^2 = 0.87 \qquad d^* = 2.03 \text{ (i)} \qquad (5\text{-}26)$$

$$QVIMP_t = \underset{(.6846)}{-2.6059} - \underset{(7.6960)}{4.2182}FPV_t + \underset{(.0161)}{0.0513}GNP_t$$

$$\bar{R}^2 = 0.66 \qquad d^* = 0.94 \text{ (na)} \qquad (5\text{-}27)$$

Equation (5-25) tries to explain the imports of veal in terms of retail price of veal (RPVt), quantity of veal demanded and per capita gross national product. This equation reveals that this year's retail price of veal, although not statistically significant, carries a relevant economic weight since it shows that if the retail price of veal in the domestic market increases by one unit the quantity of veal imported increases by 2.4 units. This could be taken to mean that, although Greeks prefer to consume locally produced veal because of its freshness and taste, they are rather sensitive to price changes on the other hand, and, if the price of domestically produced veal increases by one real drachma, consumers turn to buying imported veal by 2.4 kg. more per head and per year.

According to Papaioannou,

> Retail price of veal is used to account for any ban imposed on imports owing to the low price in the national market, as well as for any case in which imports are set free of any duty for the necessary period of time in order to bring the increased retail price back to the desirable level, when it is dominated by inflationary movements in the national market.[13]

As was expected, the sign of the (RPV) coefficient is positive agrees with the previous study carried by Papaioannou and emphasizes the positive causal effect of retail price of veal on imports of veal which is in line with the a priori knowledge of the veal import industry. The presence of the negative autocorrelation contributes, of course, to an upward bias in the estimated coefficient of price and, consequently, in the estimated elasticity of veal imports with respect to retail price of veal in the domestic market.

The variable quantity of veal demanded per head and per year seems to be very positively associated with the imports of veal. It

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[13]Papaioannou, p. 156.

carries a large positive regression coefficient, and the use of OLS technique greatly contributes to this problem. The variable bears the sign that one should expect from knowledge of the consumption patterns of veal by Greek consumers. As veal becomes dearer and dearer in Greece, and as domestic veal production does not meet consumers' demand, Greeks turn towards meeting their needs in veal by buying imported veal. The variable seems to be statistically significant.

The income variable, although it bears the right sign, seems not to be statistically significant. The positive coefficient of income indicates that imports of veal will increase as income increases. The only explanation which can be given for the negative sign of the estimated regression coefficeint of the income variable is the indeterminancy of the standard test (Durbin-Watson) for serial autocorrelation. There is obviously a symmetrical upward movement in the time-series data used for the variables included in the model which may contribute to the appearance of the minus sign for the income variable.

Import Elasticities for Veal

Table 14 reveals that the short-run price elasticity of imported veal with respect to domestic retail price is 0.41, while that with respect to FPV is 0.56. The positive and negative elasticity coefficients with respect to price variables each has its own explanation. And the explanations behind these variables differ from each other. As the retail price of veal goes up, it is obvious that consumers tend to substitute for domestic veal either other domestic substitutes or foreign veal coming into national market whose price is lower, while, when farm price of veal goes up, farmers slaughter their calves, thus causing a short-run decrease in the imports of veal.

TABLE 14

IMPORT ELASTICITIES OF VEAL

Dependent Variable	Explanatory Variables			
	RPV	QVD	FPV	GNP
QVIMP	+0.41	+27.26	-	+0.03
QVIMP	-	+ 1.10	-0.57	-
QVIMP	-	-	-0.55	+0.17
Average	+0.41	+14.18	-0.56	0.10

The import elasticity with respect to quantity of veal demanded is very large and should probably be taken to mean that if per capita veal consumption is going to increase, then veal imports will dramatically increase. More reasonable elasticity seems to be that calculated from the (5-26) model. The veal import elasticity with respect to GNP seems to be very low. One reason for this seems to be the inclusion of the variable QVP in the same model, but it still remains low even when this variable is excluded, as happens in model (5-27). The best model seems to be the first one which gives positive elasticities with respect to three variables included since one should expect such a sign from economic reasoning and from the data.

One comment is in order here. The veal import elasticity with respect to income is low because, on the average, Greek consumers spend enough of a proportion of their food budget on veal consumption.

The retail price elasticity reveals that any increase in domestic veal price will mean increase in imports. Thus, from a policy point of view it seems that if the government wants to reduce veal imports the best policy to follow is to increase farm price of veal. Of course, this is a short-run view and should be taken only as such. But an increase in the FPV_t could probably mean an increase in the RPV_t which, in turn, could mean an increase in veal imports. This empirical finding explains why the government steps into the market and regulates the retail prices and the imports. But this is only a short run solution to the problem, a solution which favors price regulations and veal imports control. From a long run perspective the increased price of veal should be expected to contribute positively in farmers' minds as far as price expectations are concerned, and it is also expected, other things being equal, that farmers should positively respond and try to produce the quantity of veal demanded by Greek consumers.

The Demand for Milk

Retail Demand for Milk

Fluid milk is indispensable for human beings, especially during the earliest period of growth, and through the entire human lifespan as well. Milk is easily digested and assimilated, and the nutrients are applied in forms that are particularly adapted to the underdeveloped digestive systems of young human babies at birth. Also, milk is high in minerals, on the dry basis, and it is especially rich in calcium and phosphorus, the two minerals needed in largest amounts by growing humans. This nutrient value of milk has been recognized by Greek people especially during war periods and that is why Greek farmers have taken care to have one or two milking cows in their homes. Apparently, it is a cheap food, too, if the cows are grazing outside in the fields.

The equations fitted to explain the variation of the quantity of milk demanded at the retail level over the sample period considered in this thesis were as follows:

$$\underset{}{QMKD_t} = \underset{(31.9533)}{79.7307} - \underset{(1\ 012.2449)}{2\ 708.7250}RPMK_t + \underset{(10.4292)}{26.8157}RPCH_t + \underset{(.1175)}{0.2238}GNP_t$$

$$\bar{R}^2 = 0.87 \qquad d^* = 1.07\ (i) \qquad (5\text{-}28)$$

$$QMKD_t = \underset{(36.2642)}{73.5651} - \underset{(1\ 148.0322)}{2\ 490.3619}RPMK_t + \underset{(.1291)}{0.3025}GNP_t$$

$$\bar{R}^2 = 0.84 \qquad d^* = 0.41\ (za) \qquad (5\text{-}29)$$

In the retail side, the retail price of milk is of great importance since it is statistically significant, bears the sign expected from economic reasoning and carries significant economic weight. The estimated regression coefficient is rather overestimated since the two variables RPMK and RPCHS are strongly influenced by the GNP variable. Nonetheless, all the variables in this model seem to be statistically significant and they do have to contribute to the explanation of the variation of the quantity of milk demanded at the retail level. Cheese, which is a substitute for milk as a source from which one can get the nutrients embodied in milk, was found to be statistically significant,and the magnitude of its estimated regression coefficient seems to be plausible. The problem of the indeterminancy about the serial correlation may contribute somewhat to both the large regression coefficient and non-statistically-significant variable in the (5-28) model. Milk and cheese are positively associated in the retail level.

When the variable RPCHS is omitted from the model, things do not change much. The only noticeable difference is in $\bar{R}^2$. $\bar{R}^2$ is reduced by three units in the (5-29) model, and the problem of autocorrelated disturbances disappears.

Elasticities of Milk at the Retail Level

The own-price elasticity, E_p, of demand for milk at the retail level was found to be -4.21, which means that as the retail price of milk goes up by one percent, quantity of milk demanded is expected to go down by 4.21 percent and vice-versa (see Table 15). This elasticity was found to be equal to -1.31 in Papaioannou's research effort.

TABLE 15

ELASTICITIES FOR MILK AT THE RETAIL LEVEL

Dependent Variable	Explanatory Variables		
	RPMK	GNP	RPCHS
QMKD	-4.39	+0.45	+0.16
	-4.03	+0.60	-
Average	-4.21	+0.52	+0.16

The two models fitted for the retail demand of milk gave income elasticities equal to +0.45 and +0.60 which provide evidence that fluid milk is considered as an inferior good in the retail sector in Greece ($E_y < 0$). And the retail cross-product elasticity of milk with respect to cheese was found to be +0.16 ($E_c < 0$), providing evidence that fluid milk and cheese are complement goods.

Farm Demand for Milk

For the calculation of the farm demand for milk at the farm level the following equations were tried:

$$\underset{}{QMKD_t} = \underset{(16.6418)}{52.0933} - \underset{(524.9463)}{3\,050.9752FPMK_t} + \underset{(.0811)}{0.1807GNP_t} + \underset{(62.5893)}{539.4646FPCHS_t}$$

$$\bar{R}^2 = 0.97 \qquad d^* = 1.38 \text{ (i)} \qquad (5\text{-}30)$$

$$QMKD_t = \underset{(36.2642)}{73.5651} - \underset{(1\,148.0322)}{2\,490.0000FPMK_t} + \underset{(.1291)}{0.3025GNP_t}$$

$$\bar{R}^2 = 0.84 \qquad d^* = 0.41 \text{ (sa)} \qquad (5\text{-}31)$$

$$QMKD_t = \underset{(17.1844)}{-14.1406} - \underset{(657.1072)}{1\,464.6039FPMK_t} + \underset{(.2509)}{2.5546T}$$

$$\bar{R}^2 = 0.94 \qquad d^* = 0.74 \text{ (sa)} \qquad (5\text{-}32)$$

From equations (5-30) to (5-32) it can be seen that within the time t year span farm price of milk plays an important role in explaining the variations in the quantity of milk demanded at the farm level. This variable is statistically significant in all models used and bears the sign expected from economic theory since the minus sign means that as the farm price increases, the quantity of milk demanded will decrease and vice-versa. The regression coefficients carry significant economic weight, although seems that the OLS used give upward biased estimators.

The income variable appears statistically significant and has the right sign. The time variable tried in one of the equations lends empirical evidence to support the data which show an increased per capita consumption of milk over the sample period.

The farm price of cheese, again, has an impact on the quantity of milk demanded at the farm level. The two products seem to be substitutes at the farm level since they are positively associated, which means that as the farm price of cheese goes up the quantity of milk demanded is expected to increase.

Elasticities of Milk at the Farm Level

The own-price elasticity of milk at the farm level was found to be -1.05, or, $E_{pM} > 1$ (see Table 16). Hence, milk has an almost elastic demand at the farm level as was found in the first two models.

TABLE 16

ELASTICITIES OF MILK AT THE FARM LEVEL

Dependent Variable	Explanatory Variables		
	FPMK	GNP	FPCHS
QMKD	-1.38	+0.36	+1.66
QMKD	-1.12	+0.60	-
QMKD	-0.66	-	-
Average	-1.05	+0.48	+1.66

The income elasticity at the farm level was found to be +0.48, meaning that as the income, i.e., GNP here, changes by 1 percent, the percentage change in quantity of fluid milk demanded at the farm level is almost 0.5. The cross-elasticity of demand for milk with respect to farm price of cheese was found to be positive and equal to +1.66, which suggests that milk and cheese are substitute commodities in the farm as well as in the retail level.

Since no imports of fluid milk had been realized there was not any equation fitted for that matter.

CHAPTER VI

SUPPLY

Introduction

Knowledge of supply response for agricultural products helps both in understanding the farmers' decision making process and in designing public policy (farm policy) related to the agricultural sector. The first of these two elements, the farmers' decision making process, is closely associated with the mechanism of supply response. On the other hand, public programs and farm policies related to supply regulation, stabilization measures, price support, etc. implicitly assume a certain level of supply response to changes in prices.

Among the studies of various agricultural products, supply response for cattle and feed-grain should be of interest to both public policy makers and private policy makers (farmers and/or businessmen involved) for at least two reasons:

a) public farm policy was directed towards diversification over the first twenty years of the sample period in Greece to meet the uncertainty which is involved in agricultural production; only lately has it been directed towards more specialization in certain regions in an attempt to alleviate farmers' income;

b) such a study contributes significantly towards the economic well-being of all the numerous participants involved.

According to Nerlove,[1] the objectives of research on supply response include (1) improving the understanding of the mechanism of supply response, (2) improving the ability to forecast supply changes and (3) improving prescription of better solutions to problems related to agricultural supply. This study is focusing mainly on the first two objectives.

The Role of Prices in Supply Response

Farmers' decisions about their production depend on the relative costs and prices of all their inputs and outputs; they are also influenced by their overall income, by their liquidity situation, and by their expectations as to future price developments. The extent to which price changes affect the supply of agricultural products is thus often difficult to determine. Many other factors influence production; such factors in the short-run could be weather and diseases, and in the long-term, developments in technology, changes in cost of production and other factors. Unless price changes are large, such other factors may override their effects. Opportunities for work off the farm may also play a role.

Moreover, the reaction to a price change in the short-term, i.e., in a period during which most production resources are fixed, is not necessarily the same as the reaction to one in the long-term, when machinery, buildings, etc. can be replaced or altered. The purpose for adjustment also varies between farms. The farm with a limited

[1]M. Nerlove. "Estimates of the Elasticities of supply of Selected Agricultural Commodities," Journal of Farm Economics, Vol. 28, 1956, pp. 496-509.

area is typically suitable to enterprises yielding a high return per unit of land, such as dairying, vegetables, etc. The larger farmer, however, may have greater flexibility in choosing his line of production - subject, of course, to natural constraints - but is liable to have at any given moment a heavy investment in capital equipment which is designed for certain enterprises and which cannot be quickly replaced. In the very long term, the possibility of changing farm sizes depends on the aggregate land and capital availability.

In terms of production economics, an analysis of supply response to price changes often gives inconclusive results, particularly when a long-run response is sought. Cases are even noticed wherein a reduction in price causes a farmer to increase his output in the short-term in order to maintain his income, if he has no profitable alternative to such an action, or if he is short of feedstuffs. Further, the effects of rising or falling prices are almost never symmetrical: an increase in price, for example, may stimulate an expansion of production, involving investment in equipment, while a subsequent decline in price may not have much effect because the equipment remains in use.

These considerations may seem to imply that price policy can have only a limited role in guiding production. It must be added that price policy has other aims besides that of demand and supply adjustment, and, indeed, the preoccupation with farm incomes restricts the scope for reducing prices in order to discourage output. There are, in fact, rather few cases in which support prices for major commodities have been significantly reduced. There are nevertheless some clear cases wherein a prolonged price reduction resulting from market forces has cut back not only production, but also productive resources.

For several agricultural products short-term adjustments, mainly through the market, can be seen to occur, although usually with a time lag which may in some cases set up a cyclical pattern (Cobweb theorem case). Price policy therefore, cannot disregard its effects on supply. It should be realized, too, that when governments step in to provide price guarantees or any other price support scheme, they are bound to exert a sustaining influence on production. The level of returns to agriculture must - in the long-run - influence the volume of resources used within the sector and, hence, (through it) the volume of production.

A price change for a specific product can definitely have a substantial effect if alternative lines of production are available or if alternative investment opportunities in other products are offered. Such substitution in production between various crops and animal feeding enterprises could thus take place, especially in a somewhat longer term. The determination of price relationships is therefore an important instrument in guiding production. This is why this study concentrated on supply relationships in cattle.

Finally, it should not be forgotten that price changes also have an effect on consumption, an effect which should be looked at, since for the products studied here demand is elastic in response to price, and also since changes in producer prices often have a limited effect on consumer prices, especially in cases where only a small share of the final value of the product consists of its farm value. Nevertheless, the effects, though limited in magnitude, are bound to be in the direction of improving the supply-demand balance. The absolute price level of feedstuffs, for example, has an important impact on the price policy for beef and/or veal produced and consumed. Changes in relative prices of concentrates and of roughage influence the composition of compound feeds; in addition, the general level of feedstuff prices influences the extent to which livestock are grazed on pasture or fed on concentrated feedstuffs and can even govern the level of supply of livestock products.

These various considerations underline the need for price policy both to take account of supply adjustment problems and to indicate the scope for effective action in this respect. A price policy can in practice be freely used to influence supply.

The major problems of Greek meat production developments should be centered around supply response, i.e., the relationships between output quantities and resource use and prices. Agricultural supply models may help in understanding these problems in that, through appropriate quantitative relationships, they may provide estimates of changes in output, acreage and yield per acre associated with changes in input use and in prices, which may be useful information in the hands of policy makers.

Formulation of the Models

Market supply relationships for agriculture as well as for other sectors of an economy are ceteris paribus relationships; that is these are the quantities that will be offered at the alternative prices with all other factors affecting supply held constant. Such factors can be prices of inputs, prices of other products that can be produced with the same resources, technology and the number of firms.

Thus, the supply relationship, like the demand relationship discussed in Chapter V, can be expressed by an implicit functional form such as in equation (6-1):

$$Q^S = f(P_i, P_j, P_0, Te, E, N, C) \tag{6-1}$$

where: Q^S: quantity supplied

f : function symbol

P_i: price of the commodity at hand

P_j: price of inputs

P_0: price of other products

Te: technology

E : expectations

N : number of firms

C : capacity of the firm

A priori knowledge of economic theory dictates that the following outcomes should be expected from this implicit formulation of a supply relationship.

$$\frac{\partial Q^S}{\partial P_i} > 0, \frac{\partial Q^S}{\partial P_j} < 0, \frac{\partial Q^S}{\partial P_0} > 0, \frac{\partial Q^S}{\partial Te} > 0$$
$$\frac{\partial Q^S}{\partial E} > 0, \frac{\partial Q^S}{\partial N} > 0, \frac{\partial Q^S}{\partial C} > 0 . \tag{6-2}$$

These relationships in (6-2) will serve as a guide - based on knowledge of economic theory - to understand and evaluate results from empirical analysis.

The hypotheses which underline the supply response of farmers to changes in price are those of static economic theory where perfect knowledge and foresight prevails in the perfectly competitive markets of both inputs and/or outputs.

The individual farmer (and, by the aggregation procedure, all farmers) is usually free to vary the levels of both cost (cost of inputs) and output, and his ultimate aim is the maximization of profit. The total revenue of a farmer who sells his output in a perfectly competitive market is expressed in the number of units he sells multiplied by the fixed unit price he receives. His profit, then, is the difference between his total revenue and his total cost. The costs the same farmer is facing are represented as the units of inputs he buys in the input market times the unit price of the input.

The empirical analysis of supply deals with the same products as the demand analysis did in Chapter V. These products are: feed-grain, roughage, beef, veal and milk. However, the supply analysis refers only to the farm level.

Domestic production is calculated by multiplying the number of animal units (or land units) by the average yield per animal (or per land unit). Thus, if A stands for the number of acres planted, N for animal units (slaughtered and/or milked) and $\bar{Y}$ for average yield per land and/or per animal unit, the production (domestic) is represented by the following identity:

$$\begin{aligned} O &\equiv A \times \bar{Y} \\ O' &\equiv N \times \bar{Y} \end{aligned} \tag{6-3}$$

The identity (6-3) suggests that the quantity of the product produced could have been taken as a dependent variable to explain the supply response in feed-grain production (direct estimation).

The procedure followed in this thesis (i.e., to break down the production equation into two steps) seems to be more realistic from the analytical purpose point of view. The direct estimation of the feed-grain supply response does not reveal the whole set of variables which contribute to the explanation of the variation in feed-grain production. On the contrary, the indirect method (a procedure which gives two separate equations with the area or the animal unit as one dependent variable and the average yield as the other dependent variable) provides the whole set of variables which contribute to the variation of supply response for feed-grain and/or for livestock products. The same holds true for each one of the products being studied here, and the same approach has been followed throughout the entire analysis of supply response in this thesis.

Thus, in an abstract way the identity (6-3) comes from the following two equations:

$$A = f1(A_{t-1}, P_{t-1}, K_1, U_t) \tag{6-4}$$

$$\bar{Y} = f2(P_{t-1}, A_t, K_2, K_3, t_1, V_t) \tag{6-5}$$

and/or

$$N = f1(N_{t-1}, P_{t-1}, K_1, U_t) \tag{6-4'}$$

and

$$\bar{Y} = f2(P_{t-1}, N_t, K_2, K_3, t, V_t) \tag{6-5'}$$

where: A: area in acres (stremmas)

N: animal units, i.e., number of animals

A_{t-1}: area in acres in t-1 year

P_{t-1}: price of the product studied in t-1 year

V_t, U_t: random disturbances

$\bar{Y}$: average yield per acre (land unit) or per animal unit.

K_1, K_2, K_3: weather conditions in critical production periods.

since $O \equiv A \times \bar{Y}$,

$O' \equiv N \times \bar{Y}$, then

$$O = f1(A_{t-1}, P_{t-1}, K_1, U_t) \cdot f2(P_{t-1}, A_t, K_2, K_3, t, V_t)$$

and/or (6-6)

$$O' = f1'(N_{t-1}, P_{t-1}, K_1, U_t) \cdot f2'(P_{t-1}, N_t, K_2, K_3, t, V_t)$$

It can be observed that the weather variable enters into both equations, i.e., in equation (6-4) which gives the area planted and in equation (6-5) which gives the average yield per unit of land. The weather itself is a function of many other variables[2,3] but the analysis here is kept simple since otherwise things begin to get complicated and the data requirements (and availability) increase enormously.

Direct vs. Indirect Method of Estimation

As far as which method is better to use for the supply response of an agricultural product, it should be mentioned here that the

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[2]L.H. Shaw, "The Effect of Weather on Agricultural Output: A Look at Methodology," Journal of Farm Economics (1964): 218-30.

[3]B. Oury, A Production Model for Wheat and Feed Grains in France (1946-1961). (Amsterdam: North Holland Publishing Company, 1966).

indirect method has been widely utilized in the empirical analysis conducted by agricultural economists. The direct method has two disadvantages. First, the area planted is not entirely independent from the weather conditions prevailing during the sowing period. Second, the partial elasticity of the area planted with respect to the price of the product is not equal to the elasticity of the quantity with respect to price. These two elasticities could be equal if E_{AP} (elasticity of area planted with respect to product price) were equal to zero. But such a hypothesis can hardly be supported. On the other hand, it is plausible to assume that the average yield depends - to a certain extent - upon the product price changes.

From identity (6-3) it can be shown that

$$E_{OP} = E_{AP} + E_{\bar{Y}P} \tag{6-7}$$

and

$$E'_{OP} = E_{NP} + E_{\bar{Y}P} \tag{6-7'}$$

and that

$$E_{OP} > E_{AP} \tag{6-8}$$

and

$$E'_{OP} > E_{NP} \tag{6-8'}$$

where: E_{OP}: elasticity of (production) quantity produced with respect to price

E_{AP}: elasticity of area planted with respect to price

$E_{\bar{Y}P}$: elasticity of average yield with respect to price

E'_{OP}: elasticity of quantity of a livestock product produced with respect to price of that product

E_{NP}: elasticity of the number of animals with respect to price of the product produced from these animals.

On the other hand, due to non-homogeneity of the production land (and/or the animal units), it could be the case that changes in the area planted (and/or in the number of animals kept on farms), assuming production resources per unit of land (and/or per animal) are given, result in changes in the average yield per unit of land (and/or per animal). This means that (6-8) could be written as:

$$\begin{aligned} E_{OP} &\gtrless E_{AP} \\ E'_{OP} &\gtrless E_{NP} \end{aligned} \qquad (6\text{-}9)$$

Empirical Estimation of Feed-Grain Supply

In the category feed-grain the items of corn, barley, oats and rye are included. To attain a "common denominator," these four items have been expressed in Total Digestible Nutrients (TDN) weight according to appropriate conversion factors for each one of them.

Foote, Klein and Clough,[4] writing about the Demand and Structure for Corn and Total Feed Concentrates for the U.S.A. in 1952, presented a simple diagram showing the major economic relationships in the feed-livestock economy (see Figure 5 below). This simple diagram depicts nothing else but the factors which enter into the implicit supply relationship in (6-1). Thus, letters were added to the diagram to present

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[4]R. Foote, J. Klein and M. Clough, The Demand and Price Structure for Corn and Total Feed Concentrates, USDA Techn. Bull., No. 1061, October 1952.

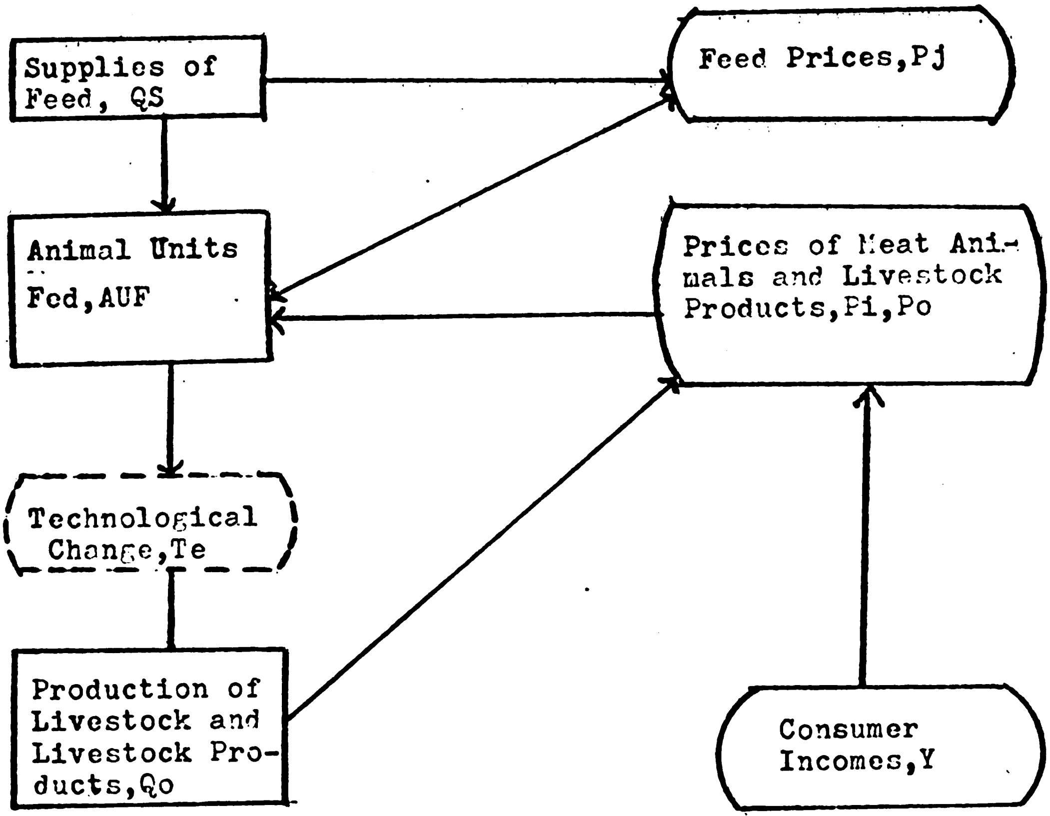

Figure 5. The Major Economic Relationships in the Feed-Livestock Economy. (Arrows show direction of influence.)

the factors which can be found in (6-1) in order to help the reader to have both a visual diagrammatic presentation and a kind of functional form in his mind at the same time.

In any given year, supplies of feed-grain in Greece are calculated mainly from:

a) the number of stremmas (acres) planted (and harvested) for feed-grain;

b) yields per stremma (acre);

c) stocks, which vary considerably from year to year, tending to be large when production is relatively large, (and the storage program supported by the state is in operation) and low when production is small (and the storage program is not in operation);

d) imports which are always coming into the country since Greece belongs to a feed-grain deficit group of countries;

e) weather conditions, since year-to-year changes in yield depend mainly upon weather and level of fertilizer used plus some cultural changes.

Cultural practices used in feed-grain production are introduced faster when prices are high, and, once they have been introduced, they tend to remain in use. Current prices of feed-grain have little or no effect upon the total acreage used for feed-grain in Greece.

The formulation of the supply equation for feed-grain developed into two separate equations. The first one deals with the number of stremmas planted, and the second one, with the average yield per stremma (1 stremma = .24 acres). This break-down was made because the key variables are both the number of stremmas planted and the average yield per stremma. The final outcome of multiplying these two variables is the domestic supply of feed-grain (domestic production).

The total supply of feed-grain existing at any point of time in Greece is expressed by the following identity:

Total Supply of Feed Grain = Domestic Production + Beginning Inventory (Stocks) + Imports

With this information as background, the following equations were tried in estimating the feed-grain domestically produced in Greece:

$$NSTRFGPL = \underset{(2542.0021)}{3023.1811} + \underset{(.1576)}{0.7746}NSTRFGPL_{t-1} + \underset{(56\ 383.6908)}{27\ 181.1706}FPFG_{t-1}$$
$$- \underset{(106\ 419.5469)}{56\ 779.7982}FPR_{t-1} + \underset{(14\ 709.9458)}{5\ 080.0690}FPFERT$$
$$+ \underset{(199.4423)}{616.3903}DV_g - \underset{(3.08118)}{3.7225}K$$

$$\bar{R}^2 = 0.84 \qquad d^* = 1.93 \qquad (6\text{-}10)$$

$$NSTRFGPL = \underset{(2185.1469)}{2598.9794} + \underset{(.1615)}{0.5935}NSTRFGPL_{t-1} - \underset{(48\ 488.7291)}{14\ 492.7857}FPFG_{t-1}$$
$$+ \underset{(15\ 175.3846)}{21\ 639.8038}FPFERT + \underset{(225.9058)}{300.9037}DV_g - \underset{(2.9397)}{6.2719}K + \underset{(.2417)}{0.511}AVF$$

$$\bar{R}^2 = 0.91 \qquad d^* = 2.26 \qquad (6\text{-}11)$$

The two models (equations) fitted to explain the variation in the number of stremmas planted did not give satisfactory results in the sense that some of the variables included do not carry the sign specified by economic theory. The deficiency with these types of models is that they employ many variables, all of which greatly contribute to the explanation of the variation, though two of them - in each model - carry a wrong sign.

The weather variable, K, taken as the rainfall in mm during the months October and November when the sowing of winter feed-grain is taking place, is statistically significant only in one of the equations fitted, and its estimated regression coefficient seems to be fair. Its sign is inversely related to the number of stremmas (acres) planted. This is taken to mean that as the rainfall during that period increases, the number of stremmas planted is expected to be fewer, a situation verified by the weather conditions in Greece.

The number of stremmas planted in the previous year appears to be a statistically significant variable since it picks up the (habitual historical) pattern of feed-grain production. The sign of the estimated regression coefficient is positively related to the dependent variable, and its magnitude is rather fair.

The variable farm price of feed-grain prevailing the previous year carries a wrong sign and is not statistically significant. This is due to model specification since another model, which is expressed below, yields a right sign and significance to the variable.

Number of stremmas planted and the price of roughage prevailing one year earlier are inversely related, which means that as the price of roughage goes up, the expected stremmas to be devoted to feed-grain are expected to be fewer. Such a relationship is valid since both of these inputs compete for the same resources, mainly land.

The other input variable, the farm price of fertilizer, appears with a wrong sign in both equations, is not statistically significant, and has a very large estimated regression coefficient. Price of inputs such as fertilizer of all kinds was kept at rather low levels during the sample period since the fertilizer industry has been heavily subsidized by direct and indirect government support. Thus, the cost of fertilizer does not seem to be a constraint to the number of stremmas devoted to feed-grain production, at least over the sample period examined here.

The subsidy variable used in the form of a dummy variable seems to be statistically significant with a right sign and with a consistent and significant magnitude of the estimated regression coefficient. This subsidy variable refers to the subsidy given to feed-grain growers in 1963-64 and beyond as a unit payment for the amount of output produced.

Indeed, Greece reached - for the first time in her long history - the level of self-sufficiency in grain for human consumption only late in the 1950s. Due to such an attainment along with an inability to compete in the world feed-grain market, farm policy has been oriented towards the increase of feed-grain production.

Another, simpler formulation which seems to be more promising includes only two explanatory variables in the lagged form of t-1. The lagged variables are $FPFG_{t-1}$ and $NSTRFGPL_{t-1}$. Such a formulation provided the following equation:

$$NSTRFGPL = \underset{(1043.1211)}{-5062.2144} + \underset{(34.2270)}{110.5514}FPFG_{t-1} + \underset{(.1824)}{0.8451}INSTRFGPL_{t-1}$$

$$\bar{R}^2 = 0.91 \qquad d^* = 1.74 \text{ (za)} \qquad (6\text{-}12)$$

In equation (6-12) each variable included is statistically significant and bears the sign expected from economic theory; also, each one carries rather important economic significance in explaining the variation in the area planted with feed-grain.

The second part (element) fo the supply equation was examined by trying the following equation:

$$\bar{Y}FG = \underset{(93.1408)}{-107.8157} + \underset{(2.0012)}{14.3567}T + \underset{(.4538)}{0.5633}K + \underset{(9104.1)}{16256.173}FPFG_{t-1}$$

$$\bar{R}^2 = 0.84 \qquad d^* = 1.60 \qquad (6\text{-}13)$$

Equation (6-13) explains the variation in the average per stremma yield in feed-grain production in terms of a time trend, weather conditions during the October-November period and the price of feed-grain the previous year. The model gives rather satisfactory results in the sense that all but one variable (the weather variable) are nearly statistically significant, and all of the variables included bear signs expected from economic theory.

The time variable is used as one of the explanatory variables to pick up whatever "technological change" has taken place in feed-grain production. Such change could involve better seeds used, the utilization of pesticides, weed control, the use of fertilizers, and so on.

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To tackle the problem of variation in the dependent variable in terms of a regular movement over time, two alternatives of action are open.[5] The first is to find the relationship between the dependent variable and the time and subtract this component of the variation before going on to consider the relationship between the dependent variable and the independent variables. The second alternative, to include time as one of the independent variables, has been followed here so that the correct number of degrees of freedom could be allowed for in carrying out tests of significance. A more simple formulation here should be to use only the T variable and the farm price of feed-grain variable lagged one year.

As far as the weather variable is concerned, better results could have been obtained if the April-May rainfall could have been used instead of the October-November rainfall. In fact, the April-May rainfall plays a more crucial role in determining yield in winter feed-grain production. Such data, however, were not available to the author at the time of the analysis.

In what follows the quantity of feed-grain domestically produced is used as the dependent variables to test how much the empirical analysis lends support to the economic theory expressed in (6-9).

$$\begin{aligned} QFGS = \underset{(200.2010)}{611.2921} &+ \underset{(.0912)}{0.5599}AUF \\ \bar{R}^2 &= 0.80 \end{aligned} \qquad (6\text{-}14)$$

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[5] James Thomas, <u>Notes on the Theory of Multiple Regression</u> (Athens: Center of Economic Research, 1976), p. 122.

$$QFGS = -1\,214.2439 + \underset{(49\,514.6699)}{151\,034.9085}FPFGP_{t-1} + \underset{(.1443)}{0.5746}AUF + \underset{(236.7308)}{66.7762}DV_g$$
$$\qquad (232.4241)$$

$$\bar{R}^2 = 0.81 \qquad\qquad d^* = 1.39\ (i) \qquad\qquad (6\text{-}15)$$

$$QFGS = \underset{(622.3847)}{-1\,296.8261} + \underset{(.0956)}{0.619}AUF + \underset{(49\,146.1364)}{152\,090.4849}FPFGP_{t-1}$$

$$\bar{R}^2 = 0.70 \qquad\qquad d^* = 1.34\ (i) \qquad\qquad (6\text{-}16)$$

$$QFGS = \underset{(82.9034)}{1203.4458} + \underset{(80.4260)}{153\,150.2436}FPFGP_{t-1} + \underset{(15.2231)}{46.7720}K + \underset{(.0440)}{0.6201}AUF_{t-1}$$

$$+ \underset{(8.1224)}{25.004}\,T$$

$$\bar{R}^2 = 0.96 \qquad\qquad d^* = 1.66 \qquad\qquad (6\text{-}17)$$

The striking finding here arises from equation (6-14) in which the variable animal units fed explains 80 percent of the variation in the variable quantity of feed-grain domestically produced in Greece. Maybe the quantity of feed-grain affects AUF. The explanatory variable is statistically significant and bears the right regression coefficient sign, but its economic weight seems to be underestimated. The magnitude of the estimator of this variable seems to be very consistent on all three equations used.

The price variable lagged one year appears to be statistically significant in both equations tried and has a positive regression coefficient, which means that the higher the last year's price of feed-grain were, the more feed-grain farmers produce. The magnitude of the regression coefficient is large which verifies the situation of the real world as far as the feed-grain industry in Greece is concerned. Feed-grain is mainly growing on lands where other crops cannot be competitive. Feedgrain production is also rather "easy" activity and, following mechanization, is carried out even by people living in the towns and/or cities and, even further, by people living abroad as emigrants. These people lease their lands to others or they themselves sometimes take care of this farm activity.

Feed-grain has - from time to time - been subsidized by the state, especially later in the sample period when the P.L. 480 program was not at work. The dummy variable used for the years when the subsidy was in effect shows a positive causal effect with the dependent variable which means that when the subsidy is given, the feed-grain produced will increase. In the formulation tried here this variable does not seem to be statistically significant, but the indeterminancy of the d^* statistic for the presence of serial autocorrelation may contribute to that appearance. The magnitude of the regression coefficient is certainly different from zero.

Again, the econometric models used in this study lend to empirical evidence to support what was thought to be the case in economic theory and in practice under the conditions prevailing in this industry in Greece. Thus, from policy point of view it is safe to conclude that the livestock numbers existing and fed in any year t, the last year's price of feed-grain and a subsidy variable are the most relevant variables in the feed-cattle economy influencing domestic production of feed-grain.

The weather variable and the time variable used as a substitute for the technological change taking place in the industry should increase $\bar{R}^2$. Such a model resulted in equation (6-17).

From the last equation fitted (6-17) it can be concluded that the previous models give rather satisfactory results since they explain almost 70-80 percent of the variation in the quantity of feed-grain domestically produced without taking into account any explicit consideration of the weather and the terminology. The weather variable, at least in a short-run context, undoubtedly plays an important role in the average yield per land unit of feed-grain and, hence, in the quantity of feed-grain produced.

Elasticities of Supply for Feed-Grain

It should have been noticed by now that the statistical estimates are rather satisfactory up to this point as far as both statistical and economic significance is concerned. With regards to the signs of the estimated parameters, economic theory helps to conclude what estimator carries a wrong or right sign. And, as far as size of the estimated coefficients of the parameters is concerned, due to the lack of a priori knowledge the results should be based on a) the degree of significance of the parameters, b) their consistency in the different formulations (equations) tried in cases where there was more than one alternative model and c) the findings in other studies both within the same country and/or abroad.

The calculation of different elasticities is of help to the interested researcher and to the policy maker. Thus, in Table 17 below these estimated elasticities are given.

Table 17 indicates that the parameter of the farm price of feed-grain lagged one year carries a wrong sign and that it is not statistically significant in the formulation which uses as a

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TABLE 17

ESTIMATED ELASTICITIES OF SUPPLY FOR FEED-GRAIN

Equation	Dependent Variable	Expanatory Variables			
		$NSTRFGPL_{t-1}$	$FPFG_{t-1}$	FPR_{t-1}	AUF
6-10	NSTRFGPL	+0.77	-0.08	-0.08	-
6-11	NSTRFGPL	+0.59	-0.04	-	+0.70
6-12	NSTRFGPL	+2.03	-0.000	-	-
6-13	$\bar{Y}FGS$	-	+1.24	-	-
6-14	FGS	-	+0.21	-	+0.76
6-15	FGS	-	+1.96	-	+0.78
6-16	FGS	-	+1.98	-	+0.85
6-17	FGS	-	+1.99	-	+0.85

dependent variable the number of land units planted with feed-grain. It is suspected that this non-significance is due to model specification. The elasticity of number of land units planted under feed-grain with respect to the farm price of feed-grain prevailing the previous year is very small. Indeed, the data reveal that there were no great differences in the number of acres planted from year to year. Instead, the increase in feed-grain production resulted from a more intensive farming method adopted by feed-grain farmers. Indeed, when this elasticity is calculated from equations which use as a dependent variable the quantity of feed-grain, it is higher, more plausible and more consistent. Generally, it can be observed that $E_{AP} < E_{OP}$, which verifies what was said about this relationship on p. 140.

This elasticity relationship can be viewed as an indication that the market prices serve as a stimulus in farmers' decision making behavior for them to produce a certain quantity of feed-grain on their farms. The same quantity, of course, can be produced not only by changing the number of acres (stremmas) planted with feed-grain, but also by changing the average yield of land under feed-grain. In some parts of Greece this last alternative is the only alternative open to farmers who are facing the severe land constraint problem.

The elasticity of both number of acres planted with feed-grain and quantity of feed-grain produced with respect to animal units fed seems to be consistent in both types of models. A positive sign and such a magnitude verify the fact that animals existing on farms need to be fed at a maintenance level regardless of economic justification.

It has been found elsewhere that for a dairy cow which yields 1000-1500 kg of milk per year the land which is required for development under barley-feed is 0.59 stremmas.[6] Since the average yield per milk over the sample period was 1,004 kg per year, the results found here seem plausible.

The price roughage elasticity seems very low and should be used with great caution.

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[6]Kitsopanidis, p. 8.

Empirical Estimation of Roughage Supply

Under the classification roughage the main fodder plants for hay are included. These plants are the following: barley, oats, vetch, peas, alfalfa, grass cut for hay, bitter vetch, vetchling (lathyrus), lentil, maize, sorghum and marigolds. As in the case of feed-grain, these fodder plants have been converted into Total Digestible Nutrient weight in order to arrive at a common denominator.

Hay and pasture production heavily depends on weather conditions during the critical sowing period and in the spring period when rainfall is rather a scarce good in Greece. The price and level of fertilizer used are among the variables which contribute to the explanation of the variation in roughage production. Soil conditions and types of soil are also contributory factors.

The same kind of supply functions as those used in deriving the supply functions for feed-grain was employed here.

From an economic point of view, variables expressing competitive products should be included as well in the formulation of the roughage model. Thus, wheat production should be among these competitive parameters since wheat production competes for the same resources as roughage production. A price ratio of wheat price to roughage price should have taken care of that problem, but this has not been tried in this thesis.

Furthermore, a problem is raised here as far as the model formulation is concerned when alfalfa is included in deriving the quantity of roughage produced. As it is known, alfalfa (and other perennial plants) is on the ground more than one year, and it is (usually) planted every five years. Thus, a time lag element enters into account when the number of acres (stremmas) planted under alfalfa is used as a dependent variable.

The area planted with alfalfa in year t is the result of decisions made in t-i time periods prior to t period. The t-i (i = 1,...,5) decisions refer to the prices of alfalfa held over these t-i periods or, better, over the t-5 period when the actual area of alfalfa was planted.

This time lag problem could have been overlooked, the results of the empirical analysis would have then been faulty. But through use of the parameter QRP_{t-1} the cumulative effect of the t-i time periods are hopefully captured. Equation (6-18) does not, of course, capture the whole cumulative influence on the number of acres planted under alfalfa in year t, but it does capture the change in the number of acres.

To explain the variation in the quantity of roughage produced, the following equations were tried:

$$NSTRRPL = 88.5619 + \underset{(.1178)}{0.9428}NSTRRPL_{t-1} + \underset{(86\ 426.8533)}{66\ 347.1417}FPR_{t-1}$$

$$- \underset{(66\ 589.0535)}{61\ 328.5113}FPFGP_{t-1} + \underset{(136.7057)}{38.1358}DV_p + \underset{(2.7604)}{2.2163}K$$

$$\bar{R}^2 = 0.92 \qquad d^* = 2.41 \qquad (6\text{-}18)$$

$$NSTRRPL = \underset{(1040.5214)}{-2458.0452} + \underset{(423.8201)}{1229.4023}FPR_{t-1} + \underset{(.2542)}{1.1434}NSTRRPL_{t-1}$$

$$\bar{R}^2 = 0.98 \qquad d^* = 2.89 \qquad (6\text{-}19)$$

$$\bar{Y}RSTR = \underset{(31.6997)}{242.4423} + \underset{(.0574)}{0.3470QRP} + \underset{(.5044)}{0.7057QFERT} + \underset{(6.4438)}{15.0297T}$$

$$\bar{R}^2 = 0.94 \qquad d^* = 1.62 \qquad (6\text{-}20)$$

$$QRS = \underset{(1279.2312)}{3335.4018} + \underset{(23971.0578)}{81895.3537FPR_{t-1}} - \underset{(6\,015.8899)}{35\,636.3260FPFERT}$$

$$- \underset{(124.1469)}{352.7713DV_r} - \underset{(2.13)}{2.3029K}$$

$$\bar{R}^2 = 0.88 \qquad d^* = 1.24 \qquad (6\text{-}21)$$

$$QRS = \underset{(402.6275)}{1201.4080} + \underset{(17\,133.9801)}{73\,520.1313FPR_{t-1}} + \underset{(.0928)}{0.8792QRS_{t-1}}$$

$$\bar{R}^2 = 0.98 \qquad d^* = 1.86 \qquad (6\text{-}22)$$

Equations (6-18) to (6-22) illustrates the models fitted to explain the variation in the quantity of roughage supplied in Greece. The first two models, (6-18) and (6-19) use the variable number of acres (stremmas) planted under roughage, while the equation (6-20) gives the average yield per acre (stremma). Finally, equations (6-21) and (6-22) use as their dependent variable the quantity of roughage produced. Thus, a comparison can be made again as to which method gives more satisfactory results. The first model uses many parameters which may contribute to an explanation of the variation in the number of acres planted under roughage in Greece.

The variable number of acres (stremmas) planted in t-1 year bears the right sign and seems to be statistically significant, and its estimated regression coefficient is rather fair. This variable picks up the habitual pattern of farmers who are involved in the roughage production business, and a coefficient of a magnitude of 0.94 means that this habitual pattern will be followed by the farmers in the future if other things do not change.

The own-product price, i.e., the farm price of roughage received by the farmers one year earlier, bears the right sign in both models and carries great economic significance, and statistical significance in the (6-19) model, though not in the (6-18) model. This has to do with model specification and the variables included in the model. In the (6-18) model the weather variable is included among the explanatory variables of the model and, along with the other two main variables, the farm price of a competitive product (such as feed-grain) and a subsidy variable (DV_r) given to the alfalfa growers during the period 1965-1972, picks up some percentage of the explanation of the variation in the dependent variable in that it may cause the variable farm price of roughage in t-1 year to behave differently in the two models in terms of its significance. But in both models this variable carries the right sign and fair economic significance.

The price of feed-grain in model (6-18) carries a right sign in the sense that as feed-grain becomes dearer, a greater number of acres of roughage is expected to be planted by the farmers. This parameter is not statistically significant in such a formulation, and the size of its estimated regression coefficient has been rather over-estimated.

The subsidy variable used in the form of a dummy variable carries a right sign in the sense that whenever the subsidy is given, farmers are expected to increase their area under roughage production, although the magnitude of the estimated regression coefficient is rather low and the parameter seems not to be statistically significant in this formulation. The insignificance of the subsidy variable indicates that since the demand for roughage is a derived demand, the final outcome on supply of roughage at its long-run equilibrium point should depend upon the price(s) of the livestock products produced, in the production of which roughage is used.

Model (6-19) uses the number of acres (stremmas) planted under roughage as a dependent variable which is explained in terms of the price of roughage prevailing and in terms of acres planted under roughage in t-1 year. There is, of course, a high degree of similar upward trend in the parameters used in this formulation, and the results should be used with great caution.

Both variables used in the (6-19) model carry a right positive sign and are statistically significant, and the magnitudes of their estimated coefficients carry a considerable economic weight. The corrected coefficient of multiple determination is high enough (0.98), but this is due greatly to high intercorrelation between the parameters $NSTRRPL_t$ and $NSTRRPL_{t-1}$ used in the model.

Equation (6-20) explains the variation in the average yield per acre (per stremma) of roughage production. The variable QRP, i.e., quantity of roughage produced in year t, is taken as a proxy variable for the weather parameter. The variable is closely correlated with the dependent variable which may contribute to the high value of $\bar{R}^2$ ($\bar{R}^2 = 0.94$). Thevariable quantity of roughage produced is positively related to the $\bar{Y}$RSTR variable which means that as the quantity of roughage produced increases, the average per acre (stremma) yield of roughage is also expected to increase, although this last increase is equal to 0.34 of the increase of the QRP. This positive relationship should be taken to mean that the aggregate increase in roughage production (in the future) - other things being constant - is expected to come not only from an intensive farming system of roughage production, but also from an increase in the number of acres (stremmas) devoted to roughage production.

Related to this problem of roughage production is the use of fertilizer and other technological improvements which are embodied in the time trend variable T which is included in the equation. The fertilizer parameter indeed contributes to the explanation of the variation in the average yield per acre (stremma) of roughage production. The fertilizer variable carries a positive sign which means that the higher the level of the quantity of fertilizer per acre (stremma) is, the higher the average yield of roughage is expected to be. In another formulation where the October-November rainfall was used the fertilizer variable either came out with a wrong sign or it was not statistically significant.

The time variable in the same model (6-20) appears to be statistically significant and carries a right sign, and its regression coefficient weight seems to be valid. From the data used it is revealed that, indeed, the average per acre (stremma) yield in roughage production almost doubled, but so did the number of acres (stremma) under roughage production. However, the total quantity of roughage produced during the sample period went up almost five times.

This fivefold increase in total production of roughage is in part due to more fertilizer used, more irrigated areas used, better quality of land and/or seeds used, etc., factors embodied in the parameter of technology T. The significance of the time variable further means that investment projects which are related to roughage production - even if they are small-scale in nature - have to seriously be considered and promoted all over the country.

The models (6-20) and (6-22) use as a dependent variable the quantity of roughage produced. Here, again, the farm price of roughage prevailing in t-1 year is positively related to the quantity of roughage produced, which means that the higher the price of roughage is, the more the quantity of roughage to be produced is expected to be. The price parameter is statistically significant, and the magnitude of its estimated regression coefficient seems to be valid. The significance of this parameter (both the economic and the statistical) does mean that farmers who grow roughage in Greece do respond to market price changes in Greece.

The fertilizer variable used in the form of the price of fertilizer appears to be statistically and economically significant, and it seems to carry a right sign. The magnitude of the estimated regression coefficient seems to be rather high, but, in general, due to the fact that the quantity of roughage production depends heavily on the level of fertilizer used, the empirical analysis apparently supports that a priori knowledge.

The dummy variable used to represent the subsidy variable, although statistically significant, carries a wrong sign which leads to some reservations as far as the model specification is concerned.

The weather variable appears not to be significant as it was used here (rainfall during October-November period). Rainfall plays a more important role for roughage production during spring and summer time.

Finally, the last model (6-22) uses lagged variables, and it appears to give significant results. But the problem of correlation has to be taken into account when this model is utilized. Both variables, the FPR_{t-1} and the QRS_{t-1}, are statistically significant, bear the right sign (being positively correlated to the QRS_t) and carry significant economic weight. The corrected coefficient of multiple regression, $\overline{R}^2 = 0.98$, is high enough, but it seems that the serial correlation problem contributes somewhat to that.

In closing this section it can be observed that, in general terms, the econometric models do contribute to quantifying the supply relationships in the supply schedule for roughage in Greece.

Elasticities of Supply for Roughage

Producers of roughage do not respond to price changes in an unknown mechanical (or imaginary) way. Prices play a central role in guiding production. This is not, of course, taken to mean that production decisions of farmers are governed solely by prices. Government programs, the limits set by climate and soil and the availability of equipment (capital in its broad sense) obviously exert a strong influence over what farmers plant each year. Since the Greek producer (farmer) is a profit maximizer, the view which is taken here is that prices, especially relative prices, influence his behavior.

Knowing the elasticities of supply - in a quantitative aspect - one has an idea of what to expect if certain parameters change while others are kept constant. Thus, with such a view the elasticities of supply for roughage can be calculated and are given below in Table 18.

TABLE 18

SUPPLY ELASTICITIES FOR ROUGHAGE

Equation	Dependent Variable	Independent Variables	
		FPR_{t-1}	$FPFGR_{t-1}$
6-18	NSTRRPL	+0.25	-0.48
6-19	NSTRRPL	+0.005	-
6-21	QRS	+0.31	-
6-22	QRS	+0.27	-

Table 18 above reveals that the supply elasticities of roughage calculated from the direct-approach based models is more consistent and greater than the elasticity calculated from models based on the models which take into account the indirect method, although in this particular case here one model (6-18) of the two that use the NSTRRPL as a dependent variable gave as high an elasticity as 0.25.

The supply elasticities of roughage and of feed-grain calculated from both models offer clear evidence that the elasticities which were calculated from models which used the quantity variable (as the dependent variable) rather than the number of acres (stremmas) planted variable are better than those coming from the second type of model, in the sense that they are more consistent and look more plausible.

Empirical Estimation of Beef Supply Response

In this section the results for beef supply which were obtained from the empirical analysis are presented. This empirical analysis seems to be of great significance to all segments involved in the production of livestock products, especially to the policy makers.

In the demand analysis it was shown that beef is considered price and an income elastic good in Greece. This should be taken to mean that expansion of beef production should be welcomed in Greece. Thus, from a farm policy point of view it should be very important to know the supply elasticity for this livestock product, given the fact that the encouragement of beef production in Greece is the main aim of Greece's farm policy.

It was asserted earlier in this thesis that Greek farmers are assumed to be profit maximizers. This is especially true for beef and veal producers who for the most part produce for the market despite their habitual inertia, the structural constraints and the economic uncertainty which prevailed over the sample period. Thus, the expected price seems to be the determining factor in guiding the risk taken in beef production.

Lack of more data constrained model specification, but in general terms both the "direct" and the "indirect" methods were used and distributed lags were tried to test the actual production process.

To explain the variation in the number of cattle going to slaughter and the quantity of beef supplied the following models were tried:

$$BCSL = \underset{(27.5236)}{26.3955} + \underset{(.1513)}{0.8999}BCSL_{t-1} + \underset{(.8051)}{0.2113}(FPB/FPFS)_{t-1}$$

$$\bar{R}^2 = 0.70 \qquad d^* = 1.95 \qquad (6\text{-}23)$$

$$\bar{Y}BC = \underset{(6.7350)}{69.9434} + \underset{(8.7328)}{16.98886}DV_b + \underset{(.5046)}{5.7429}T$$

$$\bar{R}^2 = 0.87 \qquad d^* = 1.01\ (za) \qquad (6\text{-}24)$$

$$QBS = \underset{(2.4252)}{14.8231} + \underset{5.6274}{12.7128}\left(\frac{FPB_{t-1} + FPB_{t-2}}{2}\right) + \underset{(.7922)}{2.4817}AUF_{t-1}$$

$$\bar{R}^2 = 0.96 \qquad d^* = 1.64 \qquad (6\text{-}25)$$

$$QBS = \underset{(6.3018)}{20.4089} + \underset{(.1412)}{1.1278}QBS_{t-1} - \underset{(.0215)}{0.3182}FPFS_{t-1}$$

$$\bar{R}^2 = 0.98 \qquad d^* = 1.67 \qquad (6\text{-}26)$$

The first of the above equations (6-23) deals with the number of cows slaughtered and the second one (6-24) with the average yield, in carcass weight, of beef per head of cattle. This break down was made because the key variables are both the number of beef cows on hand and the average yield per cow. This type of formulation, as in the case of feed-grain and roughage production, gives more insights and presents the whole set of variables which contribute to the explanation of beef supply.

Some equations expressing the direct method were also tried in order to obtain both models' reaction. Furthermore, Almon's distributed lags were tried in order to explain the variation in the number of beef cattle slaughtered over time. By using this last method a more dynamic picture of the beef production industry can be obtained, and it is hoped that this should contribute towards a better understanding of the beef production process and, hence, of the impacts of policy measures taken towards increasing beef production.

The introduction of the variable "cattle population" either as the number of beef cows slaughtered in t-1 year or as the number of cows milked and/or number of calves slaughtered in the prior year, seems to be verified by a priori knowledge that there exists a certain relationship between the quantity of beef meat produced and the number of animals existing on the farms or the number of animals slaughtered the previous year. This relationship can be disturbed at a certain point of time either by factors affecting the meat production directly, such as animal diseases and weather, or by factors which influence meat production through the price mechanism which affects production and number of animals existing by making or not making the business profitable.

The variables quantity of feedstuffs and price of feedstuffs were tried in a couple of alternative equations, but the results were rather poor. These two variables are related to each other, but they present different courses with regards to the number of animals slaughtered. The variable quantity of feedstuffs produced represents the existing conditions in the industry for feeding the existing cattle on farms, while the second variable, price of feedstuffs, indicates the cost side of the business. The cost structure of a firm or of an industry plays an important role in deciding that firm's or industry's competitive position, and, hence, that cost structure affects the producers' (farmers') decision making process.

A priori knowledge does not provide an idea as to what sign to expect for these two variables from the empirical analysis. At the beginning it seems rather obvious to expect a positive sign for the first variable, i.e., the quantity of feedstuffs, since as more feedstuffs are produced, more cattle are expected to be fed, and, hence, more cattle are expected to be slaughtered. On the other hand, a negative sign should be expected for the variable price of the feedstuffs since the dearer feedstuffs are, the lesser quantities of them will be demanded and fed to cattle, and, hence, the fewer cattle will be slaughtered.

However, the opposite could be expected as well, in the case where feedstuffs are scarce and their prices are high. In reference to Greece, it can be observed that it generally rains only in the winter months, from November to February, when low temperatures are unfavorable to the growth of grass. From May to September, on the other hand, there is little or no rain at all. This uneven distribution of rainfall is one of the main reasons for the premature slaughter of calves because of the inadequate summer fodder supplies and the price falls which occur in early summer when the farmers are obliged to sell.

Feed cost is considered as a variable cost and the equilibrium output of the industry in the short-run is based on this cost. This does not mean, of course, that the level of the fixed cost of the industry does not have any significance in the analysis of the short-run maximization of profits. Each firm, and, hence, the industry as a whole, faces discontinued production and a loss equal to its fixed cost. The firm or, for that matter, the industry, will produce at a loss in the short-run if its loss is less than the level of its fixed cost, i.e., if industry's (firm's) revenue exceeds total variable cost. The weighted prices of the last two years for beef were taken in the form of their simple average in one of the "direct" equations since it was believed that these prices are the most recent ones in farmers' memory when they compare the beef price at year t when they slaughter or sell beef cattle.

The variable animal units in t-1 period is, of course, related to the quantity of beef supplied at year t, but it is of great importance to know that the level of production of other meats plays a considerable role in the level of beef production. Thus, from a policy point of view the results here could be used as an indicator for the program of substitution of beef meat for other meats and, especially, poultry meat.

In general terms, models (6-23) to (6-26) satisfactorily explain the variation in the number of cattle slaughtered and/or average carcass yield per cattle head and/or the direct beef meat supply since over 79 percent of these three variations are explained by the corresponding models.

The parameter beef cattle slaughtered in t-1 year seems to contribute to the explanation of the variation of the cattle going to slaughter (slaughtered). Indeed, there is a direct relationship between the two variables since the number of beef going to slaughter this year was the same as that the year before, the only difference between the two variables being the calves left for fattening from t-1 year.

The lagged beef-feed price ratio seems to be positively related to $BCSL_t$, although it does not appear to be statistically significant, and its economic meaning is not important enough. The data reveal that the ratio was in favor of the beef producers since it was increased by almost 75 percent over the sample period. The fact that it is not statistically significant added to the fact that its economic weight is not great should be kept in mind when this model is used.

The explanatory power of the model is 70 percent and, considering the model's simplicity, that figure is considered to be high. Seventy percent of the variation in the number of cattle slaughtered is attributed to the parameters $BCSL_{t-1}$ and $(FPB/FPFS)_{t-1}$.

The model (6-24) explains the average yield in carcass beef produced by a cattle head. One of the two variables included in the model is a dummy variable (DV_b) used to take into account a subsidy given to beef producers to raise animals weighing more than 250 kg liveweight for the years 1963-1968. The variable seems to be almost statistically significant and carries a positive sign which means that the higher the subsidy is the higher the average weight of beef cattle is expected to become. Given the administrative difficulties involved in applying a subsidy scheme, it seems that when the subsidy is administered in a "good way," it does contribute to the increase of beef meat per animal head.

The second variable used in the (6-24) model is a time variable which picks up the improvements which had taken place in the national herd. Indeed, the major developments in the cattle herd were:

(a) increased calf drop percentage, (b) decreased death losses, (c) improvements in the quality aspects of the national herd by adoption of the artificial insemination technique and (d) increased number of cattle fed in barns in a more intensive way. All these developments resulted in an increase in the average per animal dressed weight of beef production in Greece.

Indeed, the time variable appears to be statistically significant and carries a positive regression coefficient which means that the more improvements adopted for use by the farmers, the greater the average meat yield per animal is expected to be; this is verified by the data observed over the time span examined here. The economic significance of the time variable is high enough since for one unit of change in the time variable, there are almost six units of change in the dependent variable $\hat{Y}BC$.

Models (6-23) and (6-24) combined explain the variation in the supply of beef and illustrate in a more analytical way the parameters which influence beef meat production in Greece.

Models (6-25) and (6-26) explain the variation of the quantity of beef produced in terms of: (a) the farm prices of beef received by farmers in the last two years (these prices are weighted prices and a simple arithmetic average mean of these two prices has been used here), (b) the number of animal units fed on farms in t-1 year, (c) the quantity of beef produced in t-1 year and (d) the farm price of feedstuffs in t-1 year. The two models reveal high corrected multiple regression coefficients ($\bar{R}^2$) and parameters which are all statistically significant, carry a right sign and bear significant economic meaning.

The size of the herd seems to have quite a considerable role to play in specifying the amount of beef produced. In addition, feed cost and product prices do play a serious role in beef production for reasons explained above in this section.

Beef producers produce particularly for the market and are more sensitive to changes in price of input and price of product taking place in the market. The most serious expense in the short-run span for beef producers is feed expenses, and the producers reaction is precipitated by changes in feed cost. From the other side the change in product prices (Farm Price of Beef) is the only price which dictates slaughtering behavior.

A general observation verified by the empirical analysis is that the higher the product prices, the higher the production of beef will be, and the higher the price of feedstuffs, the lesser the quantity of beef will be produced by the farmers.

Studies in other countries have shown that beef cow operations are a low profit business and can be viable in places where there is a large amount of underutilized roughage which can be used by beef cows at a very low cost. Trimble[7] talks about the unprofitability of an investment in a beef cow in the United States when both fixed and variable costs are included, and he recognizes that costs are involved in input and product markets. A substantial change in the price of both of them has a great impact on farmers' expectations and, hence, on their

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[7] Richard L. Trimble: "An Economic Analysis of the Effect of Monetary Policy on the Beef Industry," Ph.D. Dissertation, Michigan State University, East Lansing, Michigan, 1973.

decision making process regarding investment. The costs may be due to:

a) biological uncertainties which refer to physical and/or biological aspects of production that affect costs and investments;

b) unforseen uncertainties related to unexpected diseases, droughts, floods, etc., and finally,

c) uncertainties related to the whole economic environment of a country and/or international trade -- in the case of an open economy like that of Greece's. Such uncertainties may be the inflation rate, the rate of unemployment, the monetary and/or fiscal policy of the government, the level of interest rate, etc., all of which make the cattle feeding business an unusually high-risk enterprise which may partly explain why Greek farmers have not invested enough money in it.

Farmers look at two things: The first is a "feeding margin" defined to be the difference between the feed cost per kilogram gained and the price received from the grain fed to the cattle. This margin does not involve the land and other fixed factors used to support the cow. The most relevant decision made by farmers seems to be the addition of a cow to an existing family herd, or the substitution of a beef cow herd for an enterprise that uses the same fixed resources. Trimble's data point out that investment in a beef cow will generate revenue sufficient to cover all fixed and variable costs and provide a return on invested capital equal to the firm's cost of capital only if relatively high calf prices and low cost of capital exist.

The second thing examined by farmers is a "price margin" which is defined to be the difference between purchase cost and selling prices per hundred weight or per animal unit in case of live animal transactions. A decrease in market price which cannot be predicted in advance by farmers can be disastrous for those who buy improved type of cattle and then must bear the burden of a negative price margin.

To make things clear two points need elaboration here. First, a negative price margin does not necessarily indicate a loss, as it may be more than compensated for if liveweight gains are a high proportion of final sale weight and the feeding margin is favorable. Second, positive price margins may not mean that the farmer makes a profit if they are offset by a poor feeding margin. However, neither of these margins reflects investment costs (which also affect net returns of cattle feeding) since the Greek farmer does not keep very good records and accounts.

Price Elasticities of Beef

Beef-feed price coefficients in the lagged formulation of the models appear to be positive, while feed cost coefficients in these equations appear to be negative.

Supply response analysis is particularly needed currently in Greece because of the severe problems which production of meat continues to face in adjusting supplies to market demands and in substituting foreign imported meats for domestic ones. In addition, the balance of payments problem which Greece is facing dictates possession of such knowledge. Furthermore, such an analysis will give some positive direction to and shed some light on the confusion existing today in Greece with respect to the causes of these difficulties.

Supply elasticities presented in Table 19 below were found to be positive for the beef-feed price and negative for the feed cost parameter. In the (6-23) model, for lack of a better indicator, the

TABLE 19

PRICE ELASTICITIES OF BEEF

Equation	Dependent Variable	Independent Variables		
		$(FPB/FPFS)_{t-1}$	$(FPB_{t-1}+FPB_{t-2})/2$	$FPFS_{t-1}$
6-23	BCSL	+0.02	-	-
6-24	QBS	-	+0.48	-
6-25	QBS	-	-	-0.62

production response is presented by the number of beef cattle slaughtered. It seems that, although the sign is according to what was expected from economic theory, the size of the elasticity seems to be rather low since, for a 1 percent change in the beef-feed ratio there is a 0.02 percent change in the number of beef cattle going to slaughter.

The low short run supply elasticity of beef cattle slaughtered with respect to beef-feed price ratio in the previous year may have to do with decisions made in more than one period and with expectations concerning present price that were formed during several previous years.

The response of beef production to price changes in beef taken as a simple arithmetic average of t-1 and t-2 prices of beef was found to be equal to +0.48. This means that 48 percent of the quantity of beef supply response is positively associated with the average weighted prices received by farmers in the last two years.

A -0.62 feed cost elasticity of beef supply was found here and calculated from model (6-25). This is taken to mean that for a 100 percent change in the feed cost upwards a 62 percent downward response should be expected in the production of beef. The rest of the supply response seems that it is contributed over to other time periods.

Reuttinger observes that "most agricultural economists who have their hands into estimating beef supply functions have observed zero or negative elasticities of beef output with respect to beef price (and similarly, zero or positive elasticity of beef output with respect to feed price."[8] He presents supporting empirical evidence that this is due to two reasons. First, cows and heifers have a dual function in that they can be slaughtered to produce meat or they can be retained to build up inventories. Second, there is an aggregation error because the components of beef supply, which are steers, cows and heifers, are not examined separately. It seems that each component has its own supply response. It is thus observed here that past prices do have to contribute to the formulation of price supply response in farmers' behavior as far as both the number of cattle to slaughter and/or to produce beef is concerned.

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[8]S. Reuttinger, "Short-Run Beef Supply Response," American Journal of Agricultural Economics 48 (November 1966): p. 909.

The low product price elasticity of supply (+0.48) provides evidence that beef production in Greece has to overcome some "technical problems" (structural and/or better improved animals to be used) if it is to compete with other industries within the country. The fact that the price elasticity of supply of beef with respect to farm price of feedstuffs was found to be greater than the own-price elasticity of supply should probably be taken to mean that the supply of feedstuffs is the most crucial parameter in determining beef supply (production) in Greece. This is related to the above mentioned problems of structure of the beef industry in Greece and to technological developments taking place within the industry as well.

Empirical Estimation of Veal Supply Response

As in the case of beef, the supply of veal is analyzed here in terms of two equations. The first equation examines the factors affecting the number of veal calves slaughtered, and the second equation considers the factors that mainly influence the average carcass yield of finished veal per calf.

Veal Calves Slaughtered ($VCSL_t$) Equation

Each of the meat animal species has a somewhat different supply elasticity. In the case of veal, it seems that the number of cows milked on farms on December 31 (in year t-1) and the veal-feed price ratio in year t-1 mostly affect farmers' decision to slaughter their calves.

Veal calves slaughtered includes slaughtering of calves born and raised on farms and slaughtering of calves which have been imported into the country, fed for a period of time and then slaughtered. Veal, as distinct from beef, is produced from calves up to 24 months of age and younger.

Male and female veal calves tended to be marketed in a rather stable fashion over the sample period in Greece, although some differences were noticed during the period's last years. Veal production was a complementary farm activity to the whole farm business, a fact which complicates the decision-making process of Greek farmers.

In the short-run, veal producers may speed up or hold off the slaughtering of veal-calves in response to changes in prices of veal and/or beef. In the longer run period of time, changes in veal production may also occur as a result of variation in price ratios. In an annual marketing period, however, it is not obvious that significant response in marketings of veal can be produced. Hence, the specification of the equations which follow is influenced by these considerations.

Veal Calves Slaughtered

$$VCSL_t = \underset{(65.644)}{-136.7922} + \underset{(.204)}{0.8916}NCM_{t-1} + \underset{(.286)}{0.6497}(FPV/FPFG)_{t-1}$$

$$\bar{R}^2 = 0.87 \qquad d^* = 1.89 \qquad (6\text{-}27)$$

Dressed Carcass Weight per Calf

$$\bar{Y}VC_t = \underset{(7.785)}{25.3818} + \underset{(10.771)}{43.3569}DVa + \underset{(.864)}{5.9330}\ T$$

$$\bar{R}^2 = 0.97 \qquad d^* = 1.78 \qquad (6\text{-}28)$$

Supply of Finished Veal

$$QVS_t = \underset{(5.179)}{15.2263} + \underset{(1.742)}{0.7537}QVS_{t-1} - \underset{(.179)}{0.6824}FPFS_{t-1}$$

$$\bar{R}^2 = 0.96 \qquad d^* = 1.87 \qquad (6\text{-}29)$$

The results for the veal supply-submodel, in general, were satisfactory for all equations as measured by significant regression coefficients, high coefficients of determination and consistent signs of various parameters. None of the equations in final form showed a clear presence of serial correlation.

The slaughter function was estimated as a relatively simple relationship. It incorporates cows milked - excluding calves - on farms on December 31, in year t-1, and the veal-feed price ratio. The former variable was highly significant statistically, positively correlated with the $VCSL_t$ and had a sign expected from a priori knowledge. The existence of high inventories of animals in preceding time periods had a positive effect on slaughtered number of calves in the current time period.

The veal-feed price ratio yielded a positive coefficient of +0.65, indicating that farmers positively respond to any veal-feed price ratio. In other words, whenever veal prices increased by 1 unit, veal cows going to slaughter tended to increase by 0.65 unit.

The weight to which veal calves were fed before slaughter was highly determined by factors such as the quality improvement of the national herd - embodied in the time variable employed - and a subsidy program variable which subsidized farmers who grew feedstuffs on their farms to feed veal calves. Both of these variables yielded significant regression coefficients, consistent signs for their parameters and a high degree of determination.

The model giving the supply of finished veal was estimated as a rather simple relationship of the quantity of finished veal in the preceding year and the cost of feeding the calves in the preceding year. The former variable was assumed to represent the habitual elements of practices by farmers who were engaged in veal production. The latter variable represented the cost structure and position of the veal production industry. Both variables yielded statistically significant results with consistent signs and significant economic weights.

Price Elasticities for Veal

Estimated supply elasticities with respect to both various price variables and non-price variables are outlined in Table 20. Supply response appeared to be rather inelastic at the two levels at which it was measured, namely, inspected slaughter and at the finished (market) level. A 1 percent change in veal-feed price ratio was associated with only +0.03 percent change in the number of veal cows slaughtered, and a 1 percent change in the price of feedstuffs was associated with only -0.65 percent change in the quantity of finished veal supplied (see Table 20).

TABLE 20

PRICE AND OTHER ELASTICITIES OF VEAL

Equation	Dependent Variable	Explanatory Variables			
		NCM_{t-1}	$(\frac{FPV}{FPFG})_{t-1}$	QVS_{t-1}	$FPFS_{t-1}$
6-27	$VCSL_t$	+0.87	+0.03	-	-
6-29	QVS_t	-	-	+0.68	-0.65

Empirical Estimation of Milk Supply

The same procedure for beef and veal production was followed here for milk production. Total supply was disaggregated first in the two familiar components, i.e., the number of cows milked and the average fluid milk per cow.

Wilson and Thomson[15] found that the supply of milk was largely predetermined with respect to the price of milk in year t and was more elastic, but still inelastic, with respect to the average price of milk in years t-1, t-2 and t-3. Rojko,[16] on the other hand, implicitly assumes that annual milk supplies are predetermined. The equations fitted are as follows:

Number of Cows Milked

$$NCM_t = \underset{(104.104)}{-27.1957} + \underset{(.1049)}{0.9627} NCM_{t-1} + \underset{(3039.587)}{2155.5521} FPMK_{t-1}$$

$$\bar{R}^2 = 0.96 \qquad (6\text{-}30)$$

$$NCM_t = \underset{(33.065)}{72.01664} + \underset{(.177)}{0.7057} NCM_{t-1} + \underset{(.856)}{1.0094} QMC_t$$

$$\bar{R}^2 = 0.92 \qquad d^* = 1.17(i) \qquad (6\text{-}31)$$

Average Fluid Milk per Cow

$$\bar{Y}MC_t = \underset{(6.662)}{25.050} + \underset{(10.112)}{43.1020}\ DV_r + \underset{(.767)}{5.9647}\ T$$

$$\bar{R}^2 = 0.95 \qquad d^* = 1.78 \qquad (6\text{-}32)$$

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[15] R. Wilson and R.G. Thomson, "Demand, Supply, and Price Relationships for the Dairy Sector, Post-World War II Period," Journal of Farm Economics (May 1967): 360-371.

[16] A.S. Rojko, The Demand and Price Structure for Dairy Products, USDA Technical Bulletin 1168, 1957.

Total Supply of Milk

$$QMKS_t = \underset{(7.834)}{35.5269} + \underset{(.197)}{0.6348}\, QMKS_{t-1} - \underset{(.0327)}{12\,968.879}\, FPFS_{t-1}$$

$$\bar{R}^2 = 0.98 \qquad d^* = 1.94 \qquad (6\text{-}33)$$

The results for the milk submodel, in general, were satisfactory for all equations as measured by significant regression coefficients, high coefficients of determination and consistent signs for most of the parameters. None of the equations showed a clear presence of serial correlation, except the two first equations for NCM_t which gave a d^* value very close to the upper limit of the d values of the tables.

The inventory variable, the number of cows milked in the preceding year (NCM_{t-1}), plays a crucial role in explaining the variation in the number of cows milked in the current year. The own-price of milk in the preceding year was not, strictly speaking, statistically significant, but the weight of its parameter was considerable. This seems to be in accord with what Wilson and Thomson found, results which were stated in the beginning of this section. In a second formulation to explaining the variation in the NCM_t variable the per capita quantity of milk consumed was used, but the results did not change considerably. $\bar{R}^2$ was reduced by 0.04 units, and the d^* statistic gave the same result about the presence of serial correlation.

Average yield of milk per cow was well explained in a rather simple model by using a time variable to represent all the "technological" developments in the dairy industry, and a subsidy variable given to farmers who grew roughage on their farms for feeding their own milk cows.

The total supply of milk model utilized the quantity of milk supplied in the preceding year (t-1) and the price of feedstuffs. The first variable, the $QMKS_{t-1}$, gives the situation existing in the dairy industry in terms of the quantity of milk produced which takes into account every kind of improvement adopted by the dairy industry that resulted in an increase in the quantity of milk. The second variable, $FPFS_{t-1}$, gives the cost structure of the dairy industry.

In Table 21 estimated elasticities are given. A direct elasticity of +0.12 was estimated which indicates that a 1 percent increase in farm price of milk would increase the number of cows milked by approximately 0.12 percent. The elasticity with respect to the milked cows inventory was, as expected, high at the level of +0.94. The elasticity with respect to per capita quantity of milk consumed was estimated to be +0.12, thus giving the same value as the first model.

The elasticities of total quantity of milk supplied with respect to quantity of milk supplied in the preceding year and the farm price of feedstuffs were equal to +0.03 and -0.31, respectively. These elasticities mean that for a 1 percent increase in the quantity of milk supplied in the preceding year an increase of +0.63 percent in the quantity supplied in the current year is expected. In other words, whatever improvements took place in the dairy industry in preceding years are expected to exert a positive influence on the quantity of milk supplied this year.

The supply elasticity of total quantity of fluid milk from cow with respect to farm price of feed-grain supplies was found to be -0.31 which means that a 1 percent increase in the price of feedstuffs was associated with a -0.31 percent increase in quantity of milk supplied.

TABLE 21

MILK SUPPLY ELASTICITIES

Equation	Dependent Variable	Explanatory Variables				
		NCM_{t-1}	$FPMK_{t-1}$	QMC_t	$QMKS_{t-1}$	$FPFS_{t-1}$
6-30	NCM_t	+0.94	+0.12	-	-	-
6-31	NCM_t	+0.69	-	+0.12	-	-
6-33	$QMKS_t$	-	-	-	+0.63	-0.31

Time Lag Consideration

General Discussion

In economics, as in other studies of human behavior, it is sometimes necessary to take into account the fact that what happens today largely depends on what happened yesterday. Thus, for a particular period the quantity of beef produced in Greece by Greek beef producers (farmers) is determined partly by farm prices and incomes (personal disposable income) in the current period and partly by the number of total cows which existed and/or farm prices of beef which prevailed in previous years. Even the consumption demand for beef may be partially determined by patterns of consumption in the previous periods. Indeed, this relationship between past and present forms the basis for what is called the "habit formation" hypothesis on consumption, or Duesenberry's second hypothesis, which states that "present consumption is not influenced merely by present levels of absolute and relative income, but also by levels of consumption attained in previous periods."[9]

When these relationships between present and past values of economic variables are expressed as the estimating equations for econometric research, the observations that appear in the equations will include both current values and values for one or more previous periods. The latter values are described as lagged values of the variables. A model in which lagged values of the dependent variable appear as regressors is termed an autoregressive model. And a model in which a dependent variable is explained by the current value and a series of past values of an independent variable is also essentially an autoregressive model. But this treatment of economic variables means that the relaxation of static assumptions (relaxation of the static theory) is introduced and consideration of dynamic analysis is brought in. To study supply adjustments through time, however, the factors affecting both the speed and magnitude of the adjustment process are considered in a dynamic analysis.

In agricultural supply response analysis the reaction to a change in a causal factor is speed over a number of time periods. Thus, time is introduced explicitly in several ways. The lapse of time between cause and effect is referred to as a lag and may be of fixed duration or distributed equally or unequally over time.

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[9]H.W. Branson, Macroeconomic Theory and Policy. (New York: Harper and Row Publishers, 1972), p. 188.

Nerlove (1956) seems to believe that research on changes in agricultural supply aims at understanding the mechanism of supply response, the ability to forecast supply changes and, finally, the competence to prescribe solutions to problems related to agricultural supply. But in the same paper Nerlove stresses that "farmers react, not to last year's price, but rather to the price they expect, and this expected price depends only to a limited extent on what last year's price was."[10] It seems, then, that although price plays a key role in the farmer's decision making process, other factors apparently play an important role, too.

Among such other factors, in the case of a country like Greece, especially in the early years of the sample period, farmers have been concerned mainly with labor's employment problem, their aim being how to maximize employment. That explains why Greek farmers have stayed in the tobacco business, a labor intensive enterprise, although tobacco prices have remained low for a long time, and why, when employment opportunities abroad become available, through better information and government encouragement, farmers migrated in mass numbers, Hirschman's[11] "Exit" took place. But, again, according to Nerlove[10]

> ...it seems reasonable to assume that the price expected to prevail at some future date depends in some way on what prices have been in the past. Price expectations are, of course, shaped by a multitude

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[10] M. Nerlove, "Estimates of the Elasticities of Supply of Selected Agricultural Commodities," <u>J.F.E</u>. 28 (1956): 496-509.

[11] O.A. Hirschman, Exit, Voice and Loyalty (Boston: Harvard University Press, 1970).

> of influences, so that a presentation of expected price as a function of past price may merely be a convenient way to summarize the effects of these many and diverse influences.

Koyck[12] (1954) and Nerlove (1958)[13] have accepted three general reasons for the existence of distributed lags: (a) technological reasons, (b) institutional reasons, and (c) subjective or psychological reasons. The technological reasons refer to the very realistic fact that production of any physical good requires time. For example, beef production requires two years or more in time and within this time framework it is natural that many delays occur. Delays could occur, for example, in the gestation period, in feeding, and in maintenance biological requirements. Slaughter and processing delays also exist from the time the decision is made to produce the final product. Institutional reasons refer to such a relationship as that existing between income and taxes to be paid, customs put on imported products, etc., which serve as an economic stimulus. But farmers seem to be unable to react immediately to their production plans within the short-run time span when prices change; the result of this kind of delayed reaction is that supply response function becomes irreversible.

The third reason for the existence of distributed lags is subjective or psychological. This category includes a person, a

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[12] M.L. Koyck, Distributed Lags and Investment Analysis (Amsterdam: North Holland Publishing Company, 1954).

[13] M. Nerlove, The Dynamics of Supply: Estimation of Farmer's Response to Price (Baltimore: John Hopkins University Press, 1958).

business enterprise, or another economic subject and describes their reaction in relation to the given circumstances. The attempt, for example, to maximize a utility function and/or profit, given the economic and organizational constraints facing a farmer, will result in certain behavioral pattern(s) on the part of the farmer. The view of a price change as a temporary or a permanent change by a farmer constitutes another example in that his perception has a decisive effect upon his farm management decisions.

J. Trapp (1976) writes that each force dictates its own formulation of a distributed lag relation. And he clearly states that "the econometric techniques developed to estimate lagged output response over time do not distinguish between these three forces. The distributed lag structure estimated is an aggregate measure incapable of determining the precise causes of the lagged response."[14]

Distributed Lag Models

A particular autoregressive model used in econometrics is what is called the distributed lag model. Supply response for cattle and/or calves as a tool in studying livestock-feed-grain economy has been expressed by various techniques and/or models. Kulshreshtha (1975)[15] states that "two types of problems were encountered; either (1) the signs of the price variables were inconsistent, or (2) the sign was

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[14] James Trapp, "An Econometric Simulation Model of the United States Agricultural Sector" (Ph.D. Dissertation, M.S.U., 1976), p. 64.

[15] N.S. Kulshreshtha, "Canadian Cattle and Calves Industry: A Distributed Lag Analysis," Dept. of Ag. Econ., Univ. of Saskatchewan, Saskatoon, Canada, March 1975, p. 2.

consistent, but the level of significance was very low." He then suggests that one could hypothesize that these problems may arise due to time involved in the production process which may imply model misspecification. And, if that is the problem, then the researcher could identify the appropriate time lag and estimate the response. Although the problem seems simple at first glance, difficulties are encountered since "the lag between supply and price involves two separate lags: 1) between a change in actual price and expected price and (2) between expected price and the adjustment to this expected price. The response to an actual price change, then, involves an expectation lag and an adjustment lag, and may be considered as a function of time."[16]

The pioneer work in this field has been done by Fisher (1937),[17] Alt (1953)[18] and Hicks (1953). Hicks believes that if past prices are completely dominant then price-expectations can be treated as data, too, along with past prices which are considered simply as data with respect to the current situation. The change in the current price is taken as temporary and does not influence price-expectations. But from the moment when past prices stop being completely dominant then some influence of current prices on expectations must be allowed.

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[16]J.N. Ferris, "Dynamics of the Hog Market with Emphasis on Distributed Lags in Supply Response" (Ph.D. Thesis, M.S.U., 1960), p. 27.

[17]Irving Fisher, "Note on a Short Cut Method for Calculating Distributed Lags," Bulletin de L'Institut International de Statistique, Vol. 29 (La Haye, 1937).

[18]L.F. Alt, "Distributed Lags," Econometrica 10 (1942): 113-128. R.J. Hicks, Value and Capital, Second Edition (Oxford: Oxford University Press, 1953), pp. 204-205.

Hicks goes on and defines the elasticity of expectations by referring to a particular person's expectations of the price of a commodity as the ratio of the proportional rise in expected future prices of that commodity to the proportional rise in its current price. The elasticity of a person's price expectation takes the value 0 for the case of the given expectations and otherwise the value 1, which means that a change in current prices will change expected prices in the same direction and in the same proportion.

An intermediate case of an elasticity of expectations less than 1 and greater than 0 is also recognized by Hicks. The elasticity of expectations is greater than unity when a change in current prices makes people feel that they perceive the change as a permanent one and thus expand their production. On the contrary, the elasticity of expectations will be negative if people perceive the price change as a permanent one and thus decrease their production.

Fitting the Polynomial Lag Model

The general form of an econometric distributed lag model is written as follows:

$$Q_t = \alpha + \beta_1 P_1 + \beta_2 P_{t-1} + \beta_3 P_{t-2} + \ldots + \beta_n P_{t-\ell} + \varepsilon_t \qquad (6\text{-}27)$$

where: Q_t: quantity supplied in the period t

P_t, P_{t-n}: price per unit of supply in period t and/or in period t-n

ℓ: time lag of a finite value

$\alpha, \beta_1, \beta_2, \ldots, \beta_n$: parameters of the supply function, which here take the name of reaction coefficients

ε_t: disturbance term of the equation.

The regression equation (6-27) is called a distributed lag model because the influence of the explanatory variable P on $E(Q_t)$ is distributed over a number of lagged values of P which are taken over the periods ℓ. This number of periods, the number ℓ, can be either finite or infinite. The assumptions concerning the behavior of the variable P and the disturbance term ε_t hold. In order to avoid explosive values of E(Q), it is assumed that the βs have a finite sum, i.e.,

$$\sum_{i=0}^{n} \beta_i < \infty$$

The average lag is defined as the weighted average of all the lags involved, with weights being the relative size of the respective β coefficients.

$$\text{Average lag} = \frac{\sum_{i=0}^{n} i\beta_i}{\sum_{i=0}^{n} \beta_i} \quad \text{for} \quad i = 0 \text{ to } i = n \, .$$

Theoretically, the above model can be estimated by the least squares method or by some other method which leads to estimates with some desirable properties under the usual assumptions about the disturbance term ε_t. In practice, several difficulties are likely to arise:

(a) Theory does not generally indicate the length of the run, and, if ℓ is large, we may not have enough observations to estimate all the parameters.* Because of this difficulty the statistical

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*This is a problem of degrees of freedom.

significance of the βs are analyzed in order to find out where to stop adding lagged variables.

(b) But, even if we have enough degrees of freedom (enough observations), the lagged values of the Ps are likely to be highly correlated from period to period, thus leading to a high degree of multicollinearity which affects the standard errors of the estimated coefficients.

These difficulties have, in practice, led to the imposition of a priori restrictions on both the number of the regression parameters and the form of the reaction coefficient patterns. The restrictions reduce the number of parameters, thus saving degrees of freedom and eliminating the need for a number of highly correlated independent variables. In practice, these restrictions have been of two kinds - "one resulting from the requirements that the βs should be declining in a geometric progression, and the other from the requirement that the βs should first be increasing and then decreasing."[19]

The most frequently used assumption about the nature of lag structure is that it should decline in a geometric progression. The geometric lag specification is expressed by two models, the "adaptive expectation model" and the "partial adjustment" or "habit persistent model". The difference between these two models relies upon the different set of assumptions each one makes about the behavior of the

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[19] Jan Kmenta, Elements of Econometrics (New York: The Macmillan Company, 1971), pp. 473-474.

disturbance term of the regression equation by which each one of them is expressed.

The above specification in the form of the two models has the advantage that the estimation of the regression parameters is easy, but the problem of serial correlation still remains. The serial correlation biases the parameter estimates if such a correlation exists in the regression equation. Lagged variables, it is repeated here, are one way of taking into account the length of time in the adjustment process of economic behavior and perhaps the most efficient way for rendering them dynamic. This is why they have become increasingly popular in applied econometric research.

J. Johnston seems to prefer the simple polynomial procedure, while Dhrymes[20] prefers Almon's technique since it is easier to incorporate zero restrictions on the lag coefficients.

Degree of the Polynomial and Length of Runs

If Almon's technique is accepted, it is easy to obtain estimators for the n parameters, $b_0,\ldots,b_n$, by simply obtaining estimators for the three parameters a_0,a_1, and a_2. It can further be shown that, in cases where there are more bs than as, the estimators of the bs obtained by using Almon's technique have smaller variances than the direct estimators of the bs that would be obtained by applying the multiple regression technique directly.[21] Generalizations

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[20]Phoebus Dhrymes, Distributed Lags. Problems of Estimation and Formulation (San Francisco: Holden Day, Inc., 1971).

[21]E.E. Kelejian and W.E. Oates. Introduction to Econometrics. Principles and Applications (New York: Harper and Row, Publishers, 1974).

and variations of this technique are easily applicable. For example, inclusion of additional variables in no way affects the analysis. Furthermore, in practice, Almon's technique is applied to each of the several lagged independent variables in the same equation.

A priori knowledge of theory and of the industry might dictate that either or both b_o or b_n equals zero. One way to incorporate such knowledge into the model is by simply dropping FPB_t and/or FPB_{t-n} from the basic model and proceeding as before. In practice, the information that either $b_o = 0$ and/or $b_n = 0$, or both, is transformed, by using the basic assumptions, into one or more restrictions on the as and then the resulting equation is estimated.

A second way to incorporate a priori knowledge in Almon's method is for the researcher to know both the length of the lag structure and the degree of polynomial which gives the general pattern of bs. But, in reality, none of them is known. To overcome that obstacle the researcher usually chooses a degree for the polynomial, (for instance, D) that is high enough to include any reasonable pattern of the bs. In most cases a third or fourth degree polynomial is sufficient to deal with the data at hand.

To test for the curve (which the data form gives), a flexibility to the data is usually given in such a way as to fit the best curve with no restriction on the data. This is done by not specifying any restriction on the bs so that no a priori curve is accepted. By doing this, the researcher has the advantage of not being restricted on the kind of curve he has to choose from in advance since, if a wrong one happens to be selected, there is always a way to check for it before he is making his final decision.

Suppose, now, that the reasonable lag which is believed to be consistent with the relationship at hand is L^*. Once D and L^* have been selected, estimation of the relationship under consideration for $L = D, D+1, \ldots, L^*$ is possible. The assumption made here is that lags ($L \geq D$) are usually chosen on the basis that they are greater than or equal to the degree of the polynomial (D), since it is assumed that the length of the lag, L, is at least as long as the degree of the polynomial, D. This means that there are as many bs as there are as, since, if $L < D$, then the number of independent variables has to increase; but the purpose of adopting Almon's technique is to estimate the number of parameters in the model.

Another point is worth mentioning here. If the various equations fitted are to be compared using the highest value of $\bar{R}^2$, i.e., the coefficient of determination corrected for the number of degrees of freedom, then all the regression equations corresponding to the values of L should be estimated with the same data. This, in other words, means that the first L^* observations are lost and only the remaining $T-K^*$ observations are used (T denotes the number of observations used in the sample). That value of L is used with maximizes the $\bar{R}^2$, and/or minimizes the standard error of estimate.

Recent examinations of polynomial lag models have indicated that statistical criteria for selecting the polynomial degree and lag length which will lead to unbiased distributed lag estimates are presently not available.[22] Due to this lack of information the

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[22]P. Frost, "Some Properties of the Almon Lag Technique when One Searches for Degree of Polynomial and Lag," Journal of the American Statistical Association 70 (1975): 606-612.

approach taken in this study was to select the degree and length of the polynomial lag according to the knowledge of beef and milk industries in Greece as opposed to using statistical criteria. Furthermore, constraints were used which require the distributed lag pattern to pass through zero in the second and last period of lag. These two zero constraints are based on the argument that no significant simultaneous or single period response in output generally occurs in livestock production, and, hence, after a given time period, a given incentive no longer affects production. Moreover, a number of non-restricted curves has been tried in this thesis to see if the best (curves) polynomials fitted to the data are the appropriate ones.

Polynomial lag models were tried here since an inverted V'-lag model capable of generating lag structure was desired. The rationale of an inverted-V'-lag structure for livestock supply response is discussed by J. Trapp.[23]

Some Decision Criteria

Fitting polynomial lags may involve making some arbitrary decisions, and to deal with such a problem some guidelines were borrowed from economic theory and judgement.

Economic Theory

Economic theory suggests that the effect of one variable upon another will be in the same direction over time. For example,

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[23] N.J. Trapp, "A Polynomial Distributed Lag Model of Pork Production Response," Dept. of Ag. Econ. Staff Paper No. 75-29 (East Lansing: Michigan State University, 1975).

theory specifies that price has only a positive influence on supply over a period of time. This, translated in the results obtained from the empirical analysis results, means that the estimated coefficients should all have the same signs. But this is not the case in practice. Price increases exert a different influence on supply than price decreases.

Judgment

When the lag distribution estimated from period 0 to period L has a coefficient similar to that of the last variable, the lag length is increased. On the contrary, when the lag distribution has a coefficient with a different sign than its last variable, then the lag length is decreased.

If estimated coefficients obtained from the empirical analysis are statistically significant, this is taken as an indication that this procedure is correct. If, on the other hand, estimated coefficients are not statistically significant, then the procedure is justified on the grounds that the variables included can be considered logical, since the lack of statistical significance may be due to high intercorrelation between two variables or a linear combination of variables in the particular sample of data on which the estimates are based. The technique cannot clearly distinguish the separate effects of the variables, given the available data.

Selecting the Polynomial Lag Model

In selection of the polynomial lag model, the following procedure was used. First, an arbitrary degree of polynomial was chosen which had to account for the peculiarities of the data at hand. Then, for this arbitrarily chosen degree of polynomial different lag lengths were tried, and that one was selected which minimized the standard error of the regression. For that lag length different degress of polynomial were tried, the one which minimized the standard error of the regression was chosen, and, finally, the necessary zero constraints were imposed.

The aforementioned procedure was followed since it was soon revealed that no one lag length was necessarily best in terms of minimum standard error of the regression for all degrees of polynomial and vice versa.

In a summary of what has been said in this section, it should be repeated that the difficulty in using the polynomial lag model is that the researcher has to specify the degree of polynomial and the length of the lag. As far as the latter is concerned, the data at hand can help a bit. Kmenta states that

> one possibility is to keep on extending the length of the lag until the contribution of the additional X's to the regression sum of squares is no longer statistically significant. But if the X's are highly correlated, this criterion may not work very well.
>
> Another possibility is to choose that length of the lag which results in the highest value of $\bar{R}^2$, i.e., of the coefficient of determination corrected for the "number of degrees of freedom." However, this also may not always work well since the differences between several values of $\bar{R}^2$ may be very small. Nevertheless, one or the other of these criteria, plus other considerations (for example, that all weights should be positive), may help in choosing the "best" lag for the problem at hand.[24]

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[24] Kmenta, pp. 494-495.

Empirical Results of Distributed Lag Models

The Beef Cattle Slaughter ($BCSL_t$) Equation

There are several factors which influence the number of cattle going to slaughter. The most important factors seem to be:

Price of beef: Replacement theory suggests that a cow will be slaughtered when its value for slaughter exceeds its present value which includes discounted future earnings in milk production. The higher the price of beef, relative to milk, the greater will be the number of cows going to slaughter. This theoretical view, however, considers cattle slaughter as an instantaneous response to any change in price of beef. But this is not the case in the cattle industry. As Hicks pointed out, the elasticity of expectations will be negative if farmers perceive the price change as a permanent one and they decrease their production. Thus, in response to an upward movement of price of beef fewer cattle are expected to go to slaughter, while in response to a downward movement in the price of beef more cattle are expected to go to slaughter.

Price of milk: As milk price increases, it is expected that beef cattle going to slaughter will increase, thus favoring the building up of the dairy herd.

Price of feedstuffs: Feedstuffs fed to the herd as a whole come from two sources: the market and feedstuffs grown on the farm. The last category of feedstuffs costs less to the farmer than the first one, but climatic conditions and severe competition for land and other resources from other farm activities result in a chronic problem of inadequate production of feedstuffs. Given that and the fact that cattle activity is a complementary farm activity in Greece, it is expected that an increase in price of feedstuffs will cause an increase in the number of cattle going to slaughter.

Beef-feed price ratio: Since this factor embraces two variables, the expected result is not always clear. Under Greek conditions, however, prices of feedstuffs have remained remarkably stable, while beef prices had ups and downs during some years of the sample period. Thus, farmers are expected to respond to beef prices rather than to feedstuff prices whenever this price ratio is used, and a negative relationship is expected between the beef-feed price ratio and the number of beef cattle going to slaughter.

Number of cows milked: As cows become older their productivity (in terms of quantity of milk produced) declines. Farmers take care to replace these old cows with younger ones of higher productivity. Thus, a negative association is expected between beef cattle going to slaughter and number of cows milked the previous year (short-run). In the long-run and in absolute levels more cows are expected to be slaughtered as the inventory increases.

Milk-feed price ratio: The data reveal that this ratio has been kept relatively stable, and, whenever there was a disturbance it was positively associated with the number of cattle going to slaughter.

Given the peculiarities of the data at hand, the biological production conditions of beef and the dual purpose nature of the national herd in Greece, second and third degrees of constrained polynomials were tried. The results of the empirical analysis are given in Tables 20 and 21 below.

TABLE 22

POLYNOMIAL LAG MODEL PARAMETERS AND STATISTICAL RESULTS
SECOND DEGREE POLYNOMIAL CONSTRAINED. TIME LAG: 10 YEARS

Equation (6-28)

Time Period	Regression Coefficients, t-values, d^*, Standard Error of Regression (SER)					
	Intercept	$\frac{FPMK}{FPFG}$	$\frac{FPB}{FPFG}$	$\bar{R}^2$	d^*	SER
	126.766 (21.39)			.72	1.06	15.68
t-1		0.0654 (5.82)	-0.9216 (6.19)			
t-2		0.1157 (5.82)	-1.659 (6.19)			
t-3		0.1570 (5.82)	-2.212 (6.19)			
t-4		0.1832 (5.82)	-2.581 (6.19)			
t-5		0.1962 (5.82)	-2.765 (6.19)			
t-6		0.1962 (5.82)	-2.765 (6.19)			
t-7		0.1832 (5.82)	-2.581 (6.19)			
t-8		0.1570 (5.82)	-2.212 (6.19)			
t-9		0.1170 (5.82)	-1.659 (6.19)			
t-10		0.0654 (5.82)	-0.9216 (6.19)			

TABLE 23

POLYNOMIAL LAG MODEL SIMPLE AND CUMULATIVE ($\dot{e}$) ELASTICITIES
SECOND DEGREE POLYNOMIAL. TIME LAG: 10 YEARS

Time Period	Dependent Variable BCSL	Explanatory Variables			
		$\frac{FPMK}{FPFG}$	$\dot{e}$	$\frac{FPB}{FPFG}$	$\dot{e}$
t-1		0.13	0.13	-0.14	-0.14
t-2		0.23	0.36	-0.26	-0.40
t-3		0.31	0.67	-0.34	-0.76
t-4		0.36	1.03	-0.40	-1.16
t-5		0.38	1.41	-0.43	-1.59
t-6		0.38	1.79	-0.43	-2.02
t-7		0.36	2.15	-0.40	-2.42
t-8		0.31	2.46	-0.34	-2.76
t-9		0.23	2.69	-0.26	-3.02
t-10		0.13	2.82	-0.14	-3.16

Polynomially distributed weights were estimated simultaneously (within a single function) for the following variables: the beef-milk price ratio and the farm price of feed-grain, the farm price of beef and the farm price of feed-grain, the milk-feed price ratio and the number of cows milked the previous year, the milk feed price ratio and the beef-feed price ratio.

Second Degree Polynomial(s)

Diagramatically, the distributed weights for the two variables included in the model are as they appear in Figures 6 and 7, respectively.

When the function parameters and statistics are observed several points are noteworthy. The distributed weights associated with milk-feed price ratio are all positive; however, the first weight and the last weight are rather small but still significant by the t-value criterion. All weights give a good statistical level of significance when the t-value criterion is employed. Hence, it may be concluded that significant response is indicated to milk-feed price ratio for the fourth year and onwards up to the ninth lagged year. This response is not surprising under the average typical situation prevailing in Greece, especially until the 1960s when farmers used to keep their cows until they were almost physically, though not economically exhausted. Since milk was mostly consumed on the farm by the family, the time lag - for this period - seems not to be very long.

With regard to beef-feed price ratio distributed weights it can be observed that they are all negative. This result may seem to be a little puzzling to some readers who are familiar with pure business oriented cattle operations. A closer look at the data

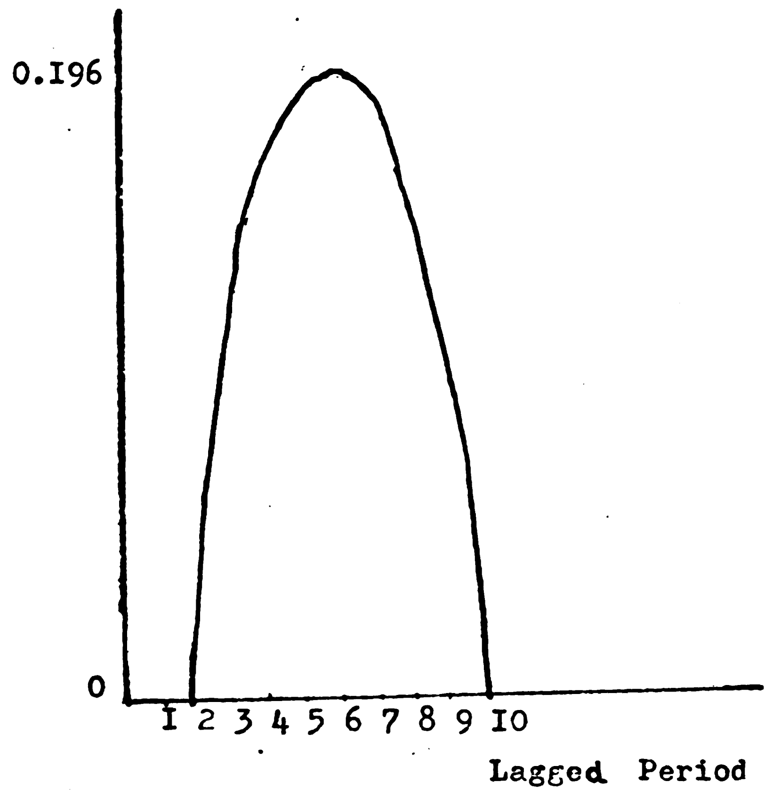

Figure 6. Milk-Feed Price Ratio Ratio Distributed Weights

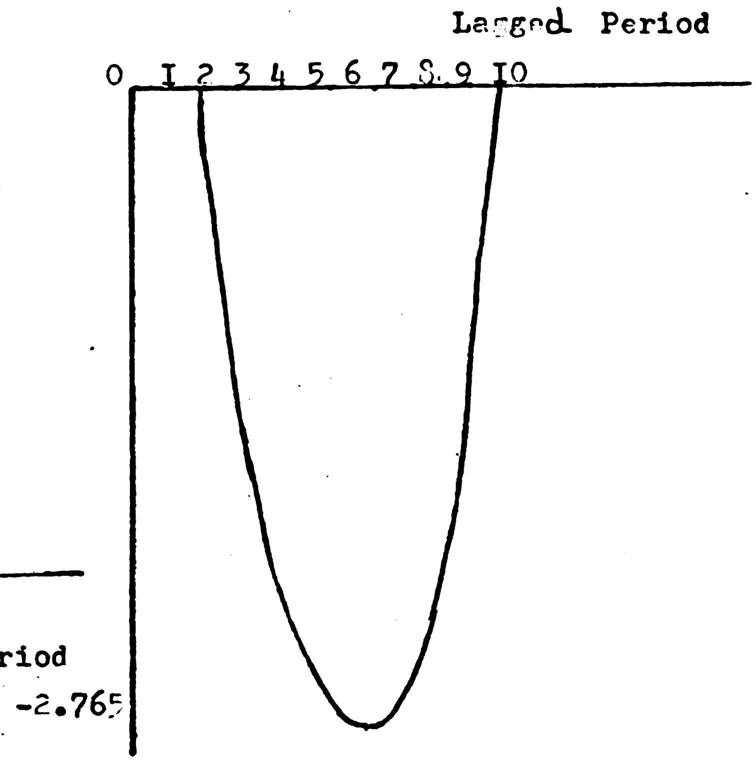

Figure 7. Beef-Feed Price Ratio Distributed Weights

reveals, however, that farm price of beef had followed a kind of erratic movement (experiencing ups and downs). Thus, for an upward movement of beef price farmers' elasticity of expectation was negative; they perceived this upward beef price movement as a permanent one and decreased their production. Given the fact that prices of feedstuffs (feed-grain) were kept remarkably constant any farmer's response was associated with changes in the price of beef.

The corrected multiple regression coefficient $\bar{R}^2$ was found to be 0.72, which is rather high considering the fact that only two variables participate in the model. It seems that the inclusion of farm price of feed-grain in the calculation of both price ratios contributes somewhat to the problem of serial correlation. To correct for the presence of serial correlation, the Cochrane-Orcutt[25] procedure was used.

A clear-cut way of summarizing the impact over time of a given price change is to observe the cumulative elasticity of output response to changes in a given price. Cumulative elasticities were calculated for each period and are presented in Table 21 and displayed graphically in Figure 8. Negative beef-feed price ratio elasticities have been converted to positive values in Figure 8 to provide easier graphical comparisons. The cumulative elasticities for the final period can be interpreted as the total or long-run elasticity, while those for intermediate years represent varying degress of short-run elasticities.

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[25] D. Cochrane and G.H. Orcutt, "Application of Least Squares Regressions to Relationships Containing Autocorrelated Error Terms," Journal of the American Statistical Association 44 (1949): 32-61.

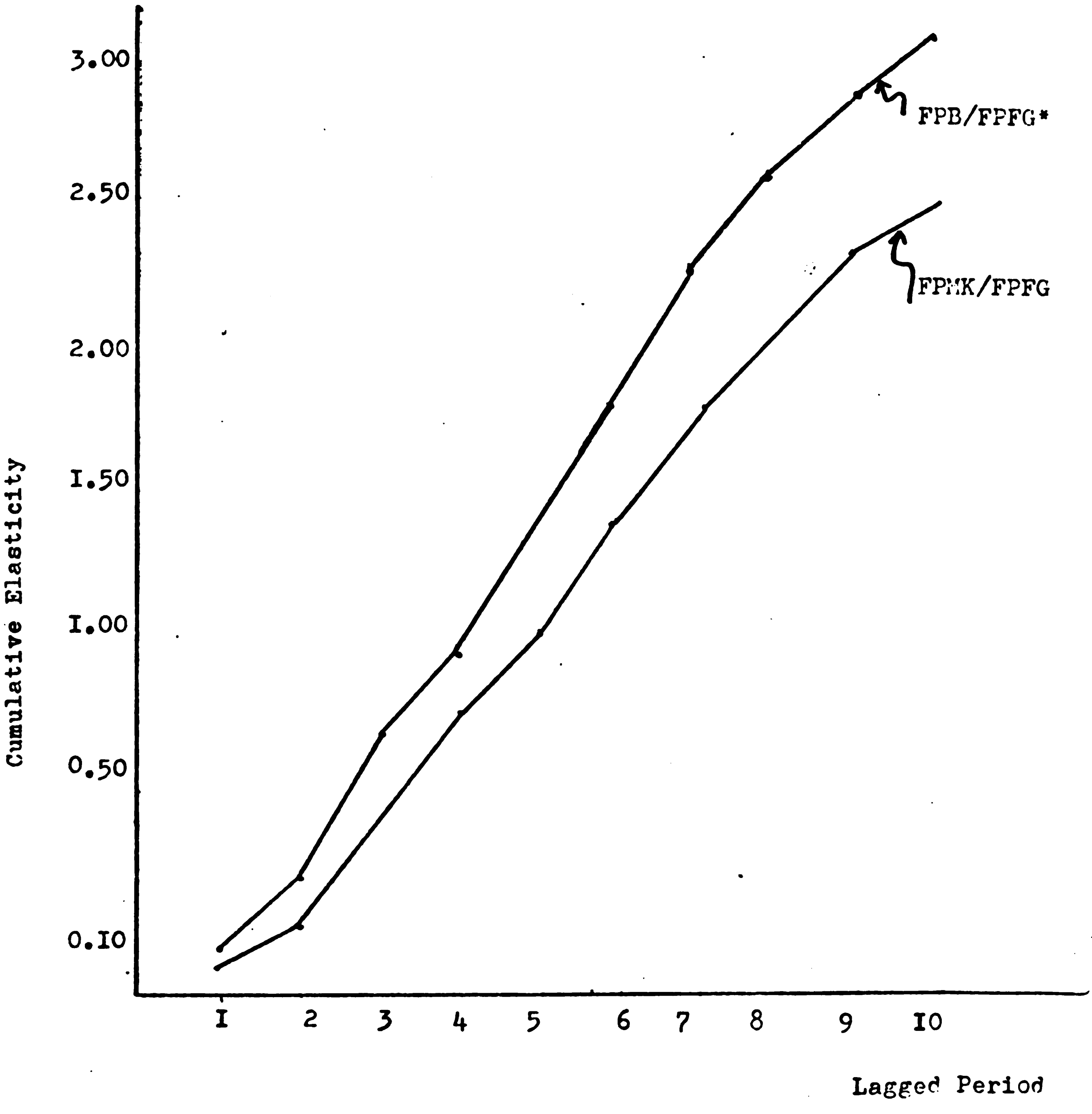

Figure 8. Cumulative Elasticities: Second Degree Polynomial

*Negative beef-feed price ratio eleasticities have been converted to positive values to provide easier graphical comparisons.

The graphical display of the elasticities shows the general pattern of marginal responses to price changes for several years in the two price ratios included in the model.

Third Degree Polynomial(s)

What follows is a brief comparison between the second degree polynomial and the third degree polynomial for the same length of run.

It seems that in terms of signs of response of the variables involved the two degrees of polynomials give the same result consistent with each other. Thus, a positive sign was obtained in both of them for all the estimated coefficients of the milk-feed price ratio and a negative sign was obtained for all estimated coefficients of the beef-feed price ratio. This finding seems to verify what was said at the beginning of this section about output and input response in the number of beef-cattle going to slaughter.

In terms of significance of the estimated coefficients - when a t-statistic is employed - it seems that in the second degree polynomial all of the estimated coefficients are significant. However, in the third degree polynomial estimated coefficients corresponding to t-8, t-9, t-10 years appear not to be statistically significant by the t-value criterion. This result seems more plausible and it led to the employment of an eight year run length polynomial. Results for the third degree polynomial with a time lag of ten years and with a time lag of eight years are given below in Tables 21, 22, 23 and 24.

In terms of R^{-2}s, it seems that the third degree polynomial gives higher values ($\bar{R}^2$ = .84 and $\bar{R}^2$ = .72, respectively) compared with those of the second degree polynomial, while in terms of standard errors of regression the third degree polynomial seems to give standard errors of regression of a lower value than the second degree polynomial (12.31 and 15.68, respectively).

From Table 21 it is revealed that the intermediate short-run elasticities, although they look the same, differ; and so do the final long-run elasticities of the two variables involved. The beef-feed price ratio cumulative elasticity rises faster than the milk-feed price ratio cumulative elasticity which may indicate that output prices cause greater fluctuations in the number of beef-cattle going to slaughter. While this happens when a second degree polynomial is employed, events occur in the reverse when a third degree polynomial is employed (see Table 23). Table 23 reveals that the short-run elasticities of the milk-feed price ratio are higher than those of beef-feed price ratio in the first four years become equal at the fifth year; the beef-feed price ratio elasticities begin to rise faster thereafter, i.e., after the sixth year.

Table 22 shows equation (6-29) which was tried for a third degree polynomial with a length of run of ten years. The t-values underneath the estimated regression coefficients show that parameters corresponding to years t-8, t-9, t-10 are not statistically significant for the milk-feed price ratio, while the same parameters are significant for the beef-feed price ratio.

The non-significance of the parameters corresponding to years t-8, t-9 and t-10 for the milk-feed price ratio is in accord with other findings elsewhere[26] where it was found that milk-cows

[26] Kitsopanidis, p. 12.

which yield an average of 1501-2000 kg of milk per year have an average economic life of 6 to 7 years. This lead for an eight years length of run to be estimated for the variable number of beef cows slaughtered which is given later in this section.

Equation (6-29) in Table 22 gives an $\bar{R}^2 = 0.84$ and that combined with the fact that most of the parameters are statistically significant gives some reliance in using it. The various elasticities are shown in Table 23 and the shape of the various lag coefficients is shown in Figures 9 and 10. The shape of the elasticities is shown in Figure 11.

Trying a third degree constrained polynomial with eight years lag in the variables FPB and FPFG gave the results illustrated in Tables 24 and 25.

It is interesting to note that this third degree polynomial which utilizes the farm price of beef and the farm price of feedgrain along with the NCM_{t-1} variables gives a supply response which is negative for the first variable (FPB) and for the first four years and is positive thereafter. For the second variable (FPFG) the supply response is negative only for the first two years and positive thereafter. The same is true for their respective cumulative elasticities

An explanation for such behavior by farmers as far as the price of beef is concerned may be that because any change in beef price is conceived by them as permanent, they keep their beef-cattle from slaughter. However, this perception by farmers seems to last only two years. After two years they are ready to accept change in beef

TABLE 24

POLYNOMIAL LAG MODEL PARAMETERS AND STATISTICAL RESULTS
THIRD DEGREE POLYNOMIAL, CONSTRAINED. TIME LAG: 10 YEARS

Equation (6-29)

Time Period	Regression Coefficients, t-values, d^*, and Standard Error of Regression (SER)					
	Intercept	$\frac{FPMK}{FPFG}$	$\frac{FPB}{FPFG}$	$\bar{R}^2$	d^*	SER
	125.813 (28.900)			.84	1.83	12.31
t-1		0.0900 (1.622)	-0.1172 (.164)			
t-2		0.1465 (1.907)	-0.4656 (.470)			
t-3		0.1745 (2.419)	-0.9603 (1.026)			
t-4		0.1795 (3.531)	-1.516 (2.255)			
t-5		0.1665 (5.670)	-2.049 (4.984)			
t-6		0.1405 (3.289)	-2.473 (4.377)			
t-7		0.1070 (1.497)	-2.705 (2.942)			
t-8		0.0709 (.779)	-2.658 (2.281)			
t-9		0.0376 (.413)	-2.248 (1.929)			
t-10		0.0123 (.193)	-1.390 (1.714)			

TABLE 25

POLYNOMIAL LAG MODEL SIMPLE AND CUMULATIVE ($\dot{e}$) ELASTICITIES
THIRD DEGREE POLYNOMIAL. TIME LAG: 10 YEARS

Time Period	Dependent Variable BCSL	Explanatory Variables			
		$\frac{FPMK}{FPFG}$	$\dot{e}$	$\frac{FPB}{FPFG}$	$\dot{e}$
t-1		1.17	0.17	-0.02	-0.02
t-2		0.28	0.45	-0.07	-0.09
t-3		0.34	0.79	-0.15	-0.24
t-4		0.35	1.14	-0.24	-0.48
t-5		0.32	1.46	-0.32	-0.80
t-6		0.27	1.73	-0.38	-1.18
t-7		0.21	1.94	-0.42	-1.50
t-8		0.14	2.08	-0.41	-1.91
t-9		0.07	2.15	-0.35	-2.26
t-10		0.02	2.17	-0.22	-2.48

TABLE 26.

POLYNOMIAL LAG MODEL PARAMETERS AND STATISTICAL RESULTS
THIRD DEGREE POLYNOMIAL, CONSTRAINED. TIME LAG: 8 YEARS

Equation (6-30)

Time Period	Regression Coefficients, t-values, and Standard Error of Regression						
	Intercept	NCM_{t-1}	FFB	FPFG	$\bar{R}^2$	d^*	SER
	107.423 (2.540)	0.0440 (.3231)			.86	1.76	11.98
t-1			-389.6 (4.7)	-1012.0 (1.2)			
t-2			-526.9 (4.9)	-628.0 (.5)			
t-3			-478.2 (5.2)	660.0 (.6)			
t-4			-309.9 (5.1)	2635.0 (3.0)			
t-5			-88.56 (1.5)	3997.0 (5.5)			
t-6			119.5 (1.3)	5066.0 (5.5)			
t-7			247.9 (2.4)	5083.0 (5.0)			
t-8			230.2 (2.8)	3557.0 (4.5)			

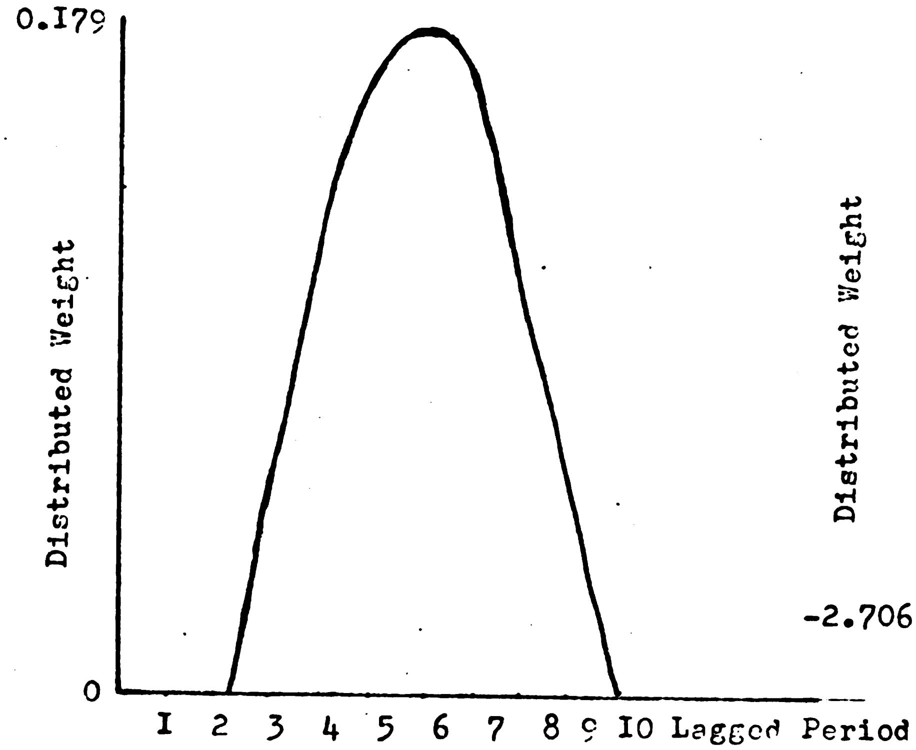

Figure 9. Milk-Feed Price Ratio Distributed Weights (Third Degree Polynomial)

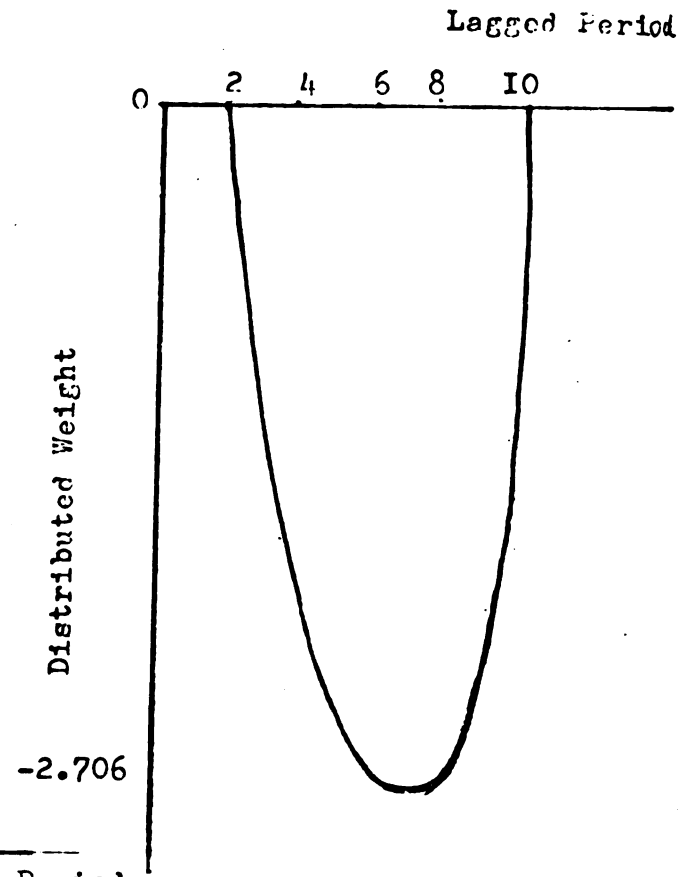

Figure 10. Beef-Feed Price Ratio Distributed Weights. (Third Degree Polynomial)

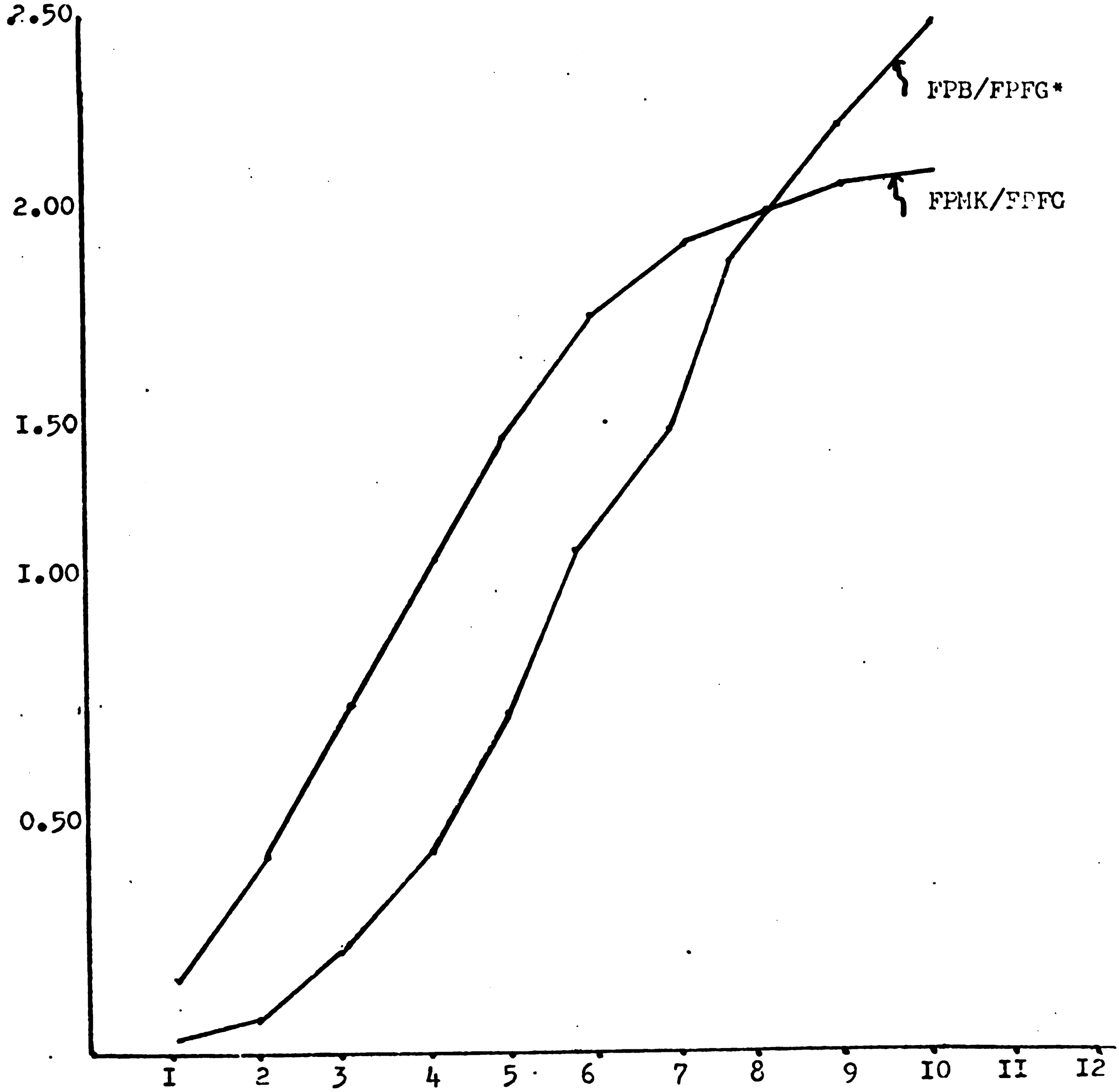

Figure 11. Cumulative Price Elasticities: Lagged Period Third Degree Polynomial

*Negative beef-feed price ratio elasticities have been converted to positive values to provide easier graphical comparisons.

TABLE 27

POLYNOMIAL LAG MODEL SIMPLE AND CUMULATIVE ($\dot{e}$) ELASTICITIES
THIRD DEGREE POLYNOMIAL. TIME LAG: 8 YEARS

Time Period	Dependent Variable BCSL	Explanatory Variables			
		FPB	t	FPFG	$\dot{e}$
t-1		-0.56	-0.56	-0.09	-0.09
t-2		-0.76	-1.32	-0.05	-0.14
t-3		-0.69	-2.01	0.06	0.08
t-4		-0.48	-2.49	0.22	0.30
t-5		-0.14	-2.63	0.34	0.64
t-6		0.18	2.45	0.43	1.17
t-7		0.39	2.84	0.43	1.60
t-8		0.36	3.20	0.30	1.90

prices as temporary and, as the price of beef goes up, more cattle are slaughtered.

As far as price changes in the farm price of feed-grain are concerned, it seems that it takes only two years for farmers to realize that any change in feed-grain is not a permanent one; during these two years whenever feed-grain prices move upwards the number of cattle going to slaughter moves downwards. Yet for the rest of the years farmers perceive changes in feed-grain prices as permanent ones and positively respond to them by slaughtering their cattle. Their actions are in accord with the a priori knowledge revealed by the data.

The distributed weights of the coefficients for this model are displayed in Figures 13 and 14, and the simple and cumulative elasticities for such a model are shown in Table 25.

From Table 25 it is obvious that both short-run and long-run elasticities (taken in absolute terms) are greater for the farm price of beef variable than for the farm price of feed-grain variable. Because this result is in accord with findings of previous models, there is a strong indication that it is true. In only three years was the elasticity of the price of feed-grain higher than that of the price of beef.

Figure 15 graphically displays long-run cumulative elasticities - in absolute values - calculated from the model in Table 24.

<u>Number of Cows Milking</u> (NCM_t) <u>Equation</u>

In what follows in this section the number of cows milking variable is examined and, following the previous procedure, two degrees of polynomials are tried in a polynomial lag formulation. There are

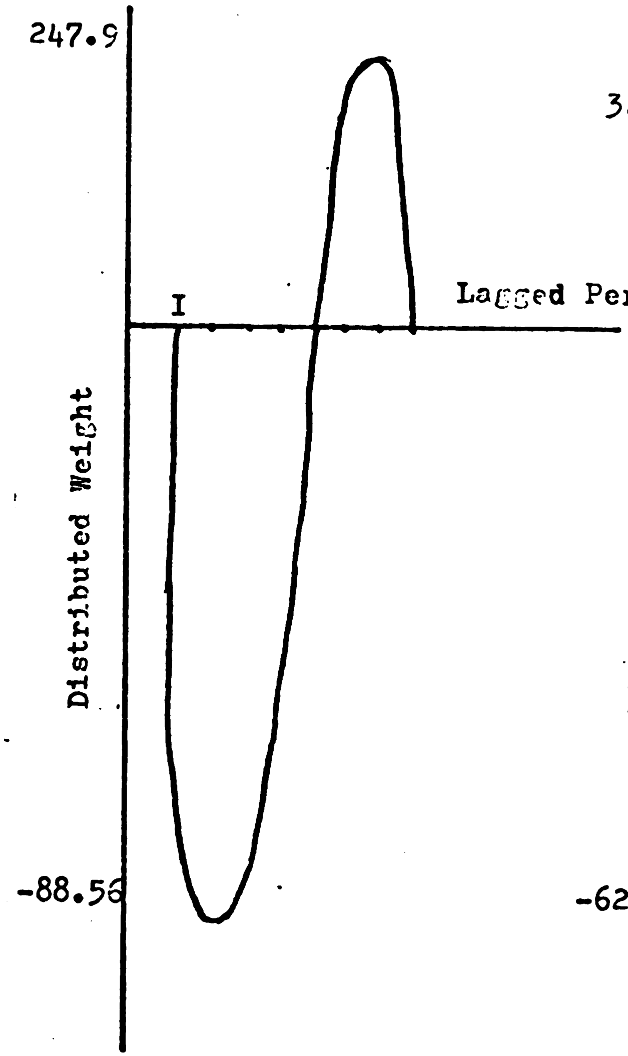

Figure 12. Beef Price Distributed Weights: Third Degree Polynomial

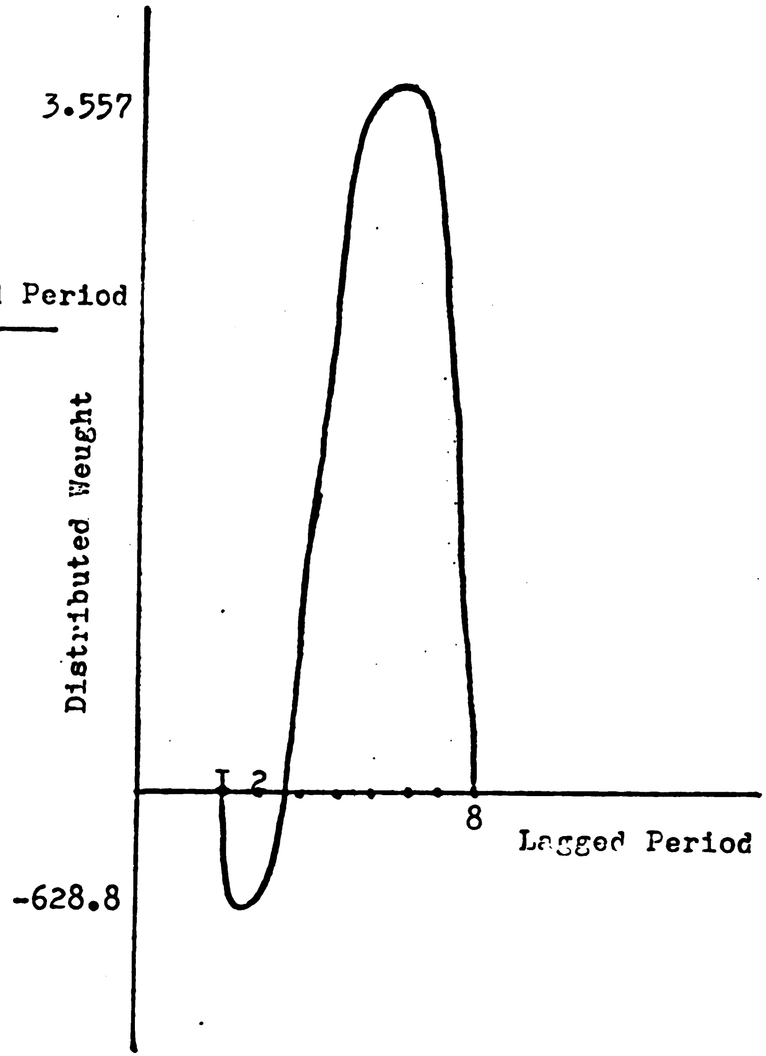

Figure 13. Feed-Grain Price Distributed Weights: Third Degree Polynomial

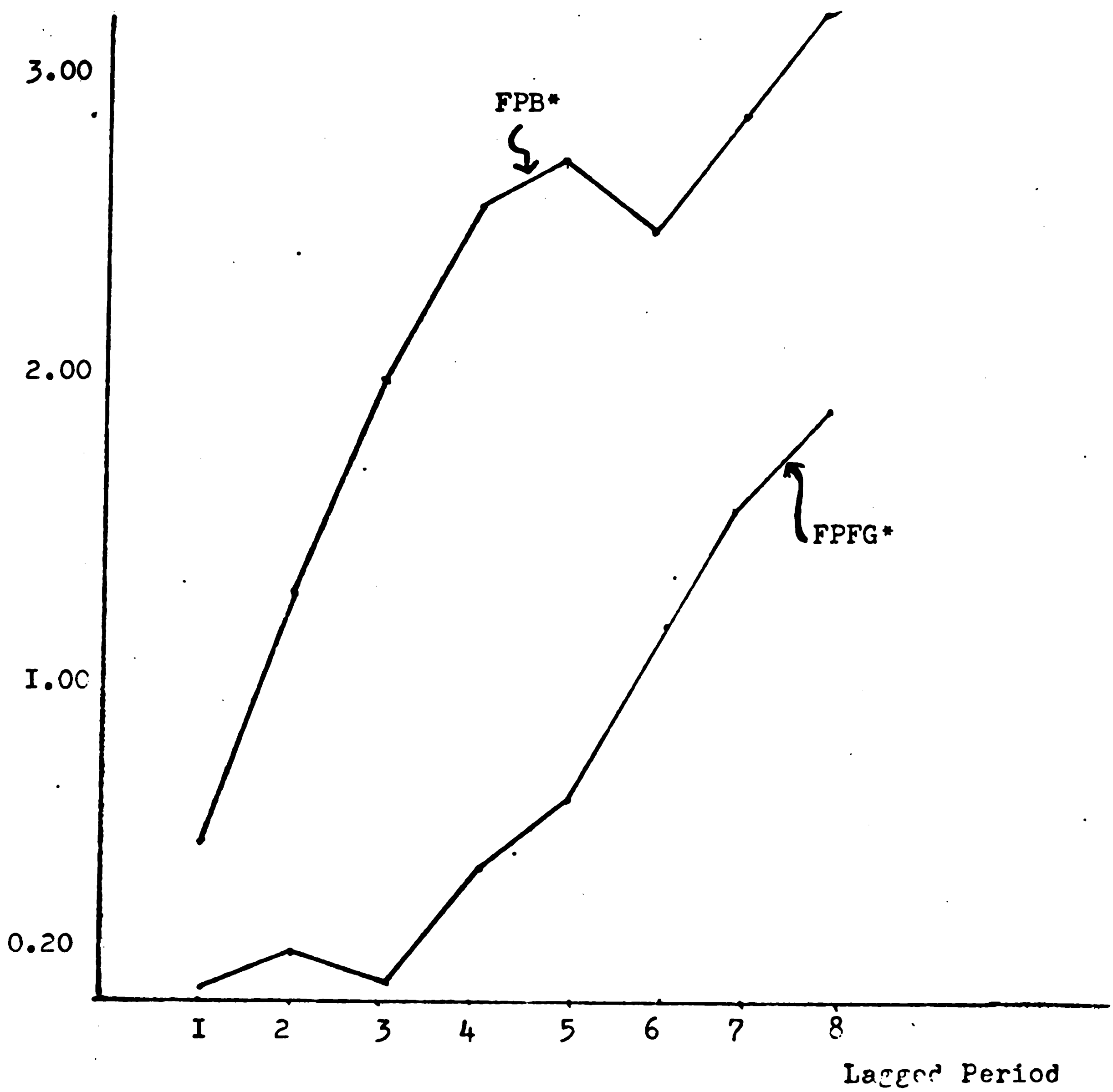

Figure 14. Cumulative Elasticities: Third Degree Polynomial

*Negative price elasticities have been converted to positive values to provide easier graphical comparisons.

several variables which are thought to have an influence on the number of cows milked.

a) Price of milk. It is expected that as price of milk increases the number of cows milked will increase.

b) Yield per cow. As yield per cow increases, as is the case here, the number of cows will decline if, of course, the farmers' target is to produce a given quantity of milk.

c) Price of inputs. As input prices increase, other things being equal, it is expected that the number of cows milked will decrease.

d) Profitability of alternative enterprises. These enterprises can be found either within the farm and within the agricultural sector or outside agriculture, i.e., off-farm employment of resources used in dairy activities. The profitability of the farm products which compete for resources within the farm and the sector can be expressed in terms of the prices of those products which compete with dairying for the same resources. Such products could be lamb and mutton, pork and chicken. The profitability of off-farm employment opportunities could be expressed as the wage differences in the farm and non-farm sectors.

Inventory of heifers. According to the definition of a beef-cow given earlier and according to the biological fact that at least two years is required from the time a heifer is born until it begins to produce milk, the number of milking cows two years from now will be influenced by the current inventory of heifers. This is generally regarded as a stage in milk production and not as a factor except when it is used to forecast cow numbers a year or two ahead.

Though these points about the variables influencing the dependent variables NCM_t come from economic theory, all these variables were not used. Instead, an effort was made to keep the models as simple as possible. Thus, the variables FPMK ÷ FPFG , FPB ÷ FPFG and the variable NCM_{t-1} were utilized in the polynomial distributed lag formulation. The equations fitted here are shown in Tables 26, 27, and 28.

Second Degree Polynomial(s)

Here, again, the polynomial lag model suggests that the rate of output (i.e., number of cows milking) response to milk-feed price ratio first increases and then declines (see equation 6-31). This type of output response is in accord with other studies like the one carried out by Chen, Courtney, and Schmitz in which they state that

> ...The polynomial lag model suggests the rate of output response from a price change first increases and then declines. This output response does not seem to be unrealistic for milk production since it appears unlikely that the greatest marginal output from a given change in price is forthcoming in the immediate period after the price change.[28]

The response to the two price ratios examined here is shown in Figures 16 and 17, and the simple and cumulative elasticities are provided in Table 27.

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[28]Dean Chen, R. Courtney, and Andrew Schmitz, "A Polynomial Lag Formulation of Milk Production Response," A.J.F.E. 54, No. 1 (Feb. 1972): 77-83.

TABLE 28

POLYNOMIAL LAG MODEL PARAMETERS AND STATISTICAL RESULTS
SECOND DEGREE POLYNOMIAL, CONSTRAINED. TIME LAG: 10 YEARS

Equation (6-31)

Time Period	Regression Coefficients, Standard Errors, d^* and $\bar{R}^2$					
	Intercept	NCM_{t-1}	$\frac{FPMK}{FPFG}$	$\frac{FPMK}{FPFG}$	$\bar{R}^2$	d^*
	98.510 (50.936)	0.7249 (.157)			.93	1.80
t-1			0.0169 (.012)	-0.1593 (.183)		
t-2			0.0304 (.022)	-0.2867 (.329)		
t-3			0.0405 (.029)	-0.3823 (.439)		
t-4			0.0473 (.034)	-0.4460 (.513)		
t-5			0.0506 (.037)	-0.4779 (.549)		
t-6			0.0506 (.037)	-0.4779 (.549)		
t-7			0.0473 (.034)	-0.4460 (.513)		
t-8			0.0405 (.029)	-0.3823 (.439)		
t-9			0.0304 (.022)	-0.2867 (.329)		
t-10			0.0169 (.012)	-0.1593 (.183)		

TABLE 29

POLYNOMIAL LAG MODEL SIMPLE AND CUMULATIVE ($\dot{e}$) ELASTICITIES
SECOND DEGREE POLYNOMIAL. TIME LAG: 10 YEARS

Time Period	Dependent Variable NCM	Explanatory Variables			
		$\frac{FPMK}{FPFG}$	$\dot{e}$	$\frac{FPB}{FPFG}$	$\dot{e}$
t-1		0.03	0.03	-0.00	0.00
t-2		0.06	0.09	-0.01	-0.01
t-3		0.09	0.18	-0.02	-0.03
t-4		0.10	0.28	-0.02	-0.05
t-5		0.11	0.39	-0.02	-0.07
t-6		0.11	0.50	-0.02	-0.09
t-7		0.10	0.60	-0.02	-0.11
t-8		0.09	0.60	-0.02	-0.13
t-9		0.06	0.75	-0.01	-0.14
t-10		0.03	0.78	-0.07	-0.21

TABLE 30

POLYNOMIAL LAG MODEL PARAMETERS AND STATISTICAL RESULTS
SECOND DEGREE MODEL. TIME LAG: 4 YEARS

Equation (6-32)

Time Period	Regression Coefficients, Standard Errors, d^* and $\bar{R}^2$, Simple (e) and $\dot{e}$ Elasticities						
	Intercept	NCM_{t-1}	FPMK	d^*	$\bar{R}^2$	Simple e	Cumulative $\dot{e}$
	-219.4802 (88.36)	0.9663 (.2116)		3.45	.79		
t			610.8126 (681.58)			0.03	0.03
t-1			1223.00 (360.6)			0.07	0.10
t-2			1834.0 (541.0)			0.10	0.20
t-3			1834.0 (541.0)			0.10	0.30
t-4			1223.0 (360.0)			0.07	0.37

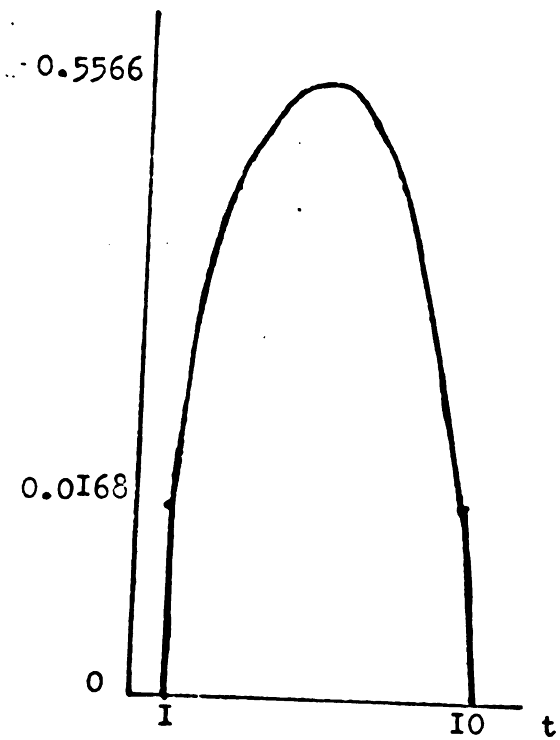

Figure 15. Milk-Feed Price Ratio Distributed Weights

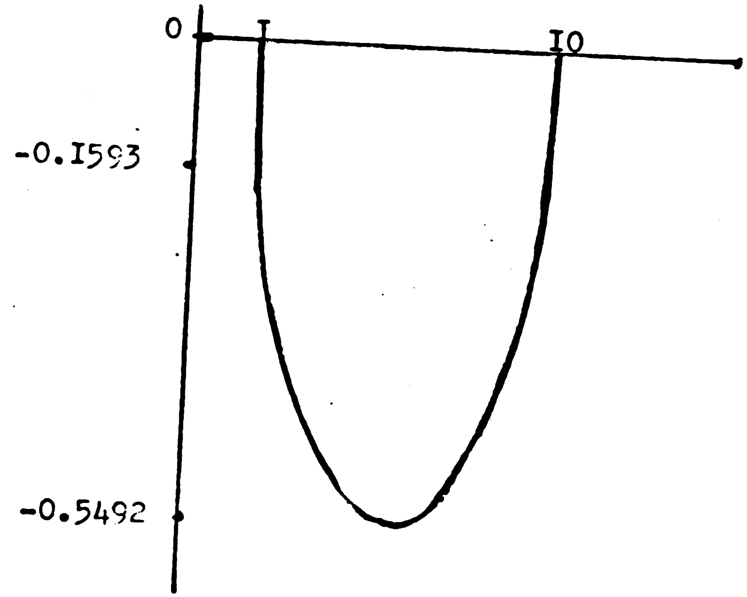

Figure 16. Beef-Feed Price Ratio Distributed Weights

In observing the function parameters and statistics, several points are worth mentioning. The distributed weights associated with milk-feed price ratio are all positive; however all the weights have questionable levels of significance as indicated by their standard errors values. Hence, it may be concluded that this type of formulation gives no significant response to milk-feed price ratios examined in this model.

The distributed weights to beef-feed price ratio are all negative; however the weights are not statistically significant and it may be concluded that no significant response is indicated to beef-feed price ratio. The largest weights for both price ratios appear in t-5 and t-6 years.

It is interesting to note that here the two elasticities appear to have quite different slope. The milk-feed price ratio is steeper, while the beef-feed price ratio appears to show a more gradually smooth trend (see Figure 18).

If milk-feed price ratio changes by 1 percent at time t-1, the simple supply elasticity is 0.03 and 0.00 for the beef-feed price ratio. This value reaches a maximum of 0.11 at t-5 and t-6 years for the milk-feed ratio, while a maximum of 0.07 appears to be at t-10 for the beef-feed price ratio. It can be generally observed that both short-run and long-run elasticities are small, verifying the fact that the number of cows milking does not respond directly to only two economic factors but to non-economic factors as well (i.e., feeding the family).

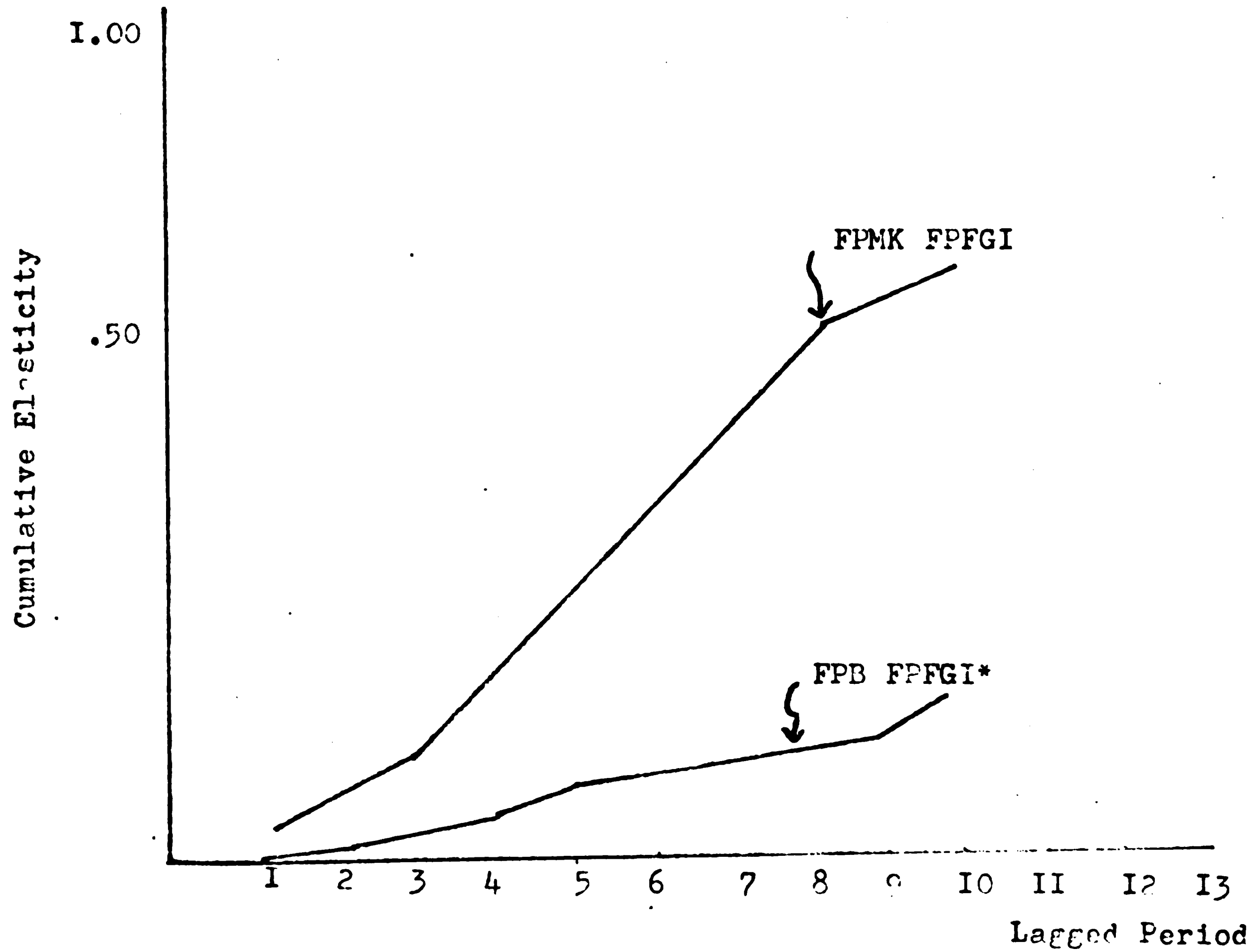

Figure 17. Cumulative Elasticities: Second Degree Polynomial

*Negative price elasticities have been converted to positive values to provide easier graphical comparisons.

A Second Degree Model of Four Years Time Lag

In this model a four years time lag is incorporated using only one price variable, i.e., the farm price of milk variable. It seems that this simple model gives good results in terms of sign of the parameter estimated and statistical significance of it and of $\bar{R}^2$. The results of this model are shown in Table 28.

In the last model all the lagged parameters are statistically significant, bear a consistent sign, and have important economic significance. The $\bar{R}^2 = .79$, which is high enough, and the cumulative elasticity at t-4 year is + 0.37, which is very acceptable.

It is interesting to note here that the introduction of the variable NCM_{t-1} not only increases $\bar{R}^2$ from 0.83 to 0.93, but also gives a negative type of response for the beef-feed price ratio and, at the same time, corrects the deficiency for the milk-feed price ratio appearing in other formulations. It is recognized that livestock inventories will increase when favorable prices and feed costs are expected to occur. In contrast, inventories are expected to decrease as a result of a rise in feed cost. The introduction of the current livestock inventories in this long-run supply formulation response was not statistically significant, and, thus, Tryfos'[29] point about the significance of a current inventory variable appearing among the independent explanatory variables in a short-run supply function cannot be verified here.

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[29]Peter Tryfos, "Canadian Supply Functions for Livestock and Meat," A.J.F.E. 56, No. 1 (Feb. 1964): 107-113.

Third Degree Polynomial

In what follows a polynomial of the third degree is tried. The difference between the second degree polynomial and the third degree one is that in terms of $\bar{R}^2$ the latter gave an $\bar{R}^2$ higher by 0.01 percent than the former and that result occurred only in the case where the variable NCM_{t-1} was included in the model. The first of the many differences between the two models exists in the pattern of response of the two price variables included in the model.

While the second degree polynomial gives a clear positive response for the milk-feed price ratio and a clear negative response for the beef-feed price ratio, the third degree first gives a negative response to the first price ratio (FPM:FPFG) for the first three years and then a positive supply response thereafter (see Figures 19 and 20). On the other hand, this third degree polynomial gives a positive supply response to the beef-price ratio for the first four years and a negative one thereafter.

The second difference between the two polynomials is the magnitude of the elasticities corresponding to the two variables included in the model. Although the individual year elasticities differ, the final long-run cumulative elasticity is almost the same for the two models and for the two variables included in the model [(+0.78, +0.67) and (-0.21, -0.29)], respectively (see Tables 27 and 29). The cumulative elasticities calculated from the third degree polynomial are portrayed in Figure 21.

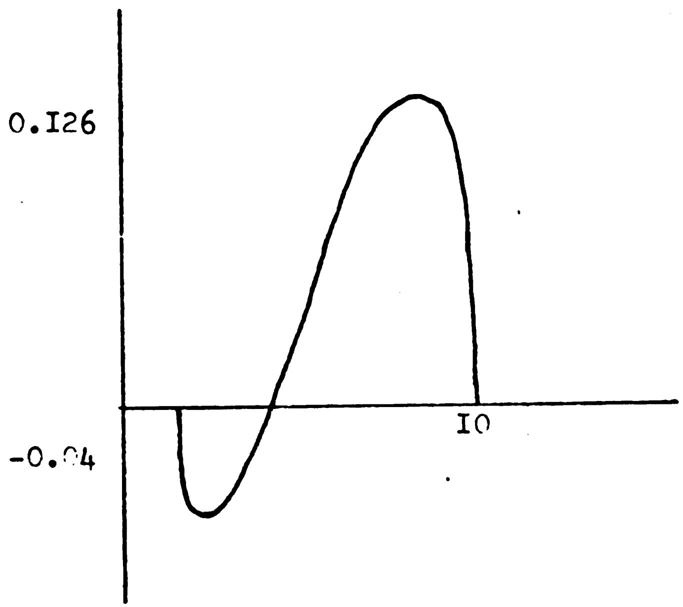

Figure 18. Milk-Feed Price Ratio
Distributed Weights
Third Degree Polynomial

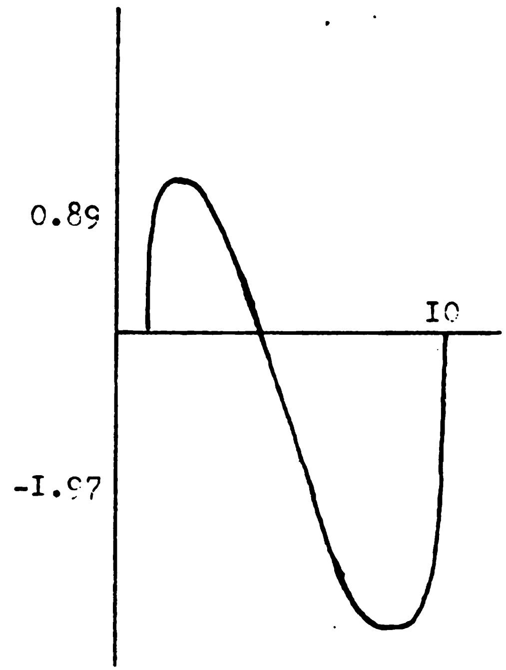

Figure 19. Beef-Feed Price Ratio
Distributed Weights
Third Degree Polynomial

TABLE 31

POLYNOMIAL LAG MODEL SIMPLE AND CUMULATIVE ($\dot{e}$) ELASTICITIES. THIRD DEGREE POLYNOMIAL. TIME LAG: 10 YEARS

Time Period	Dependent Variable NCM	Explanatory Variables			
		$\frac{FPMK}{FPFG}$	$\dot{e}$	$\frac{FPB}{FPFG}$	$\dot{e}$
t-1		-0.09	-0.09	0.10	0.10
t-2		-0.13	-0.22	0.13	0.23
t-3		0.12	0.10	0.11	0.34
t-4		0.08	0.18	0.06	0.40
t-5		0.03	0.21	-0.02	0.38
t-6		0.03	0.24	-0.09	0.31
t-7		0.09	0.33	-0.16	0.15
t-8		0.13	0.44	-0.20	-0.05
t-9		0.14	0.58	-0.20	-0.25
t-10		0.09	0.67	-0.14	-0.29

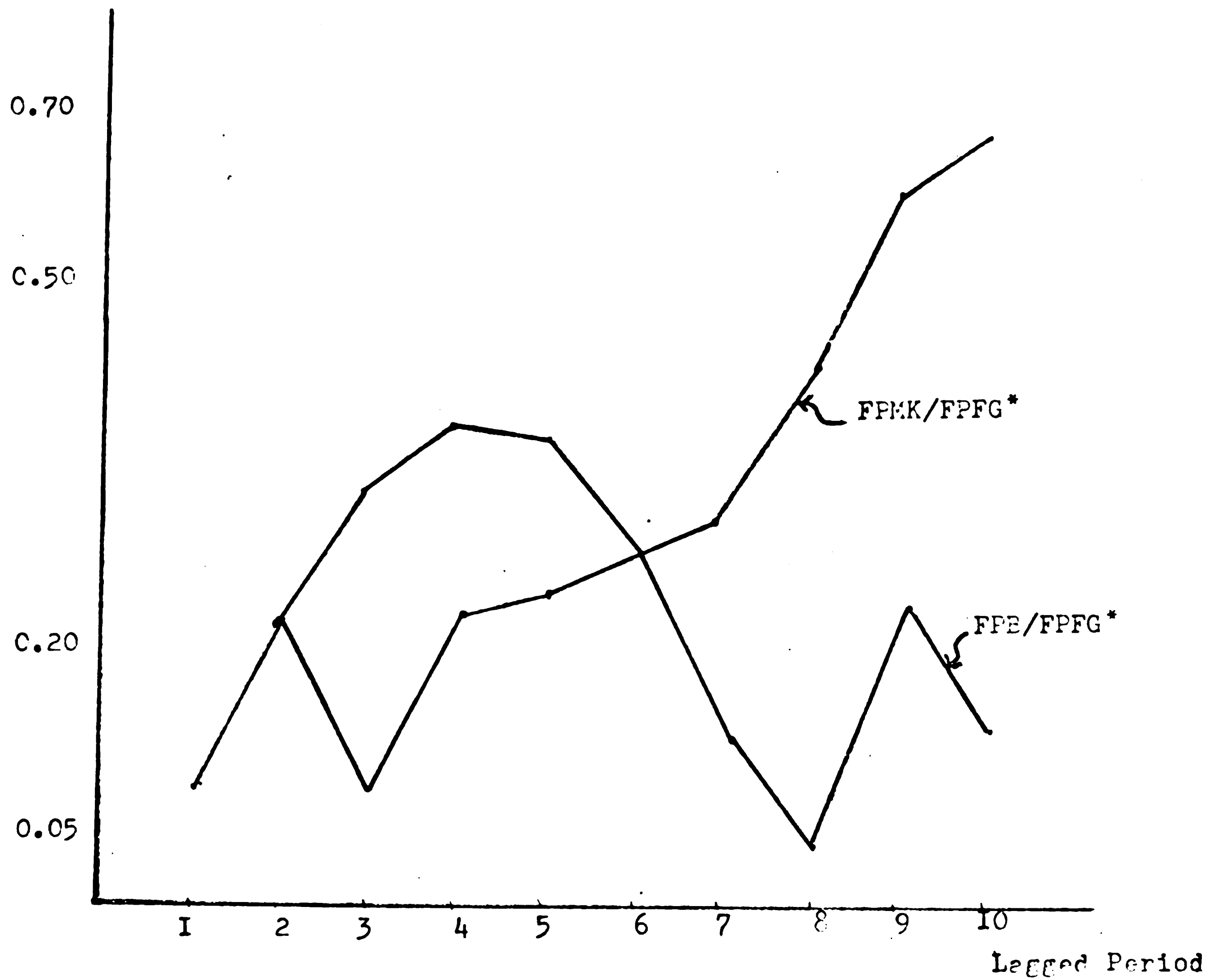

Figure 20. Cumulative Elasticities. Third Degree Polynomial

*Negative price elasticities have been converted to positive values to provide easier graphical comparisons.

Summary

From a look at the elasticities derived from the various models, it can be observed that model specification indeed plays a considerable role in specifying the magnitude of the elasticities. However, the polynomial lag models give a rate of output response (i.e., the number of cows milking) from a price change which is first increased and then decreased. This type of output response does not seem to be so unrealistic since it is derived only if a flexible price lag structure, such as the polynomial lag formulation, is used.

The problem faced here is that the distributed lag models are derived from time series data in which it is likely that more than one price change occurred. It seems very unrealistic, for example, to assume that the output response (i.e., the number of cows milking here) is due only to a once-and-for-all change in one price, and that the other prices during this long period (one to eight or ten years) remained unchanged. Thus, it is more realistic to assume that the aggregate supply function estimated indicates the responsiveness of production from a whole set of price changes.

Even in the case of equation (6-32) where one price, the price of milk, is examined, it is believed that the condition of ceteris paribus holds and refers not only to other factors (technology, etc.) influencing the milk production, but also to the rest of the set of prices which affect milk production.

These findings here are in accord with the findings of H. Halvorson (1958, p. 1104 for the U.S.A.)[30] where he reports a 0.35

[30] H. Halvorson, "The Response of Milk Production to Price," Journal of Farm Economics 40 (1958): 1101-1113.

long-run milk supply elasticity for price, while W.W. Cochrane reports a short-run price elasticity of supply for whole milk ranging from 0.3 to 0.4.[31]

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[31] W.W. Cochrane, "Conceptualizing the Supply Relation in Agriculture," Journal of Farm Economics 27 (Dec. 1965): 1161-1176.

CHAPTER VII

TRENDS AND PROJECTIONS

Most projections of the demand for agricultural products are made primarily on the basis of assumptions as to the rate of population and income growth. Population in Greece has not grown very much, nor is it expected to grow very much on the near future. The rates at which population changes annually in both absolute and in percentage terms during 1963-1973 are shown in Table 30 below, along with the number of tourists coming into the country from 1969-1972.

From Table 30 it can be seen that increase in population does not account for very much in the aggregate increase of consumption of beef and veal. Tourism, on the other hand, is a seasonal problem to be tackled. A separate empirical analysis carried out by the author indicated that when annual data were used along with the numbers of tourists as a spearate independent variable, statistically significant results were not produced for the parameter of tourists coming into the country. Consider that these tourists stay 20 days in the country; if it is assumed that they consume the average quantity that an average Greek consumer did daily, i.e., 21 grs of beef and 31 grs of veal per day, then multiplying these numbers by the number of tourists going into the country, one gets 1023 tons of beef and 1510 tons of veal. These amounts are not considered to be that much, given the fact that annual beef production accounted

TABLE 32

MID-YEAR ESTIMATES OF POPULATION IN GREECE: 1963-1972
AND NUMBER OF TOURISTS COMING INTO COUNTRY FROM 1969-1972

Mid-year	Population	Changes		Tourists
		Absolute Numbers	Percentages %	
1963	8 479 625	31 392	0.37	-
1964	8 510 429	30 804	0.36	-
1965	8 550 333	39 900	0.47	-
1966	8 613 651	63 318	0.74	-
1967	8 716 441	102 790	1.19	-
1968	8 740 765	24 324	0.28	-
1969	8 772 764	31 999	0.36	1 139 400
1970	8 792 806	20 042	0.23	1 407 500
1971	8 831 036	38 230	0.43	1 981 300
1972	8 888 628	57 592	0.05	2 436 400

Source: National Statistical Service of Greece, Statistical Yearbook (Athens, 1974).

for 15 000 tons in 1972, and veal production accounted for 76 000 tons in the same year.

Thus, major increases in demand for both beef and veal are expected to come from an increase in per capita income. Given that income elasticities for both domestically produced and/or imported beef and veal are high (5.90, 3.75 and 1.18, 0.10 for domestically produced beef and veal and for imported beef and veal, respectively), it is expected that this will continue to be the major source of an increased demand in the years to come.

Given the facts that in 1972 consumption exceeded production by 45 000 tons (which accounts for a 68.8% level of self-sufficiency for Greece) and that income import elasticities were +1.18 for beef and +0.10 for veal, means that Greece would continue to rely heavily on imports of these two products to fulfill domestic demand. It is interesting, though, to look at Table 31 which gives per capita total meat consumption and beef and veal consumption in Greece as well as in some West European countries in 1960 and 1972. It is worth noting that per capita total meat consumption in Western Europe increased from 54.1 kg in 1960 to 72.8 kg in 1973, an increase which represents slightly over a one-third rise. If beef and veal are considered separately, it is seen that per capita consumption only increased from 18.3 kg per head in 1960 to 22.2 kg per head in 1972.

When beef and veal are considered as a percentage of total meat consumption, it is shown in Table 31 below that beef and veal's share of the total consumption fell more than 3 percentage points for all of whole Western Europe over the twelve year period covered here. The explanation lies in the following three reasons

a) consumer expenditure for beef and veal reached a high level;

b) competition was present from other meats with lower prices, especially poultry;

c) a different pattern of consumption was established by different consumers in the different European countries.

From Table 31 it can be concluded that Greek consumers will still continue to increase their consumption of beef and veal since

TABLE 33

PER CAPITA TOTAL MEAT CONSUMPTION AND BEEF AND VEAL CONSUMPTION, WESTERN EUROPEAN COUNTRIES, 1960 AND 1972, IN kg

Country	Consumption					
	1960			1972		
	Total Meat	Beef & Veal	Beef & Veal as % of Total Meat	Total Meat	Beef & Veal	Beef & Veal as % Total Meat
Belg.-Lux.	63.6	23.0	36.2	83.6	26.9	32.2
France	76.4	27.4	35.9	96.3	28.5	29.6
W. Germany	65.1	19.7	30.3	86.9	23.4	26.9
Italy	31.6	13.6	43.0	61.8	25.4	41.1
Netherlands	48.1	17.6	36.6	60.9	18.0	29.6
Denmark	62.4	16.2	26.0	63.5	16.2	25.5
Ireland	62.1	15.2	24.5	86.0	19.6	22.8
U.K.	71.6	24.6	34.4	77.0	22.5	29.0
EEC-9	60.6	20.9	34.5	79.4	24.3	30.6
Greece	23.5	4.9	20.9	54.0	16.9	31.3
Western Europe[1]	54.1	18.3	33.8	72.8	22.2	30.5

[1]Including Ireland.

Source: Organization for Economic Cooperation and Development and Foreign Agricultural Service and Econ. Res. Service (U.S. Dept. of Agri.). Adopted from: Western Europe's Beef Production, Consumption and Trade. E.R.S., U.S.D.A. ERS-Foreign 367, September 1974, p. 15.

the domestic (Greek) consumption level for total meat was around 54.0 kg/capita in 1972. This means that Greek consumers will be demanding beef and veal as their incomes rise until they at least reach the EEC-9 consumption level which in 1972 was 24.3 while that of Greece was 16.9 (almost 2/3 of that of EEC-9). But this means that for beef and veal consumption to increase the total meat consumption has to increase following the income increase. The OECD 1985 projections for total meat consumption of 55.3 kg per capita was easily surpassed by Greek consumers in 1972 which means that, except for income, there have been other factors which influence consumption of meat, the most probable one seeming to be relative prices.

Trends in Domestic Demand and Supply of Feed-Grain

The quantity of feed-grain demanded largely depends on its relative price, the prices of livestock products, total domestic production of feed-grain, the rate of its utilization both inside and outside the livestock industry and the composition of the livestock industry. This last factor plays a crucial role in feed-grain demand.

It is well known that for one kilogram of red meat to be produced higher quantities of feed-grain are needed than the amount required to produce one kilogram of pork or poultry meat. This fact has begun to be realized the last few years in Greece, and Table B-1 in Appendix B reveals that production of pork and poultry meat almost doubled between 1969 and 1974. This doubling means that policy makers - through advertisement or various kinds of policy supports -

are trying to divert meat production from red-meats to other meats as well in order to meet increased demand for meat in Greece and, at the same time, to reduce the quantities of feed-grain required to produce the meat demanded.

Feed-grain, and particularly corn, greatly contributed to the financial burden which Greece carried all the years of the sample period. Imports of corn had a low peak of 96 000 metric tons in 1961 but had increased since then to reach a high peak of 439 000 metric tons in 1971. In money terms, this meant that Greece had to pay $5.7 million dollars in 1961 and $29.3 million dollars in 1971 only for imports of corn.

Equations (5-11) and (5-12) in Chapter V gave an elasticity of the quantity of imported feed-grain with respect to animal units fed with feed-grain in the range of +0.2 to +0.3. This elasticity means that as the animal units increase by 1 percent imports of feed-grain quantity demanded will continue to increase by +0.2 or +0.3 percent in the same direction.

The production, consumption, imports and self-sufficiency rate for feed-grain and for the years 1965-1972 are given in Table 32 below.

Table 32 reveals that the self-sufficiency rate in feed-grain was 65 percent in 1965 and increased to 95 percent in 1972, and, if the latest data received from the National Statistical Service of Greece is correct, imports of corn reached a level of 960 000 metric tons in 1974 and a level of 464 000 metric tons in 1975. Given the rates of feed-grain utilization and the import elasticity of demand

TABLE 34

PRODUCTION, CONSUMPTION, IMPORTS AND SELF-SUFFICIENCY RATES
FOR FEED-GRAIN IN GREECE: 1965-1972
IN THOUSAND METRIC TONS OF TDN AND IN PERCENTAGES

Year	Feed-Grain			
	Production	Consumption	Imports	Self-Suff. Rate
1965	1 108	1 612	504	.68
1966	2 010	2 366	356	.85
1967	2 180	2 670	490	.82
1968	1 610	1 963	353	.82
1969	1 916	2 304	388	.83
1970	1 845	2 615	770	.70
1971	2 452	3 221	769	.76
1972	2 701	2 829	128	.95

Source: Calculated by the author.

for feed-grains, it is expected that feed-grains will continue to be imported in Greece.

As far as milk is concerned, the Agricultural Bank's estimates show that milk production from cows will reach a level of 900 thousand tons in 1980, while its consumption will be at the level of 715 thousand tons, thus creating a gap of 135 thousand tons by that year. Thus, the prospects of increasing milk production look good, assuming that other things will remain unchanged.

The Model as a Whole

In the preceding analysis the individual models have been specified and estimated, the aim of the specific objectives of this thesis. In what follows in this section the individual models which refer to each particular product are put together, and, thus, a subsystem is formed. Each subsystem is thus formed from a demand equation, the two components of the supply equation, an import demand equation* and, finally, an identity equalizing supply and demand. The direct supply equation is given as an outside equation, which provides a separate piece of information and, in particular, the derivation of the direct supply model.

Hence, for the five products investigated here five subsystems were formed, all of which were linked in such a way as to make up the whole system of the feed-grain-livestock economy in Greece.

It should be clarified here that in the preceding analysis the basic theoretical model for supply and demand was of the form:

$$Q_t = \beta_0 \pm \beta_1 P_t + U_t \quad \beta_0 \geq 0, \frac{\partial Q_t}{\partial P_t} < 0 \tag{7-1}$$

instead of the actual one:

$$P_t = \beta_0 \pm \beta_1 Q_t + V_t \quad \beta_0 \geq 0, \frac{\partial P_t}{\partial Q_t} < 0 \tag{7-2}$$

---

*In the case of milk and roughage, no import demand equations are given since, by assumption, no imports of these two commodities have taken place.

This reversibility of estimation was done since the estimation of price elasticities was among the major elements of the specific objectives of the study. The actual model, however, is the one given by (7-2) when single-equation models are utilized. But it is a simple matter to transform model (7-1) to model (7-2).

Karl Fox[1] has claimed that single-equation models are valid for perishable and other agricultural products, livestock products included. The argument about the use of these equation models runs as follows.

For many agricultural products the quantity supplied in the market for these commodities is predetermined from some previous production period, since the quantity is partly dependent on factors determined in a previous time period when the production activity was initiated. The process of producing an agricultural commodity is assumed to take place in an irreversible manner with each step dependent on previous predetermined stages. The quantity that reaches the market depends, then, on some predetermined variables (exogenous variables).

If the above mentioned argument is accepted, it follows, then, that the price of the commodity is determined by the quantity offered in the market, especially in a perfectly competitive world and under the assumption that no storage of supply or other means of withholding supply are in operation.

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[1]Karl A. Fox, Econometric Analysis for Public Policy (Ames: Iowa State College Press, 1958), pp. 75 and 105.

When (7-2) is used and when Q_t is predetermined, $cov(Q_t V_t) = 0$, and the OLS estimates can be shown to be unbiased and consistent. In the case where model (7-1) is used, P_t has to be assumed predetermined and $cov(P_t U_t) = 0$; then, the OLS estimates are unbiased and consistent. This assumption can be established here if P_t is expressed as a function of other predetermined variables, and, when so estimated, can be asserted as such in (7-1). Only under this assumption $cov(P_t V_t) = 0$ holds; otherwise serial correlation problems arise.

Parenthetically, to be more specific about this last argument, and within the context of this research, a problem arising about the farm price of the products is examined here. Farm price here has been estimated either in terms of quantities consumed at the retail level (which are taken to be predetermined) and in terms of income and prices of other commodities which are also predetermined or in terms of lagged prices. This estimation will be more clearly seen later when the discussion on the system is undertaken, and the actual relationships are given.

Equation (7-2) above expresses a demand relationship with a priori restrictions based on both economic theory and knowledge of the industries involved. It should also be noted here that the assumption which holds in (7-2) strictly requires that the direction of functional (causal) dependence is from Q to P and not vice versa, while the assumption made in (7-1) requires that the direction of functional dependence is from P to Q which obviously is not the same.

Even though the argument on which model (7-2) is based permits the use of the OLS estimation procedure, it must be said that these models recognize the interdependence between demand and supply relations but impose a prior restrictions on their relative disturbance variances. These assumptions make the OLS method for estimating the demand equation applicable without any explicit recognition of its interdependence on the supply function in the form of simultaneous equation systems.

In what follows the structural equations in their general form are given. Variables in the model are given in a "free form" which means that those variables included and/or others as well could be taken to fit the final equations of the system. Dots within parentheses denote that there may be other variables, not specified here, which can be put in as exogenous variables to solve for the unknown variables.

The Model, the Subsystems and the "Best" Equations Fitted

Equations contained in the model along with each subsystem which they form are presented below. Endogenous variables are identified by asterisks(*).

A. Roughage Submodel

1) Domestic Demand for Roughage

$$QRD_t^* = f1(AUF_t, PR_t, PB_{t-1}, PV_{t-1}, P(L+M)_{t-1}), \ldots) \qquad (7\text{-}3)$$

2) Number of Acres Planted

$$NSTRRPL_t^* = f2(NSTRRPL_{t-1}, FPR_{t-1}, PFG_{t-1}, DV_r, K, \ldots) \qquad (7\text{-}4)$$

3) Yield per Acre

$$\bar{Y}RSTR_t^* = f3(PR_{t-1}, PFERT, DVr, K, \ldots) \quad (7\text{-}5)$$

4) Domestic (Total) Supply of Roughage

$$QRS_t^* = f4(f3 \cdot f2) \quad (7\text{-}6)$$

B. <u>Feed-Grain Submodel</u>

5) Domestic Demand for Feed-Grain

$$QFGD_t^* = f5(PFG_t, AUF_t, PB_{t-1}, PV_{t-1}, P(L{+}M)_{t-1}, \ldots) \quad (7\text{-}7)$$

6) Number of Acres Planted

$$NSTRFGPL_t^* = f6(NSTRFGPL_{t-1}, PFG_{t-1}, DV_{t-1}, K_t, PFERT_{t-1}, \ldots) \quad (7\text{-}8)$$

7) Yield per Acre

$$\bar{Y}FG_t^* = f7(T, K, PFG_{t-1}, \ldots) \quad (7\text{-}9)$$

8) Domestic Supply of Feed-Grain

$$QFGS_t^{d*} \equiv f8(f6 \cdot f7) \quad (7\text{-}10)$$

9) Import Demand for Feed-Grain

$$QFGIMP_t = f9(PFG_t^d, (PFG^d/PFGw)_t, AUF_t, GFGP_{t-1}, \ldots) \quad (7\text{-}11)$$

10) Total Supply of Feed-Grain

$$TQFGS_t \equiv f10(f8 + f9) \quad (7\text{-}12)$$

C. <u>Beef Submodel</u>

11) Domestic Demand for Beef

$$QBD_t^* = f11(PB_t, P(L{+}M)_t, PDI, \ldots) \quad (7\text{-}13)$$

12) Import Demand for Beef

$$QBIMP_t^* = f12(PB_t \text{ or } PB^d/PBw,\ P(L+M),\ PDI,\ldots) \qquad (7\text{-}14)$$

13) Beef Cattle Slaughtered

$$BCSL_t^* = f13(BCSL_{t-1},\ PB_{t-i},\ PV_t,\ (PB/PFG)_{t-i},\ PFG_{t-i},\ldots) \qquad (7\text{-}15)$$

14) Dressed Weight per Head

$$\bar{Y}BC_t^* = f14(DV_b,\ T,\ldots) \qquad (7\text{-}16)$$

15) Domestic Supply of Finished Beef

$$QBS_t^{d*} \equiv f15(f3 \cdot f4) \qquad (7\text{-}17)$$

16) Total Supply of Beef

$$QBS^T \equiv f16(f12 + f15) \qquad (7\text{-}18)$$

D. <u>Veal Submodel</u>

17) Domestic Demand for Veal

$$QVD_t^* = f17(PV_t,\ PB_t,\ P(L+M)_t,\ PDI,\ldots) \qquad (7\text{-}19)$$

18) Import Demand for Veal

$$QVIMP_t^* = f18(PV^d/PVw,\ P(L+M),\ PDI,\ldots) \qquad (7\text{-}20)$$

19) Veal Calves Slaughtered

$$VCSL_t^* = f19(VCSL_{t-1},\ PV_{t-i},\ PB_t,\ (PV/PFG)_{t-i},\ PFG_{t-i},\ldots) \qquad (7\text{-}21)$$

20) Dressed Carcass Weight per Head

$$\bar{Y}VC_t^* = f20(DVv,\ T,\ldots) \qquad (7\text{-}22)$$

21) Domestic Supply of Finished Veal

$$QVS_t^{d*} \equiv f21(f7 + f8 \cdot f9) \qquad (7\text{-}23)$$

22) Total Supply of Finished Veal

$$QVS_t^T \equiv f22(f21 + f12) \qquad (7\text{-}24)$$

E. Milk Submodel

23) Domestic Demand for Milk

$$QMKD_t^* = f23(PMK_t, PCHS_t, PBTR, PDI, \ldots) \qquad (7\text{-}25)$$

24) Number of Cows Milked

$$NCM_t^* = f24(NCM_{t-1}, PMK_{t-i}, PB_{t-i}, (PMK/PFG)_{t-i}, \ldots) \qquad (7\text{-}26)$$

25) Cow Milk per Head

$$\bar{Y}CM_t^* = f25(DVm, T, \ldots) \qquad (7\text{-}27)$$

26) Domestic (Total) Supply of Fluid Milk

$$QMKS_t^{d*} \equiv f26(f12 \cdot f13) \qquad (7\text{-}28)$$

In each quantity-demand equation variations in per capita consumption are assumed to be accounted for by changes in the retail own-price of the product, the prices of substitutes and the personal (per capita) disposable income of consumers, all of which are taken as given.

A retail price equation was estimated for beef, veal and milk which reflected the relationship between retail and farm prices. In addition to the respective prices and per capita consumption and disposable income, the wage rates in the meat processing industries were utilized in an earlier formulation of equations to proxy the farm and the retail price spread, i.e., the marketing margins.

Import demand equations for beef, veal and feed-grain are thought to be influenced by farm prices of these products in the domestic market, by the price differential between Greece and world markets, by per capita domestic consumption and by an income variable.

The retail price of lamb and mutton, which was mainly used here in this analysis as the price substitute meats, was considered an exogenous variable for the feed-cattle economy, although from the standpoint of the entire livestock economy it may be treated as endogenous.

Equations (2) to (4) in A submodel, (6) to (8) in B submodel, (13) to (15) in C submodel, (18) to (20) in D submodel and (22) to (24) in E submodel describe the supply situation prevailing in the roughage, feed-grain, beef, veal and milk industries correspondingly. The last equation of the above mentioned equations expresses the domestic supply of the five products considered here. As far as beef and veal are concerned, supply is considered as being the equivalent of the weight of beef and veal which arises from inspected slaughter. No attempt has been made to capture uninspected slaughter.

The domestic supply of beef, veal and milk is considered as the product of the number of cattle slaughtered or milked and the average cold carcass weight or the average per cow fluid milk delivered by farmers to milk processing centers. The supply of the finished product in the case of feedstuffs is treated as the product of the number of acres planted times the average per acre yield of roughage and feed-grain.

All of the variables which enter in the supply of feedstuffs equations are either lagged endogenous or truly exogenous to the system.

The number of cattle slaughtered was explained mainly by the beef-feedgrain price ratio in t-1 year and the beef cattle inventory at the beginning of the year. The beginning inventory is that reported by the National Statistical Service of Greece on December 31. Therefore, the inventory on December 31 in the year t-1 was taken as the value of the beginning year inventory variable for the year t. Early trials with this equation indicated that the inclusion of any variable other than the current beef cattle inventory would not result in a significant improvement in the coefficient of multiple determination. It was therefore concluded that for the cattle slaughter equation the inventory variable makes a substantial contribution toward explaining its variation.

A similar conclusion was reached for the number of cows milked. The beginning inventory of cows milked was indicated to be among the variables which greatly contributed to explaining the variation in the supply of cows milked.

The dressed cold carcass weight per animal is influenced by factors having to do with improvements in the composition of the national herd and a subsidy variable.

In the domestic supply equations of finished beef the animal units at t-1 year were used, and the average farm price of beef in (t-1 + t-2)/2 years was tried in one formulation, while in a second one the quantity of beef supplied in t-1 year was utilized along with the farm price of feedstuffs in t-1 year.

Generally, there were two equations in the form of an identity in each submodel, except in the fluid milk and roughage submodels where one identity was used since there were no imports for these two commodities. The first identity equation gives the domestic supply of a finished product, which is a product of the number of cattle slaughtered times the dressed weight per animal in the case of beef production and the number of cows milked times the yield of milk per cow. The second identity equation in each submodel gives the total supply of finished product, with imports taken into account.

The "best" equations chosen to test whether a significant amount of variation in the endogenous variables was accounted for by exogenous variables in each equation are provided below in a submodel division manner for the purpose of clearer presentation.

<u>A Roughage Submodel</u>

1) Demand for Roughage*

$$QRD_t = \underset{(198.1476)}{603.2417} - \underset{(68.502)}{447.7941}\, FPR_t + \underset{(.0312)}{0.5638}\, AUF + \underset{(1.984)}{6.3321}\, T$$

$$\bar{R}^2 = .98 \qquad d^* = 1.96 \qquad (7\text{-}29)^{**}$$

---

*Demand relationships are given as quantity of product consumed per unit (human or animal); to find the total demand multiply this quantity times the population (human or animal).

**In these equations here the standard errors of the coefficients are given in parentheses underneath the values of the coefficients.
(continued on page 250)

2) Number of Acres Planted

$$NSTRRPL_t = \underset{(1040.521)}{-2458.0452} + \underset{(423.820)}{1229.4023}\ FPR_{t-1} + \underset{(.2542)}{1.1434}NSTRRPL_{t-1}$$

$\bar{R}^2 = 0.98$ $d^* = 2.84$ (7-30)

3) Yield per Acre

$$\bar{Y}RSTR_t = \underset{(31.699)}{42.4423} + \underset{(.057)}{0.347}QRP + \underset{(.5044)}{0.7057}QFERT + \underset{(6.443)}{15.0297}\ T$$

$\bar{R}^2 = 0.94$ $d^* = 1.62$ (7-31)

4) Total Supply of Roughage

$$QRS_t = \underset{(402.6275)}{201.4080} + \underset{(133.980)}{520.1313}\ FPR_{t-1} + \underset{(.0928)}{0.8792}\ QRS_{t-1}$$

$\bar{R}^2 = 0.98$ $d^* = 1.86$ (7-32)

B. <u>Feed-Grain Submodel</u>

5) Domestic Demand for Feed-Grain

$$QFGD_t = \underset{(18.695)}{912.6617} - \underset{(3.648)}{15.3842}\ FPFG_t + \underset{(.089)}{0.5953}\ AUF_{t-1} + \underset{(.632)}{1.8605}\ T$$

$\bar{R}^2 = 0.97$ $d^* = 1.86$ (7-33)

6) Numbers of Acres Planted

$$NSTRFGPL_t = \underset{(1040.5214)}{2458.0452} + \underset{(423.8201)}{1229.4023}\ FPR_{t-1} + 1.1434\ NSTRFGPL_{t-1}$$

$\bar{R}^2 = 0.98$ $d^* = 2.41$ (7-340

(continued from page 249)

$\bar{R}^2$: Coefficient of determination corrected for the degrees of freedom. d^*: Durbin-Watson statistic for serial correlation. $d^*(i)$: inconclusive test. Loosely speaking, values of d^* around 2 indicate no (first order) serial correlation, and values of d^* around and below 1 indicate the presence of statistically significant positive serial correlation in the residuals. The test is often inconclusive for d^*-values between 1 and 2.

7) Yield per Acre

$$\bar{Y}FG_t = \underset{(93.140)}{-107.8157} + \underset{(2.001)}{14.3567}\ T + \underset{(.453)}{0.5633}\ K + \underset{(9104.1)}{16256.173}\ FPFG_{t-1}$$

$\bar{R}^2 = .84$ $\qquad d^* = 1.60$ (7-35)

8) Supply of Feed-Grain

$$QFGS_t = \underset{(622.385)}{-1296.8261} + \underset{(.096)}{0.6190}\ AUF + \underset{(49\ 146.136)}{152\ 090.4849}\ FPFG_{t-1}$$

$\bar{R}^2 = 0.70$ $\qquad d^* = 1.34(i)$ (7-36)

9) Import Demand for Feed-Grain

$$QFGIMP_t = \underset{(.945)}{30.7171} - \underset{(.089)}{0.1748}\ QFGP_{t-1} + \underset{(.059)}{0.2679}\ AUF_t$$

$\bar{R}^2 = 0.54$ $\qquad d^* = 2.11$ (7-37)

C. <u>Beef Submodel</u>

10) Domestic Demand for Beef

$$QBD_t = \underset{(1.5218)}{6.0049} - \underset{(10.376)}{20.5973}\ RPB - \underset{(.048)}{0.3270}\ RP(L+M) + \underset{(.016)}{0.1975}\ GNP$$

$\bar{R}^2 = 0.90$ $\qquad d^* = 1.94$ (7-38)

11) Import Demand for Beef

$$QBIMP_t = \underset{(.899)}{-5.0967} + \underset{(.068)}{0.8024}\ QBC_t + \underset{(55.442)}{174.974}\ (FPB/PIMPB)_t$$
$$+ \underset{(2.232)}{12.5456}\ FP(L+M)$$

$\bar{R}^2 = 0.96$ $\qquad d^* = 1.26$ (7-39)

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*T = 1(1951),...,22(1972).

12) Beef Cattle Slaughtered

$$BCSL_t = \underset{(27.523)}{26.3955} + \underset{(.151)}{0.8999}\, BCSL_{t-1} + \underset{(.805)}{0.2113}\, (FPB/FPFS)_{t-1}$$

$\bar{R}^2 = 0.70$ $\qquad d^* = 1.95$ $\qquad$ (7-40)

13) Dressed Carcass Weight per Head

$$\bar{Y}BC_t = \underset{(6.735)}{69.9434} + \underset{(8.733)}{16.9888}\, DV_b + \underset{(.505)}{5.7429}\, T$$

$\bar{R}^2 = 0.87$ $\qquad d^* = 1.01$ $\qquad$ (7-41)

14) Supply of Finished Beef

$$QBS_t = \underset{(.301)}{0.4089} + \underset{(.141)}{1.1278}\, QBS_{t-1} - \underset{(.021)}{0.3182}\, FPFS_{t-1}$$

$\bar{R}^2 = 0.98$ $\qquad d^* = 1.67$ $\qquad$ (7-42)

D. Veal Submodel

15) Domestic Demand for Veal

$$QVD_t = \underset{(1.850)}{-6.5543} + \underset{(14.3973)}{4.5107}\, RPV + \underset{(.093)}{0.3689}\, RP(L+M) + \underset{(.039)}{0.0632}\, GNP$$

$\bar{R}^2 = 0.96$ $\qquad d^* = 1.32$ $\qquad$ (7-43)

16) Import Demand for Veal

$$QVIMP_t = \underset{(1.055)}{-3.0645} + \underset{(10.128)}{2.4357}\, RPV + \underset{(.298)}{8.1174}\, RP(L+M) + \underset{(.005)}{0.0005}\, GNP$$

$\bar{R}^2 = 0.89$ $\qquad d^* = 1.62$ $\qquad$ (7-44)

17) Veal Calves Slaughtered

$$VCSL_t = \underset{(65.644)}{-136.7922} + \underset{(.204)}{0.8916}\, NCM_{t-1} + \underset{(.286)}{0.6497}\, (FPV/FPFG)_{t-1}$$

$\bar{R}^2 = 0.87$ $\qquad d^* = 1.89$ $\qquad$ (7-45)

18) Dressed Carcass Weight per Head

$$\bar{Y}VC_t = \underset{(7.785)}{25.3818} + \underset{(10.7712)}{43.3569}\, DVr + \underset{(.864)}{5.933}\, T$$

$$\bar{R}^2 = 0.97 \qquad d^* = 1.78 \qquad (7\text{-}46)$$

19) Supply of Finished Veal

$$QVS_t = \underset{(5.179)}{15.2263} + \underset{(1.742)}{0.7537}\, QVS_{t-1} - \underset{(.179)}{0.6824}\, FPFS_{t-1}$$

$$\bar{R}^2 = 0.96 \qquad d^* = 1.87 \qquad (7\text{-}47)$$

E. Milk Submodel

20) Fluid Milk Demand

$$QMKD_t = \underset{(31.953)}{79.7307} - \underset{(1\ 012.245)}{2\ 708.7250}\, RPMK_t + \underset{(10.429)}{26.8157}\, RPCH + \underset{(.117)}{0.2238}\, GNP$$

$$\bar{R}^2 = 0.87 \qquad d^* = 1.07(i) \qquad (7\text{-}48)$$

21) Number of Cows Milked

$$NCM_t = \underset{(104.104)}{-27.1957} + \underset{(.105)}{0.962}\, NCM_{t-1} + \underset{(3039.587)}{2155.5521}\, FPMK_{t-1}$$

$$\bar{R}^2 = 0.96 \qquad d^* = 1.54(i) \qquad (7\text{-}49)$$

22) Average Fluid Milk per Cow

$$\bar{Y}MC_t = \underset{(26.048)}{728.4024} + \underset{(36.038)}{138.5763}\, DVm + \underset{(2.890)}{19.8727}\, T$$

$$\bar{R}^2 = 0.87 \qquad d^* = 1.67 \qquad (7\text{-}50)$$

23) Total Supply of Milk

$$QMKS_t = \underset{(7.834)}{235.5269} + \underset{(.197)}{0.6348}\, QMKS_{t-1} - \underset{(605.312)}{12\ 968.879}\, FPFS_{t-1}$$

$$\bar{R}^2 = 0.98 \qquad d^* = 1.94 \qquad (7\text{-}51)$$

Projection of the Feed-Grain-Cattle Economy

The "best" equations derived in the previous section can be used to predict the future state of the feed-grain cattle economy in Greece. However, before such a prediction can be made, the estimated system must be manipulated in such a way that a unique value for each endogenous variable can be predicted. The procedure is to obtain the relevant values of the independent variables for the forecast period which is specified (say, 1973 here), insert them in the equation, and compute the dependent variable.

Since data for the independent variables are not available at this time, a kind of an *ex post* forecasting test will be tried here. More specifically, the procedure adopted here is to omit the last period's observations from the original fit, and then the equations were forecasted using the observed but not included observations. This procedure has the advantage of providing an immediate test of the equation's forecasting ability.

When an equation is part of a recursive system its sequential nature is helpful in obtaining estimates of independent variables in successive equations. An example here would be that next year's supply may depend on preceding years' prices and/or costs. Thus, using the values of these prices and/or costs, one could forecast supply. The forecast level of supply, then, could be used to forecast price in the next period. And, since the system of equations fitted in the feed-grain cattle economy can be viewed as a recursive system, it is a matter of simple manipulation to make such forecasts.

In Table 33 below ex post predictions are given for the 23 equations of the system. The 1971 values were used for the endogenous values to test the predictability of each equation fitted.

Generally speaking, the equations gave rather satisfactory predictions. But, since only one year's values for each endogenous variable were tested, it could be that predicted and actual values are close by chance. The system was also tested for values of the three last years (1971-1973). The results of such a test are shown in Table 34.

In this new test Theil's inequality coefficient was employed since it is believed that in order for forecasting procedures to be verifiable they must be "based upon theoretical consideration--however simple--and on empirical observations obtained beforehand--however scanty and crude."[2] The prediction efficiency of each equation was thus tested using Theil's ν coefficient which is given by the following formula:

$$\nu = \sqrt{\frac{\Sigma(Pi - Ai)^2}{n}} \Bigg/ \sqrt{\frac{\Sigma(Ai)^2}{n}} + \sqrt{\frac{\Sigma(Pi)^2}{n}}$$

where

Pi : predictable value

Ai : actual value

n : number of observations.

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[2]Henry Theil, Economic Forecast and Policy (Amsterdam: North Holland Publishing Company, 1965), p. 14.

TABLE 35

PREDICTED AND ACTUAL VALUES OF THE ENDOGENOUS VARIABLES FOR THE GREEK FEED-GRAIN CATTLE ECONOMY, ANNUAL AVERAGE 1972 AND PREDICTED 1972

Variable	Unit	Value 1972 Average Actual	Value 1972 Average Predicted	Absolute Difference (+) Increase (-) Decrease 1972
1) QRD, per animal	kg TDN	2682	2751	+ 69
2) NSTRRPL	000 str	3346	3696	+ 350
3) $\bar{Y}$RSTR	kg/str	635	720	+ 85
4) QRS	000 tons TDN	2125	2122	- 3
5) QFGD, per animal	kg TDN	2682	2897	+ 215
6) NSTRFGPL	000 str	6576	4399	-2177
7) $\bar{Y}$FG	kg/str	411	337	- 74
8) QFGS	000 tons TDN	2701	2257	- 443
9) QFGIMP	000 tons TDN	128	667	+ 539
10) QBD	kg/head	3.73	3.76	+ 0.03
11) QBIMP	kg/head	2.05	3.13	+ 1.08
12) BCSL	000 head	76	73	- 3
13) $\bar{Y}$BC	kg	191	206.5	+ 15.5
14) QBS	000 tons	15	16.20	+ 1.20
15) QVD	kg/head	11.23	19.43	+ 9.20
16) QVIMP	kg/head	2.3	2.4	+ 0.1
17) VCSL	000 head	257	265	+ 8
18) $\bar{Y}$VC	kg/animal	208	193	- 15
19) QVS	000 tons	76	72	- 4
20) QMKD	kg/head	61.43	41.12	- 20.31
21) NCM	000 head	427	469	+ 42
22) $\bar{Y}$MC	kg/animal	1279	1287	+ 12
23) QMKS	000 tons	546.1	471.2	- 74.9

TABLE 36

PREDICTED AND ACTUAL VALUES OF THE ENDOGENOUS VARIABLES FOR THE GREEK FEED-GRAIN CATTLE ECONOMY FOR THE YEARS 1970-72, AND THEIL'S INEQUALITY COEFFICIENT

Variable	Unit	Actual Value 1970	Actual Value 1971	Actual Value 1972	Predicted 1970	Predicted 1971	Predicted 1972	Theil's Inequality
QRD	kg TDN	2214.0	2188.0	2014.0	2046.6	2333.0	2643.5	0.08
NSTRRPL	000 str	3241.0	3209.0	3346.0	3160.2	3234.4	3199.0	0.01
$\bar{Y}$RSTR	kg/str	650.0	672.0	635.0	541.0	548.2	554.3	0.08
QRS	000 tons TDN	2108.0	2157.0	2125.0	1967.5	2200.6	2247.3	0.02
QFGD	kg TDN	2747.0	3267.0	2682.0	2781.6	3317.5	3905.4	0.27
NSTRFGPL	000 str	4988.0	6353.0	6576.0	5093.1	5798.5	6095.8	0.11
$\bar{Y}$FG	kg/str	308.0	386.0	411.0	317.9	327.3	350.0	0.05
QFGS	000 tons TDN	1845.0	2452.0	2701.0	1877.3	1972.0	2119.7	0.10
QFGIMP	000 tons TDN	770.0	769.0	128.0	526.6	603.0	629.6	0.07
QBD	kg/head	5.82	4.06	3.73	5.52	6.62	6.65	0.21
QBIMP	kg/head	4.23	2.48	2.05	3.96	4.17	4.46	0.13
BCSL	000 head	82.0	81.0	76.0	94.8	85.6	82.1	0.05
$\bar{Y}$BC	kg/animal	174.0	178.0	191.0	195.5	202.1	208.8	0.05
QBS	000 tons	14.0	14.0	15.0	15.5	14.6	14.6	0.03
QVD	kg/head	12.03	10.88	11.23	11.8	14.8	16.9	0.15
QVIMP	kg/head	3.62	2.84	2.68	3.4	4.5	5.3	0.24
VCSL	000 head	229.0	244.0	257.0	235.7	250.8	260.3	0.04
$\bar{Y}$VC	kg/animal	189.0	188.0	208.0	186.2	192.0	197.9	0.02
QVS	000 tons	74.0	71.0	76.0	46.5	57.2	68.7	0.13
QMKD	kg/head	65.42	61.36	61.43	63.60	64.13	62.8	0.01
NCM	000 head	446.0	429.0	427.0	458.3	451.2	435.5	0.02
$\bar{Y}$MC	kg/animal	1290.0	1261.0	1279.0	1276.7	1299.2	1321.6	0.01
QMKS	000 tons	575.3	541.9	546.1	507.8	529.9	535.8	0.03

The respective coefficients are illustrated in Table 34. If Theil's coefficient is equal to 0 (zero), the forecasts are perfect. If the coefficient is equal to 1, there is a complete lack of relationship between the predicted and actual values. Table 34 shows that most of the coefficients are very close to zero value. Larger coefficients were obtained for the roughage consumption variable (0.27), the number of acres (stremmas) planted variable (0.11), the quantity of beef and veal demand variables (0.21 and 0.15, respectively) and the quantity of imported veal variable (0.25).

According to the estimates (shown in Table 34), per capita beef demand was projected at 5.52 kg per head per year in 1970, while the actual 1970 demand was 5.80 kg; at 6.62 kg for 1971 versus an actual 1971 demand of 4.06; and at 6.65 kg for 1972 with an actual 1972 demand of 3.73. In general, the model also projected an upward increase in the demand for beef (for the years 1970-1972), while a substantial decline in beef consumption was noticed in Greece over the same years. These estimates, along with the value of Theil's coefficient, may give evidence that predictions should not be used uncritically.

The projections for the quantity of finished beef are rather encouraging since actual and predicted values are very close. The coefficient is almost zero which may mean that the model employed here may have some relevance.

Changes in per capita of veal consumption were also overestimated by the model for the last two years (1971, 1972), while the model underestimated the consumption for the year 1970 (11.8 vs. an actual consumption of 12.03). Veal production was severely underestimated by the model, too, especially for the years 1970 and 1971, while the model gave a closer value for the 1972 year.

Milk production was projected rather close to actual production (575, 542, 546, vs. 508, 530, 536) and, along with a low coefficient (0.03) such values may mean that projections based on this kind of model would be reliable. Finally, the estimates for the other variables were within acceptable limits and, given the low coefficients, it can be inferred that accurate estimates of projection could be obtained using the model presented here.

To provide a more comprehensive picture of how the model (or the submodels) works in making projections, a flow chart used by Egbert and Reutlinger[3] is presented here.

The letters in Figure 21 represent matrices coming from the following two demand and supply equations employed by the above investigators.

The supply equation: $\bar{y}_t = A1\bar{y}_{t-1} + A2\bar{p}_{t-1} + A3\bar{x}_t$ (7-52)

The demand equation: $\bar{p}_t = B1\bar{y}_t + B2\bar{z}_t$ (7-53)

where A1, A2, A3, B1, B2 are structural supply and demand matrices, $\bar{y}_t$ and $\bar{p}_t$ are vectors of current quantities and prices, $\bar{y}_{t-1}$ and $\bar{p}_{t-1}$ are vectors of current quantities and prices of the previous year and $\bar{x}_t$ and $\bar{z}_t$ are vectors of exogenous variables of the current year.

Figure 23 depicts the year-to-year estimating procedure. First, quantities in year t are estimated with the supply matrix by using prices and quantities $\bar{p}_{t-1}$ and $\bar{y}_{t-1}$ prevailing in the previous year,

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[3]Alvin C. Egbert and Shlomo Reutlinger, "A Dynamic Long-Run Model of the Livestock-Feed Sector." Journal of Farm Economics 47 (Dec. 1965): 1288-1305.

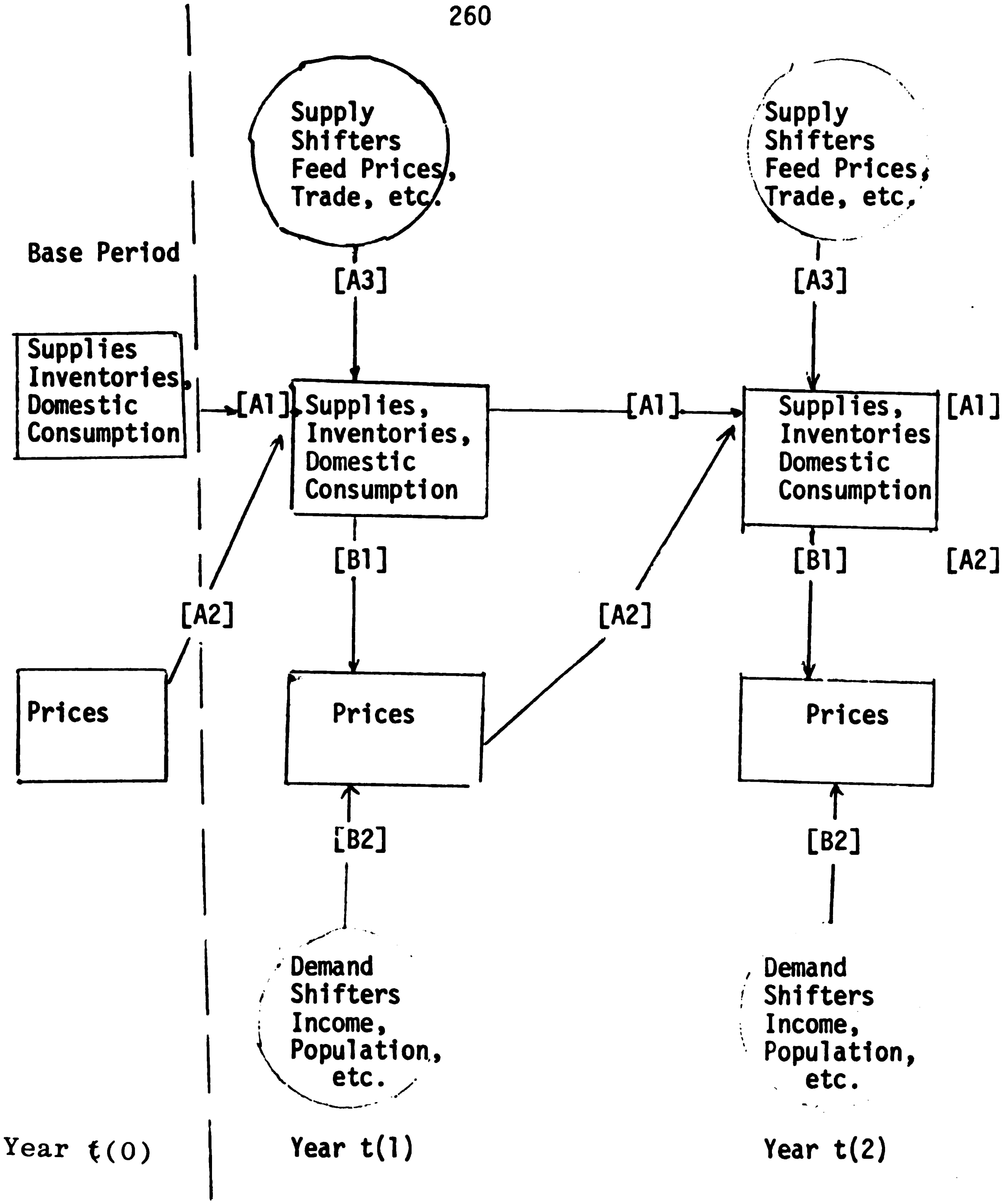

Figure 21. Flow Chart for Projecting Quantitities and Prices in the Feed-Grain Cattle Economy

i.e., the base-period-year, along with the use of the exogenous variables, $\overline{x}_t$. Then, in the next step, these quantities (in the supply matrix) were used together with the exogenous variables, $\overline{z}_t$, of the demand matrix to estimate prices. This recursive procedure was repeated to estimate quantities and prices for the next years (t+1, t+2, T+n), given the projected series of exogenous variables (circles in the flow chart). As Egbert and Reutlinger assert: "Due to the recursive nature of the model, the parameters may be estimated by classical least squares. But, because of the well known problem of multicollinearity, this method could not always be used."[4]

In this research effort here economic and statistical criteria were utilized in evaluating the different estimation equations for projecting the values of 1970, 1971 and 1972 within each subsystem. Within these criteria the statistically estimated equations with good fits and consistent parameters did reproduce the past rather well by using as a takeoff point the 1969 period.

Some of the alternative options which might have been examined in the case of Greece's feed-grain cattle economy are: (1) consideration of EEC's prices of both feed and/or livestock and examination of their impacts on supply and demand of feeds and/or livestock products, (2) alternative rates of growth in population, (3) alternative rates of economic growth of the whole Greek economy as measured by the GNP variable, (4) larger or lesser imports of both feeds and livestock products coming into the country. But such considerations are left for future research efforts.

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[4]Ibid.:1291.

Sensitivity Analysis

While the ability to reproduce the data for the period that spawned them is a critical test for any model, this is especially true of a recursive system because estimates depend only on the initial conditions, i.e., the base year period and the exogenous data. Moreover, the ability to respond to data outside either the base period or the system itself seems to be a superior test because the stability of the structure is thus evaluated. This last test is called sensitivity analysis.

The sensitivity analysis that should have been conducted here could consist of changing exogenous variables for a given time period and measuring the magnitudes of response generated by the values of the endogenous variables. In order to carry out such an analysis the definition of the base period (year) from which the change is made and the base to which response is compared must be specified and the response measures themselves calculated and given.

More specifically, in the case of Greece's feed-grain cattle economy examined here, the sentitivity analysis would consist of taking EEC prices of livestock products (beef, veal and milk) and of feed-grain, inserting them as exogenous variables into the system and evaluating the response of the endogenous variables examined here. However, such an analysis is left for a further, more thorough investigation since Greece will be negotiating full membership in the EEC community in the next three to five years. The problem of supply response under "the new conditions" is of tantamount importance for future developments in the Greek feed-grain cattle economy.

CHAPTER VIII

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

Summary and Conclusions

Objectives of the Study

The major objectives of the study were two: first, to obtain descriptive knowledge of the feed-grain-cattle economy in Greece in order better to understand the forces behind the demand and supply schedules of outputs produced (beef, veal and milk) and of inputs used (feed-grain and roughage) in their production; second, to estimate quantitatively some of the interrelationships integrated within the feed-cattle economy and among the products considered, including imported products.

The following discussion will present a short summary of the analyses associated with each of these objectives and the resulting conclusions. Following this, implications of the research and recommendations for future research are set forth.

The present research dealt with demand and supply analysis (both at the retail and the farm level) of the following livestock products: beef, veal and milk. For feed-grain and roughage, demand and supply analysis was restricted only to the farm level due to lack of data at the retail level.

The Problem

The problem which Greek agriculture faced over the period studied here (1951-1972) was that of: (a) low and unstable farm incomes; (b) low product prices for agricultural products; (c) inadequate production planning leading to chronic mismatching of supply and demand; (d) huge payments for imports of beef, veal and processed milk products and (e) uncertainty faced by farmers as to their future in the agricultural sector.

Despite these problems economic policy has been aimed at achievement of such goals as: (a) increase in farm incomes; (b) improved distribution of income; (c) full employment; (d) stabilization policy and, finally, (e) improvement of an open balance of payments problem.

Appraisal of the Results

Demand Analysis

Feed-grain grows on 854,000 hectares which represents over 43.2 percent of the total cultivated area in Greece. Its contribution to gross output achieved from crop production exceeds 20 percent of its value.

Feed grain is cultivated as: (a) the main crop in business farming or in family-type farming which is sold to the market to fulfill the demand for concentrates; (b) a complementary crop by livestock business farmers to meet their own needs and expenses in feedstuffs.

Feed-grain has been produced in Greece mainly in semimountainous and poor soil areas and secondarily in low-land areas for rotation purposes only. In the first case, the production of feed-grain has been based on the guaranteed price system (storage program)[1] provided by the government. In the second case feed-grain produced by larger farms, mainly on the plains of Thessaily, has not been subsidized by government programs although farmers owning these large farms were eligible to deliver their feed-grain to the storage program at the current market prices.

Expansion of feed-grain production into lowland areas has been very limited since it has had to compete for land with other more profitable crops. As a result of such a situation there has been an inability of feed-grain production (supply) to cope with demand. The net result of this kind of imbalance of supply and demand has been for Greece to seek suppliers in the world market.

The increased demand for feed-grains by livestock industries has led to mechanization of feed-grain production and use of better varieties, insecticides and pesticides which resulted in an overall increase in the average yield and a relative reduction in production cost of feed-grains.

In the past roughage has been produced in mountainous and semimountainous areas of low productivity. Only after 1964 was an effort made to increase its production by the introduction of a subsidy program for farmers who expanded alfalfa and clover production low land areas.

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[1]V. Kalaitzis, "Economic Consequences of the Grain Storage Program in Greece," SYGHRONDS GEORGIA (May-June, no. 3/1977), Athens, Greece (in Greek).

The own-price demand elasticities for feed-grain and for roughage were -1.23 and -0.13. To that add the cross-demand elasticities, especially those for beef and/or veal (+0.13, +0.08 and 0.64 and 0.78 for feed-grain and for roughage, respectively) and that for animal units fed with these inputs, and the result is that both of these inputs will still be greatly demanded.

The import elasticity of demand for feed-grain with respect to animal units fed with feed-grain was found to be between +0.2 and +0.3 which means that for a 1 percent increase in the animal units fed with feed-grain an increase of +0.2 or +0.3 percent in imports of feed grains will occur. The import elasticity of demand lends support to structural changes in the feed-grain industry to increase yield.

The own-price elasticity of demand for beef at the retail level was found equal to -1.41 which means that beef demand was price elastic in Greece over the examined period of time. The cross-price elasticity of demand for beef with respect to lamb and mutton was negative (-0.02), indicating that the two commodities were complementary.

The income elasticity of demand for beef at the retail level was found to be +5.90 which means that there are good prospects for further increase in beef production. This empirical finding is in accord with the actual situation prevailing in Greece today. Greece's per capita consumption of beef was estimated at 7.6 kg in 1973 per head per annum, while that of EEC-9 was 20.5 kg per head per annum.[2]

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[2]"Western Europe's Beef Production, consumption and Trade," Economic Research Service, United States Department of Agriculture, ERS-Foreign 367, Sept. 1974.

These figures mean that under the assumption that Greece will follow development patterns similar to those of Western European countries beef is expected to be greatly demanded in the years ahead.

Price elasticity of imported beef was +3.08 which lends support to the fact that beef imports will come into the country at a rate of +3.08 percent whenever the retail price of beef in the domestic market increases by 1 percent. To this add the income elasticities of demand with respect to imports, which was found to be +3.75, and the result is that imports of beef have been "pulled into" the country and not "pushed in" as farmers usually claim. Given these empirical findings and the fact that supply response to price changes (or other disturbances) is not an automatic process but requires considerable time, it seems that, from a short-run point of view, government's intervention in the importation of beef is justified. Things begin to change when a longer view is taken in which case the answer lies in government's chosen set of development priorities.

However, the empirical findings do not say anything about establishing a better import plan policy more consistent with domestic production possibilities and opportunities. For this to be done more knowledge and information are needed about the substitutability of different farm enterprises and their profitability under the historical developments and behavioral patterns established by farmers in Greece.

Per capita veal consumption was estimated at the level of 8.9 kg per annum, while that of EEC-9 was 2.5 kg per annum in the same year. This means that dietary preference has been developed in favor of veal consumption rather than beef consumption in Greece. The short-run own-price elasticity of veal at the retail level was -0.15 (see Table 12 in the text) which means that for a 1 percent change in the retail price of veal a 0.15 percent change in the quantity of veal will occur in the opposite direction. The retail import-price elasticity of veal was +0.41 (see Table 14 in the text) which means that veal will continue to be imported into Greece at a rate of +0.41 percent whenever the retail price of veal increases by 1 percent in the domestic market.

The import elasticity of veal with respect to income (GNP here) was +0.10 which means that whenever income increases by 1 percent veal imports will increase by 0.10 percent in the same direction. Both the own-price import elasticity of veal and the income import-elasticity of veal lend support to the hypothesis that veal imports have been "pulled in" rather than "pushed in" Greece as the farmers usually claim.

Short-run import elasticities of both beef and veal with respect to their farm price were -1.44 and -0.56, respectively (see Tables 11 and 14). Both these elasticities mean that in the short-run an increase in the farm price of beef and veal will lead to a decrease in the quantity of beef and veal imported. This relationship further implies that an increase in the farm price of beef and veal in the domestic market is associated with a decrease in the quantity demanded (imported) of these two commodities. This, however, is a partial analysis and holds true only under the <u>ceteris paribus</u> conditions. When the <u>mutatis mutandis</u> condition is introduced in the analysis, more interrelationships then come into the picture, and a simultaneous approach to the problem is obviously necessary. This general equilibrium analysis, however, has been left for another research effort.

Fluid milk coming from cows was consumed at a rate of 61.43 kg per head per annum. The own-price elasticity of demand for milk at the retail level was -4.21 (Table 15), verifying the fact that there are other products which can be used in the place of fluid milk at the retail level. The farm own-price elasticity of demand was -1.05 (see Table 16), verifying the relationship which exists between retail and farm levels elasticities. Cheese was found to be a complement good to fluid milk which sounds reasonable. The cross-product elasticity of milk with respect to cheese was +0.16 which provides some further evidence about the complementarity of the two products.

Supply Analysis

Chapter VI deals with supply analysis of the following agricultural products in Greece: feed-grain, roughage, beef, veal and milk. The objective of this chapter is mainly to improve knowledge as far as an understanding of the mechanism of supply response is concerned for these four products in Greece.

In economic theory the role of price changes in supply response has long ago been recognized. However, farmers' decisions about their production plans depend not only on relative prices and costs, but also on their overall income, their liquidity situation and their expectations as to future price and cost developments.

Supply analysis, like the demand analysis, was also carried out via a ceteris paribus approach. The only difference was that a small dynamic mechanism was introduced into the former to explain the role of price changes in relation to the number of cattle slaughtered and the number of cows milked.

Supply equations (giving domestic production) of both feedstuffs and livestock products were computed in two steps. First, the number of acres (stremmas) under feed-grain and roughage was computed, followed by a computation of the average yield per acre (stremma). This procedure clearly revealed all the factors which enter into a supply equation.

For the livestock products considered here the same procedure was followed. In the first step the number of cows slaughtered and/or milked was computed, and then the average yield in carcass weight and in milk per cow was estimated, mainly for the same reasons as above. Furthermore, a direct estimation of both the feedstuffs and the livestock products supply equations was attempted and the results of the two methods were compared. In general, it seems that in terms of elasticities obtained, the partial elasticity of the area planted, with respect to the price of the product at hand, is not equal to the partial elasticity of the quantity of the product supplied (produced) with respect to its price (see Table 17). This last elasticity was found to be higher and more consistent and may be more plausible.

From the empirical analysis it was found that, as far as the number of acres (stremmas) planted with feedstuffs is concerned, the weather conditions, the own-price prevailing in previous years and cultural practices adopted by the farmers (and embodied in the variable number of acres (stremmas) planted the previous year) seem to be the most relevant factors in the supply equation which was fitted to explain the variation in the number of acres planted to feed-stuffs.

A subsidy variable given by the government to roughage growers was used as a dummy variable in the empirical analysis. This variable was found to be significantly greater than zero, with a sign in accord with economic theory and an estimated coefficient consistent and significant in almost all models tried.

In roughage production the fertilizer variable used was significantly greater than zero and carried the "right" sign. This empirical finding obviously verifies the real world situation that fertilization along with irrigation plays a crucial role in roughage production and particularly in explaining the variation in the average yield of roughage production per acre (stremma).

As in the case of supply analysis for feed-grain and roughage, supply analysis for beef, veal and milk was carried out in two steps. In a first step the number of animals going to slaughter or the number of cows milked was computed, and, then, in a second step the yield of carcass meat (beef or veal) or the yield of milk per animal unit was computed. This procedure was called here the "indirect" method of analyzing supply response function.

In a separate effort the "direct" method was used, i.e., the response of the finished product produced to price changes. The results of both methods were discussed in the text and are briefly summarized here. Distributed lag analysis was also employed, particularly in estimating the number of cattle slaughtered equation and the number of cows milked equation.

Beef Cattle Slaughtered

The econometric model estimates first the number of cattle slaughtered in terms of two variables: the number of cattle slaughtered the previous year and the beef-feed price ratio the previous year. The use of the first of these two variables was thought to influence durable resources committed to beef production during previous production periods. In a short-run context these resources are fixed, but their size and structure play a major role in determining the volume of output, cattle numbers, and, in turn, the size and the structure of cattle inventories at the end of the year. This resource fixity reflects the high degree of fixity of these animals in the production of corresponding products. This relationship is empirically verified by the high positive elasticity of +0.91 found in this study and, apparently, is supported by C. Lard's[3] linear programming results for the United States which indicate that fixed costs play a major role in determining the year to year organization and profitability of enterprises on the farm. Professor G. Kitsopanidis has shown that this is also true in milk and/or beef production in Greece.[4]

The second variable which enters into the model is the beef-feed price ratio, lagged one year. Relative prices play an important role in inducing changes in the number of cattle slaughtered. The

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[3]C. Lard, "Profitable Reorganization of Representative Farms in Lower Michigan and Northeastern Indiana with Special Emphasis on Feed Grains and Livestock" (Ph.D. Thesis, Michigan State University, 1963).

[4]Kitsopanidis.

results of this study confirm generally held ideas about the low price elasticity of supply in a relatively short-run span (one year) (see Table 19 in the text). The beef-feed price ratio short-run elasticity of supply was +0.02 which seems to be in accord with ideas held in the literature that short-run livestock supply is related to prices and feed costs in previous periods, rather than to current prices and costs. The explanation for this relationship is, of course, that a relatively long production period is required before livestock can be brought to the market.

In the average weight of the slaughtered animals models what seems to have been the key variables are a time variable, used to pick all kinds of improvements taking place in the national herd, and a subsidy variable, used in the form of a dummy variable. Both these variables gave statistically and economically significant results.

Supply of Beef

In the supply of meat (beef) models (direct method) the variables tried were $(FPB_{t-1} + FPB_{t-2})/2$, the AVF_{t-1}, the QBS_{t-1} and the $FPFS_{t-1}$. The models gave statistically significant results at a 5 percent level of significance, with proper signs for the variables and reasonable magnitudes for the estimated regression coefficients.

Elasticities estimated from these two models, (6-20) and (6-25), seemed to be higher than was expected. Thus, an elasticity of -0.62 was found for the variable $FPFS_{t-1}$ and an elasticity of +0.48 for the two years lagged weighted price of beef variable. Both elasticities carried signs which were expected from economic theory. As far as the own-price elasticity is concerned, it can be observed here that M. Petit[5] found a similar elasticity of +0.32 for a two-year lagged beef-price variable, while Cromarty[6] and Wallace and Judge[7] gave short-run price elasticities of 0.037 and 0.043, respectively. These figures would make the beef-feed price ratio elasticity which was found here to equal to 0.02 more reliable.

The elasticities cited above are only rough measures of the influence of price on both the number of cattle to be slaughtered and/or the volume of beef to be produced. They confirm the general view held in the profession that for beef production the price elasticity is small in the short-run.

To see long-run effects of price changes on the number of cattle slaughtered or on the cows milked, application of distributed lag models was made. The application of the lag response for supply analysis largely depends on the fulfillment of two conditions: first, producers have to adjust their plans for output (which are unalternable in short run time period) in the next period on the basis of present or past year's prices; second, livestock product prices are determined by the available supply of these products, i.e.,

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[5]Michel J. Petit, "Econometric Analysis of the Feed-Grain Livestock Economy" (Ph.D. Thesis, Michigan State University, 1964).

[6]W. Cromarty, "Economic Structure in American Agriculture" (Ph.D. Thesis, Michigan State University, 1957).

[7]T.D. Wallace and G.G. Judge, "Econometric Analysis of the Beef and Pork Sectors of the Economy," Oklahoma Agricultural Experiment Station, Technical Bulletin 75, 1958.

prices are taken to be determined by the intersection of the demand curves with vertical supply curves.[8]

The production of beef and milk probably approximates these conditions, and the economic analysis provided the information that the extension of current prices is of major importance in planning future production plans. Production of beef and milk is essentially fixed once the size of the cattle herd is established, although a deviation in production could occur through regulation of feeding practices and/or management.

The time required for beef and milk to be produced depends upon the time required for a change in price to affect supply. The analysis carried out here revealed that the time required for a price change to affect supply was up to six or seven years in the case of milk production (see Table 26) and up to six or eight years in the case of beef production.

It should be noted here that the lag between price and marketing the product is longer than the lag between breeding and slaughter because of the lag between price and farmers' response to it. This latter lag is not determined a priori because it largely depends upon producers' expectations which, in turn, are influenced by the "state of the art" available, institutional organization and farm policy.

Generally speaking, it may be said that whenever farmers expect a price rise to continue they will respond to it, but whenever

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[8]Arthur Harlow, "The Hog Cycle and the Cobweb Theorem," Journal of Farm Economics: 42 (1960): 842-853.

the price rise is thought to be only temporary, it will initiate little or no response. It should also be noted here that farmers' response is different for different movements in prices. An upward movement in the prices of products or feed costs elicits a different response in supply than does a downward movement in the prices of these products. Furthermore, farmers' response is different in its direction for changes in own-product prices than it is for changes in feed cost and other products' prices. It has been observed in this thesis, for example, that there is a negative response between the number of cattle going to slaughter and the beef-feed price ratio and a positive one to milk-feed price ratio (see Figures 6 and 7).

P. Tryfos, writing in 1974 about the Canadian supply of livestock and meat, states that:

> If current prices and costs serve as signals for expected prices and costs, a rise in current price is likely to bring about an increase in current inventories and indirectly a <u>reduction</u> in the quantity that would otherwise be <u>supplied</u>. Similarly, a rise in feed cost will result in a decrease of current inventories and indirectly in an <u>increase</u> of the quantity that would otherwise be <u>supplied</u>.[9]

Tryfos' statement coincides with what empirically was found in this research effort through the application of distributed lag techniques and, more precisely, Almon's technique.

The diagram in Figure 22 below expresses the formation of lags and gives the (sources) causal factors that have an impact on the formation of these lags.

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[9]Peter Tryfos, "Canadian Supply Functions for Livestock and Meat," <u>American Journal of Agricultural Economics</u> 56 (February 1974): 113.

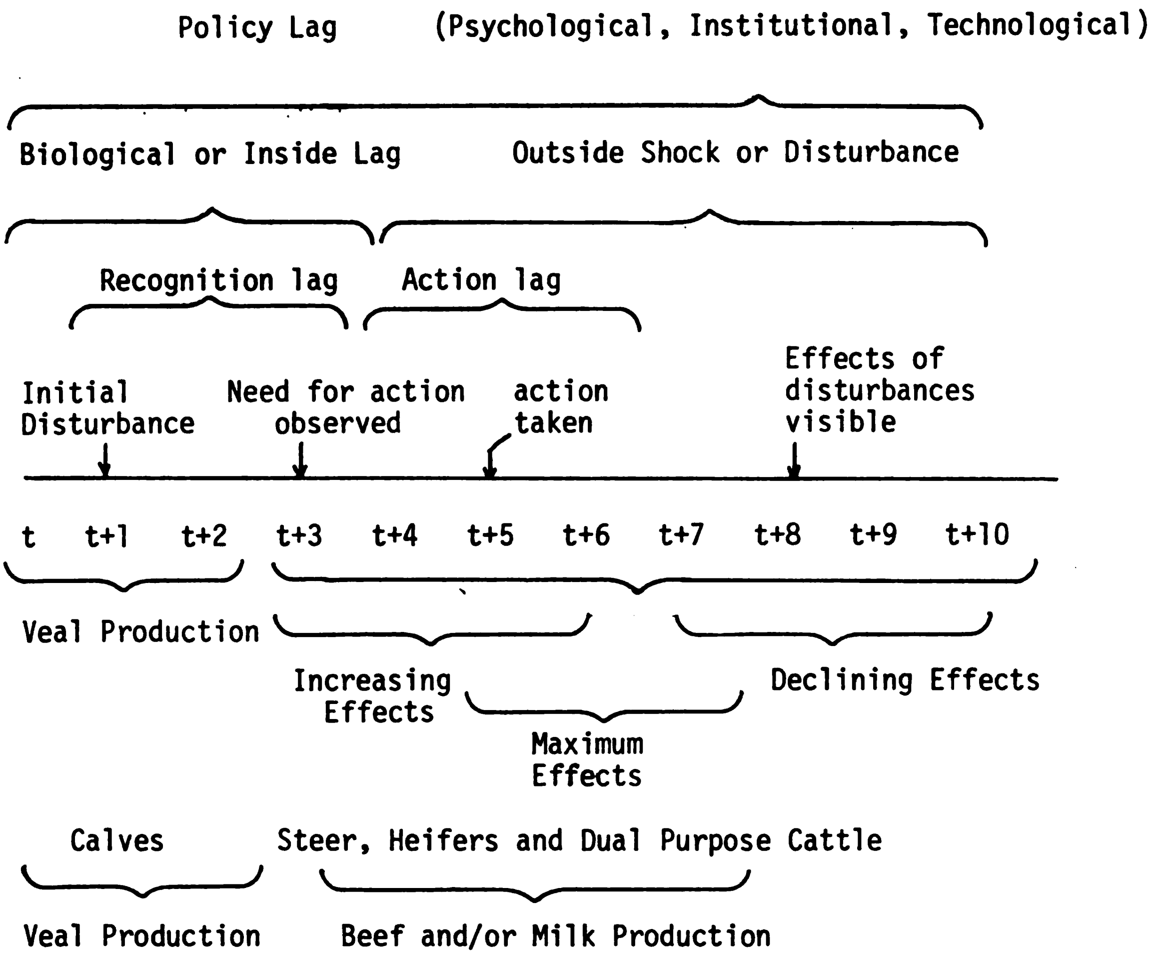

Figure 22: Formation of Time Lag in Veal, Beef and/or Milk Production.

The above diagram could be interpreted as follows. Consider a time scale of one to ten years, and suppose that a farmer establishes his cattle business at year t when he buys the stock of animals and the rest of the necessary equipment needed to run his business. At year t+1 he feels a first disturbance such as change in feed prices, change in beef, veal or milk prices, change in other livestock product or crops prices, a subsidy product program policy, etc., to name the most probable initial disturbances. Period t is taken as the equilibrium period. As far as veal producers are concerned, their recognition and action lags are much shorter than those of beef and milk producers. If the former are going to stay in the veal production business, they have to decide how many calves to slaughter within a very short time. Veal comes from animals aged six to twenty-four months. Thus, within this time span these producers have to form their price (or whatever the disturbance is) perception and act accordingly.

For beef and milk producers the "reaction path" is different and longer. It takes at least two years for a cow to become a beef and/or milk production unit. Given this datum, these producers start thinking about the course of action to be taken at t+3 year and thereafter. They need time, called recognition lag, which, according to the empirical analysis coming from equation (6-30), takes two to three years before these producers have a firmly established perception about the course of action they should take. Thus, one who starts at the t+3 year has a temporary vision of the world during t+3 and t+4 or t+5 years, and a permanent vision (and the course of action to be taken) comes at t+4 or t+5 year. Thus, the effects of any shock or disturbance are visible in periods t+6, t+7, t+8, t+9 and t+10.

The diagram in Figure 22 reveals that the first visible effects due to a price or other disturbances come at an increasing rate at years t+3 to t+6, reach a peak at t+6 to t+8 year and then begin declining thereafter. It is, of course, to be understood here that if disturbances are thrown into the above depicted system in any random way the effects will occur in an unpredictable and random manner as well. This lends support to the view that farm policy and/or import policy has to be consistent and stable for predictable behavior of farmers to be derived. To all these disturbances add the uncertainty inherited in any biological production process and the picture becomes very complicated.

The interrelationships among price, cattle slaughtered and cows milked (or among price and beef and/or milk supply) account for a time lag more or less of six to eight years, and this time lag should be repeated in a cyclical predictable way if there is no outside interference. However, outside disturbances are ever-present and their effect is constantly changing although they do not usually occur in regular, predetermined patterns. This statement is particularly true in the feed-grain-cattle economy in Greece where the major exogenous factors are the price and supply of feed-grain and roughage which, in turn, are affected by weather and/or by world market conditions.

The length of time required for growth and reproduction of a cattle herd results in an inevitable lag in the response to changes in incentives or, generally speaking, in the factors which influence cattle production. By using appropriate polynomial lags a better understanding of both the biological production path and the economic environment of the feed-grain-cattle economy can be obtained.

The distributed lag analysis along with the conventional supply analysis carried out in this study furnishes a more precise, accurate and quantitatively manageable explanation of the supply response analysis. This analysis combined with the corresponding demand analysis for the livestock products examined here and the feed-grain utilized for their production gives a more complete picture of the aforementioned economy and thus contributes to the accumulation of knowledge about the subject-matter of this research effort, an aim which became the major scope in undertaking this research.

Despite the advantages appearing to exist in using the polynomial lag formulation, supply response estimation still seems to be an extremely difficult area of research and effort for at least four reasons.[10]

First, "while widely and previously used, most distributed lag models have almost no or only a very weak theoretical underpinning. Usually the form of the lag is assumed a priori rather than derived as an implication of a particular behavioral hypothesis"[11]. This a priori acceptance of the lag means that a researcher does not get much help as to what type of lag models to accept or reject, a fact which is true even within each family of distributed lag models which is why several models were tried here even within each family of models and the results found differed markedly depending on what type of model was fitted.

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[10]Chen et al., ibid. p. 82.

[11]Zvi Grilliches, "Distributed Lags: A Survey," in Readings in Econometric Theory, Edited by J.M. Dowling and F.R. Glahe (Colorado Associated University Press, 1970), pp. 109-142. This paper was first published in Econometrica 35 (January 1967): 16-49.

Second, since the computational work becomes extremely laborious when more than two lagged variables are used, the distributed lag models must be kept simple in that respect. Furthermore, most distributed lag models utilize time series data where the variation in the output (dependent variable) response is attributed to more than one or two price changes. This deficiency combined with the previous constraint leads to the realization that results derived from these data do not really give the output response for a "once-and-for all" change in a particular price; the estimated output response (supply function) indicates the responsiveness of the output due to several price changes. This is a problem, however, encountered with all the statistical procedures using regression technique.

Third, in case of the polynomial lag formulation the restricted and/or unrestricted lag structure, i.e., the specification of the zeros, plays a crucial role in determining the shape of the lag structure. Thus, Dhrymes[12] states that "...when the zeros are at (2,9), the shape is decidedly humped, while when the zeros are at (-2,9) or (-3,9) we have monotone declining coefficients."

Fourth, estimates based on annual data often imply longer lags than similar estimates based on quarterly data.[13] Grilliches, in the same 1967 paper, gives some commandments for viruous living and they run as follows.

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[12] Phoebus Dhrymes, Distributed Lags: Problems of Estimation and Formulation (San Francisco: Holden-Day, Inc., 1971).

[13] Grilliches, p. 139.

> First, if one is working with strongly trending data one should investigate whether the dependent variables (the x's) provide an adequate explanation for these trends. Do not throw the problem into the residual category without doing something about trend removal. The standard statistical theory applies only to the case of stationary disturbances. In practice, with estimated roots close to unity, it is difficult to discover whether these high estimates are due to a slowly growing component of the series or to long lags in adjustment. Second, test for the possibility of misspecification of the model by including additional lagged terms of the independent variables. Third, if non-linear regression routines are available, use them to test simultaneously for the presence of serial correlation. If not, have some written. Fourth, forget about the Durbin-Watson statistic in this context as a test for serial correlation in the original disturbances. It is very badly biased. Fifth, do not expect the data to give a clear-cut answer about the exact form of the lag. The world is not that benevolent. One should try to get more implications from theory about the correct form of the lag and impose it on the data. Sixth, interpret the coefficients of a distributed lag model with great care, since the same reduced form can arise from very different structures. Moreover, different reduced forms may not differ much in the fit that they provide to the data, but have widely different implications as to the underlying structure that generated the data. Finally, not all is hopeless, but to get better answers to such complicated questions we shall need better data and much greater samples.[14]

Appraisal of the Research Method Used

The primary originality of this thesis lies in the fact that it incorporates all the parts involvedin the feed-cattle economy of Greece and thus gives the whole picture of that economy. Furthermore, some of the analytical insights as far as the analysis of supply

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[14] Grilliches, p. 139.

response of animals slaughtered or cows milked is concerned in the Greek context are given for the first time in this thesis.

The structure of the various models emphasizes the process through which production factors or relative prices are committed to a production and/or consumption of a particular product. In spite of the lack of adequate data and the shortcomings of those which were available, the results obtained in this thesis clearly indicate that this approach is fruitful since these results are quite similar or in some cases "better" than results obtained either within the country or elsewhere in other countries.

In the case of beef and milk supply analysis this study has clearly demonstrated the great importance of the dynamic view of supply as responding to price changes and/or outside disturbances.

Limitations of the Models and Resultant Recommendations for Future Research

The aggregation problem arising due to the utilization of the time-series method relates primarily to the difficulties involved in including relevant variables in order to clearly show or determine the competitive relationships among crop and livestock enterprises. These relationships become extremely complex on a national level, the level undertaken in this research effort. Furthermore, the use of a variable such as "technology" or "time" and "dummy" variables for policy oriented factors in the absence of the absolute values of the variables which are substituted may mean that the present results should be used with caution. Use of variables such as "technology" or "state of the art" usually show "an index of our ignorance," to repeat the words of a professor in the Department of Agricultural Economics at Michigan State University.

The presence of serial correlation and multicollinearity may contribute somewhat to obtaining some inconsistent results, but this is not a major problem since some help could be found in reducing such inconsistencies coming from these sources by employing various techniques available. This fact and the fact that the direction of bias due to other sources of error is not known - these biases may offset each other - makes one more confident in the use of the models employed here.

This research effort has better "value" when it is looked at as complementary to other studies which utilize cross-sectional data at both the micro- and the macro-level.

Thus, this thesis hopefully aids producers and policy makers in becoming better informed about probable future production problems involving beef, veal and milk and the feedstuffs needed to produce them as the various incentives within the feed-cattle economy and/or the outside disturbances change and helps to adjust production according to economic analysis information.

Increased information about the probable outcomes due to changes in prices and other outside shocks to the feed-cattle economy helps to reduce uncertainty and to increase reaction to anticipated prices with a final net result of a better matching of demand and supply forces, resulting in a more satisfactory farm life for farmers and a better urban life for consumers.

Projection of the Feed-Grain Cattle Economy

Some *ex post* predictions were given in Tables 33 and 34 in Chapter VII. The first table referred to predictions just for 1972 and used as a base-period-year only the year 1972, while the second table's predictions were based on a 1969 base period and projections were given sequentially for the years 1970, 1971 and 1972. Generally speaking, these *ex post* predictions were rather accurate, and most of the models could be used for prediction purposes by utilizing Theil's inequality coefficient as a measure of predicting the efficiency of each equation.

At this end point in this research effort the following alternative assumptions which could be used by such a model to make future predictions more reliable were pointed out: (a) consideration of EEC's prices on supply and/or demand of both feed and/or livestock products, (b) alternative rates of growth in population, (c) alternative rates of growth in the Gross National Product and (d) larger or lesser imports of both feeds and/or livestock products coming into the country. These alternative assumptions, however, have been left for further research efforts.

Policy Implications

It was previously shown that Greek consumers, like all the low-income consumers of less developed countries, preferred veal over beef. That preference was attributed to the fact that beef was tough and grass fed, while veal was more tasty and grain fed. As incomes rise, however, it was observed that beef consumption increased over veal since beef-cows were fed grain so that beef was equally tasty as veal though not as expensive. That was the trend in Northern Europe and it has been observed to be a new trend in Greece in recent years.

The above mentioned changes in consumers' preferences imply some steps for Greece's Agricultural Policy to be followed. The policy, of course, should make a distinction between a short-run and long-run time span. In the short-run time span, beef supply cannot easily be increased due to already known biological, institutional and psychological constraints. Domestic demand should be met in this case either be importing beef or by substituting beef for lamb and mutton or poultry meat and pork.

In a longer time span the supply response is greater and the demand for beef influences both the productive capacity of the beef industry and the relative prices of the competitive livestock products. In such a time frame, supply responds to economic, biological and institutional changes since all these factors are considered to be variable. Futhermore, under such a long run view new production possibilities are open to farmers through the selection of a different enterprise combination (substitution).

The high income elasticity of demand for beef at the retail level supports the view that the prospects for beef production are good and it is expected that investment in beef production in Greece should be profitable, if other things remain stable.

It was stressed elsewhere in this thesis that there are three scenarios open to Greece. In what follows some policy implications for Greece's Agricultural Policy will be given in the subsequent sections under each alternative option.

Free Trade Option

Under this scenario imports of both feed grain and beef will continue to take place, and under the ceteris paribus assumption, the enterprise combinations will remain the same. Because of the limited cultivated area, domestic production of feed grains falls short of the direct consumption of feed grains required to produce the livestock products. The upward trend in beef consumption will continue and this trend is indicative of the nature of the beef industry in Greece. The development of this industry is well reflected in the imports of beef and feed grains which are expected to rise as personal disposable income continues to increase. The composition of the national herd is changing gradually from grass-fed cows to grain-fed ones. The first scenarios will support the existing "status quo" of the enterprise combination which, at the present time, works in favor of farmers who produce agricultural products for export and not in favor of consumers who do not pay a "competitive" price to purchase beef and other livestock products.

It is believed that under such a "free-trade" scenario an improvement in the regional structure of the agricultural enterprise combination will take place. Each region will be specialized in the production of that agricultural product in which it has a comparative advantage. Utilization of the comparative advantage contributes to better utilization of natural resources, reduction of unit production costs and improved competitiveness and efficiency in the industries involved.

Self Sufficiency Option

For this solution to be achieved two things ought to happen: either to increase the number of cattle in such a way as to give an increase of total carcass weight by that much as to meet domestic demand or to divert consumption towards other meats and particularly towards pork and poultry meat consumption.

Increase in the number of cattle will mean either increasing imports of live animals from the world market or reducing the consumption of beef, veal and milk until the domestic national herd will be built in such a way as to meet the demand for those livestock products. Furthermore, increase in cattle numbers (or a change in the composition of the national herd which will result in an increase in the average carcass weight of each animal slaughtered) means a change in the enterprise combination. A new enterprise combination will include now more feed grain production to feed the increased number of cattle. This will further mean that relative prices of both feed grains and livestock products will have to increase relative to prices of other agricultural products.

If prices of beef, veal and milk increase in relation to other agricultural products, this could encourage production of these first named products and contraction of the second; but that means that incomes will have to be redistributed and the regional structure of agricultural activities have to be changed. This change in the enterprise combination is expected to have some political repercussions and impacts on the terms of trade, on factors of production and on employment.

Other problems which are expected to rise are due to the interrelationships between production of the livestock products themselves. One of the most difficult problems of policy adjustment in Greece is that related to beef, veal and milk. Beef and veal are substitutes both in production and consumption while beef-veal and milk are joint products in production but unrelated in consumption.

Greece has an overall deficit in beef and veal and an apparent problem in dairy products. Two kinds of options are open to farmers if they want to influence the amount of meat and milk that is marketed. First, if beef prices increase in relation to veal, this could encourage keeping of more calves for beef and increased slaughter weights for both. Second, if milk prices are expected to be high relative to veal, increased amounts of milk may be marketed and less fed on farms.

The objective of increasing beef production and decreasing milk production through the price mechanism at the farm level could be encouraged through the same price mechanism by raising beef prices relative to veal and milk prices. By adopting such a policy it is expected that price adjustment could have a longer term effect through encouraging an expansion in herd size. This is supported by the empirical evidence of long run elasticities found in this thesis for both beef and milk production.

A problem which rises here is that as long as beef-milk production is a joint enterprise milk surpluses will be further increased as a result. This problem is due to the fact that forage capacity and farm produced feed are fully utilized for dairy herds and hogs, and the lack of organization and managerial know-how along with the lack of capital and willingness to take the risk for an integration business explain the surplus milk coming from this joint production. While some expansion of beef production without expansion of milk output could occur based on specialized beef herds in Thessaly and Macedonia and Thrace there is little indication that this will occur in any significant amount. The surplus milk problem could be tackled by undertaking capital investment in milk processing plans since data on milk processed products indicate that a strong effective demand exists for these products in Greece.

The second option open within the self-sufficiency scenario is that of reducing consumption of red meat and increasing the consumption of white meat, mainly pork and poultry meat and meat coming from rabbits fed in specialized production units.

To change the consumption patterns of consumers, however, the following issues have to be considered. First, the relative prices of beef, veal and poultry meat (and/or other meats) should be kept on such a level that a consumer will be compensated enough for his preference diversification in order to stay on the same indifference curve or move to a higher one. This is so from the consumer's point of view.

From the producer's point of view, prices of poultry meat should at least be at the long-run costs for efficient producers to undertake the poultry meat production. At the present time prices in that industry approximate the cost levels. Given the cost-price relationship in the industry, a better quality of poultry meat is expected to appear in the market which, along with improvement in packaging and grading, are expected to have considerable impacts on the increase of this type of meat in Greece.

From the per capita yearly consumption of white meat in other countries and particularly in Spain and Yugoslavia it can be seen that by 1969 this was 13.3 kg in Spain and 13.9 kg in Yugoslavia while Europe's per capita consumption was 10.1 kg and Greece's was 7.3 kg. Taking the per capita consumption and the cost structure of the industry in Greece there is some indication that taste diversification will occur and play some significant role in reducing beef and/or veal consumption in Greece in the years to come.

It seems that the difference in the per capita white meat consumption between Europe and Greece will be given to Greek consumers by more efficient and integrated poultry-meat domestic producers who are accustomed to production centered on purchased feed and who would be responsive to price and/or output.

In the case of hogs, market interference to maintain high prices would bring about increased production. More specifically, this would provide an income effect on many small farms that produce a few hogs along with dairy or other products. Because of the large number of farmers scattered throughout Greece, who produce one or more hogs and raise one to three cattle, political pressures for buying support would be great.

In the case of grain a change in the composition of feed grains will be inevitable. Under the self-sufficiency option a continued expansion of barley, oats and corn relative to wheat and other nongrain products will occur. Wheat prices will decline somewhat relative to barley, oat and corn prices at least in the short-run since a great demand for the first will be observed in order to feed the increased number of livestock animals.

Under the same self-sufficiency option, exports of the traditional products will decline since resources apt to produce these products will be expected to shift into the production of feed grains and livestock products. Thus, under this option some long-run effects will occur when the restoration of the beginning stock will be leveled off. It is thus expected that beef, veal and milk producers will gain along with the feed grain growers. In contrast, consumers and producers who produce for export are expected to lose from such a policy. To support such a view, though, a further quantitative analysis is needed to be carried out so that the intra-industry rates of return could be evaluated and compared.

There are often difficulties with the practical application of the self-sufficiency policy. The greatest of them is that under such a policy declining industries attempt to protect their position in the market and thereby perpetuate inefficiency and waste of economic resources. Even when such a policy is adopted and carried out it is more efficient to offer a direct subsidy (income transfer) as a means of helping the industry to expand. This is so because self-sufficiency imposes on the economy both production and consumption costs while an income transfer embodies only production costs, not consumption ones.

Joining the EEC Option

By joining the EEC market, Greece hopes to expand the market for her agricultural products exported to EEC member countries. EEC's agricultural policy has thus far concentrated on achieving a common market organization with a common price for the same product within this common market area. This has been done through the elimination of the internal trade barriers and an import protection based on variable import levies while exports were assisted through a variable export subsidy. Both the levy and the subsidy are so designed as to balance the difference between EEC price levels and world market prices.

It is well known that price is the principal policy instrument used by the EEC and the effects and pressures generated by EEC policy will depend upon how price as a causative variable interacts with other variables that influence production and consumption (technology and farm structure in the first case and population and income in the second).

Both import elasticities (the own price import elasticity of beef was found here to be -1.44 and the income import elasticity for beef was found to be +3.75) are statistically different from zero and so is the import demand for feed grains (+0.3). These elasticities would be taken to mean that both beef and feed grains will continue to be imported.

Accepting the EEC option, the kinds of shifts available to Greek farmers are, again, through the price mechanism and they are related to relative prices of beef and milk. EEC is still in deficit as far as beef production is concerned. Hence, Greek policy following EEC's Common Agricultural Policy should have either to increase beef prices in relation to veal, which could encourage keeping of more calves for beef and increased slaughter weights for both; or, if milk prices are high relative to veal, increased amounts of milk may be produced which along with EEC's surpluses in dairy products will contribute to increase already existing problems in disposing of dairy products.

The objectives of the increasing beef production and decreasing milk through the price mechanism at the farm level could be encouraged by raising beef prices relative to veal and milk prices. This could be done since, although there was a need to equalize pre-existing national prices, this has not been consistently achieved within each EEC member country. There are thus differences in regional supply and demand within the EEC area itself and the price policy described above for Greece should be able to be carried out with minor modifications.

Greek livestock-product producers consider that the composition of rations used in some EEC countries has shifted to proportionately less grain. Instead, more protein and more by-product feeds in the concentrate rations of livestock and poultry have been used. In the Netherlands, for example, the proportion of grain used declined sharply from 65 percent on the total concentrates fed in 1960-62 to 34 percent in 1970-71. On the other hand, the proportion of protein materials increased nearly by one-third and the by-product feeds were more than doubled. Following such a policy, Greece should be able to change the enterprise combination followed by her farmers, increase sugar beet production, cotton production, grape production, etc., given the crop-grower farmers higher farm incomes while at the same time use these by-products (through processing them in appropriate processing-products-plays) to feed the livestock population.

The main causes for the shift in the composition of the concentrate ration in the EEC countries seem to be the relatively high EEC grain prices (agreed upon in 1962) along with the variable levy that protects the EEC cereal products from competition from imported cereal. Another reason seems to be the fact that there is either a low levy or no levy on by-product ingredients that compete with grains. Included here are the cereal offals like corn gluten feed or bran, dehydrated alfalfa, dried beet pulp, dried citrus pulp, processing by-products, and manioc. By 1972 no levy existed on soybean or soybean meal.

Price policy within the context of the EEC option is expected to affect the relative prices between feed-grain prices and wheat. Wheat prices have been higher than feed grain prices in Greece over the period covered in this thesis, for Greece wanted to achieve a self-sufficiency level in this important food item. This self-sufficiency was achieved late in the 1950s. Greece's wheat prices were higher than those in most EEC member countries except Italy during the 1955-1970 period. The same held true of the other feed grains (barley, oats and corn).

Greece, along with the EEC, in the case of feed grain will largely support a pre-existing tendency toward change in the composition of feed grain output. The close relationship between imported feed grain and the animal population in Greece found in this thesis seems to indicate that a continued expansion of barley, oat and corn production is expected to occur. Wheat prices will decline somewhat relative to other feed grain prices in Greece and in EEC countries.

Price policy could probably effect this balance by changing feed grain prices relative to wheat. This could have some policy implications since it would be important to see whether this kind of adjustment will be brought about either by lowering wheat prices or by raising the prices of other feed grains. In the second case this raising of the other feed grain prices is expected to have an impact on the prices of the livestock products.

The mix of livestock and grain prices in Greece and within the context of the Common Agricultural Policy is expected to cause an expansion in total grain output through a major shift in land use patterns. This is based on the preferences of Greek consumers for tasty and grain-fed-meat which means that beef is expected to be produced mostly on intensive beef production units which are going to utilize more concentrates and/or feed grains.

Forage acreage will be fully utilized to support existing levels or modestly increasing livestock numbers. The most important effect of price changes will be related to consumption. Veal consumption will be decreased due to higher prices while consumption of beef, pork and poultry will be encouraged through lower prices.

The Common Agricultural Policy will allow free movement of agricultural products among EEC countries and areas with a surplus in feed grains will supply the deficit areas with feed grains. The major deficit areas within EEC countries are Germany and Italy. Hence, Greece would have to compete with these two countries in buying feed grains from France, the only surplus area in feed grains within EEC territory.

Thus joining EEC, Greece will still have to look at the world feed grain market to buy the feed grain needed to feed the existing livestock population, but this time Greece will have to accept the variable import levies designed by EEC member countries.

Generally speaking, under the EEC option the following shifts are expected to be observed in the feed grain-cattle economy of Greece. Since feed grain prices have been higher in Greece than in the rest of EEC countries these prices are expected to be lower when Greece becomes a full EEC member and hence farm income for feed grain growers is expected to decline since feed grain prices are expected to be restored at the Community's price level.

Farm incomes are expected to be lower for beef and/or veal and milk producers mainly for the reason that farm prices for these products have been higher in Greece than in the EEC market. Following the common agricultural policy these prices have to be reduced in order to meet the competition from other red meats which will flow into the Greek market. Since red meats coming from the EEC market will be better standardized and priced according to their fat content and other characteristics they will be greatly demanded by those Greek consumers who could afford to buy them. Given the high income elasticity of demand for beef at the retail level in Greece this reasoning seems plausible.

The above exposed analysis would be taken to mean that some marginal feed grain producers and some marginal cattle feedlots in Greece should have to be out of production. The elimination of those marginal farmers could be taken to mean that these people would not be employed for a while. To avoid such economic and social and at the same time political problems a compensating payments scheme, drawing its funds from the EEC's financial institutions should at least alleviate these people's unbearable burden of being unemployed.

It should be noted here that the price mechanism alone will not solve the income problem of most of the low-income (marginal) farmers. The only policy which seems promising to solve that problem is the structural improvement policy which requires a continued reduction in farm numbers, which is a long, painful and difficult process. This structural policy has been recognized in EEC by adopting and executing Mansholt's plan. On the other hand, Greece's farm policy has been oriented towards that end, i.e., it promotes structural changes and favors urbanization of rural people.

But it should be kept in policy-makers' minds that under such an option, "Those who believe that a move to a Common Agricultural Policy is likely to solve, or even appreciably alleviate, the low income problem in EEC agriculture are likely to be disappointed. First, the most prosperous farms are found in northern France and the low countries. These are the countries where the greatest increases in farm incomes will occur under the new policies. This is especially true for the Paris Basin area where the large farms benefit from both higher prices and the removal of the quantum tax. The lowest income farms in Germany, Italy and western France will benefit from the new price policy. Thus, the policies as now formulated will, if anything, increase the income disparities within EEC agriculture; and, moreover, the countries with the lowest-income farms will pay the largest share of the costs of the policy."[15]

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[15] Vernon L. Sorenson and Dale E. Hathaway, "The Grain Livestock Economy and Trade Patterns of the European Economic Community with Projections to 1970 and 1975," Institute of International Agriculture, Michigan State University, East Lansing, Michigan, 1968, p. 117.

APPENDICES

APPENDIX A

TABLE A-1

GEOGRAPHICAL BREAKDOWN OF GREEK AGRICULTURAL TRADE[a]

	TOTAL	NORTH AMERICA	EEC	EFTA	OTHER OECD COUNTRIES	EASTERN EUROPE	OTHER NON-OECD COUNTRIES[b]
IMPORTS				In million US $			
1961	102	20	13	6	5	10	48
1962	87	16	15	6	3	10	37
1963	117	24	20	9	5	17	42
1964	135	28	25	11	8	15	48
1965	185	40	28	12	12	24	69
1966	180	34	35	14	10	18	69
1967	185	30	39	17	6	12	81
1968	185	20	42	12	7	18	86
1969	206	22	47	14	17	17	89
1970[c]	219	17	45	16	14	20	107
EXPORTS							
1961	169	29	50	25	1	42	22
1962	193	16	71	35	1	43	27
1963	231	51	74	32	4	50	20
1964	239	41	87	32	3	54	22
1965	243	26	91	32	8	63	23
1966	287	41	97	36	4	76	43
1967	349	53	135	32	13	69	47
1968	289	39	133	31	10	49	36
1969	288	33	125	27	6	64	33
1970[c]	311	22	142	30	9	73	35

a) SITC 0, 1, 4, 22, 29 and 263 (cotton).

b) Including Yogoslavia, Australia and New Zealand.

c) Provisional. *Figures rounded upwards.

Source: OECD, Foreign Trade Statistics.

APPENDIX B

TABLE B-1

MEAT PRODUCTION (DRESSED CARCASS WEIGHT) IN GREECE
1951-1974 (IN THOUSAND METRIC TONS)

Year	Total All categories of Meat	Beef and Veal Meat	Pig Meat	Mutton Lamb & Goat Meat	Poultry Meat	Other Meat	Edible Offals
1951	82	10	19	36	12		5
1952	96	12	22	45	12		5
1953	98	12	22	51	13		-
1954	116	15	22	57	15		7
1955	134	21	23	60	17		11
1956	152	24	24	73	19	1	11
1957	170	27	29	80	20	1	13
1958	183	31	26	85	20	1	20
1959	188	31	28	84	21	3	21
1960	211	38	29	91	26	7	20
1961	197*	48*	39	79	20	3	14*
1962	222*	55*	41	84	25	2	15*
1963	254*	75*	40	89	30	4	16*
1964	266*	75*	40	97	32	5	17*
1965	317*	93*	49	111	38	3	19*
1966	346*	104	51	115	47	8	21*
1967	368*	113	47	119	58	7	24*
1968	373*	129	44	117	63	4	24*
1969	407*	141	45	125	64	7	25*
1970	449*	138	52	131	74	27	27*
1971	477*	134	63	155	87	10	28*
1972	487*	132*	74	145	98	10	28*
1973	572*	163*	83*	130*	111*	4	81*
1974	551*	134*	89*	125*	117*	4	82*

*= Estimates

Sources: (1) For the years 1961-1974, OECD, pp. 10-13.

(2) For the years 1951-1960, FAO Production Yearbook Series.

(3) FAO Trade Yearbook Series.

TABLE B-2

LIVESTOCK POPULATION 1951-1974
Thousand Head

YEAR	CATTLE	BUFFALO	TOTAL CATTLE	PIGS	SHEEP	GOATS
1951	846	69	915	636	7 326	3 958
1952	876	71	947	587	7 784	4 139
1953	904	72	976	603	8 254	4 510
1954	917	73	990	603	8 738	4 643
1955	957	76	1 033	621	8 970	4 795
1956	981	76	1 057	641	9 275	4 894
1957	1 005	76	1 076	640	9 195	4 939
1958	1 028	75	1 103	631	9 255	5 010
1959	1 046	73	1 119	638	9 374	5 066
1960	1 074	71	1 145	628	9 353	5 064
1961	1 069	61	1 130	547	8 962	4 603
1962	1 060	57	1 117	513	8 899	4 389
1963	1 034	51	1 085	483	8 513	4 153
1964	1 017	43	1 060	486	8 097	3 990
1965	1 046	38	1 084	558	7 819	3 895
1966	1 082	33	1 115	553	7 829	3 945
1967	1 094	27	1 121	492	7 874	4 042
1968	1 038	23	1 061	392	7 724	4 005
1969	997	18	1 051	383	7 680	4 054
1970	952	14	966	446	7 535	4 130
1971	986	10	996		7 686	4 185
1972	1 054	8	1 062		7 906	4 261

Source: (1) Statistical Yearbook of Greece Series. Athens, 1961, p. 174 and Athens, 1972, p. 174.

TABLE B-3

CONSUMPTION, SELF-SUFFICIENCY AND DOMESTIC PRODUCTION OF BEEF AND VEAL IN GREECE 1951-1973. IN THOUSAND TONS AND PERCENTAGES

YEAR	BEEF AND VEAL MEAT		
	PRODUCTION (1)	CONSUMPTION (2)	SELF-SUFF. RATE (3)
1951	10	16	62.5
1952	12	18	55.5
1953	12	14	71.0
1954	15	19	52.6
1955	16	21	76.2
1956	20	24	83.3
1957	22	27	81.5
1958	24	31	77.4
1959	27	31	87.1
1960	29	45	63.8
1961	31	55	56.9
1962	38	63	60.5
1963	47	78	60.2
1964	53	78	68.2
1965	62	95	65.5
1966	73	104	70.1
1967	76	116	65.4
1968	84	136	61.7
1969	86	142	60.5
1970	90	159	56.6
1971	87	133	65.1
1972	91	136	67.1
1973	91	133	68.8

Sources: (1) For 1960-1973, Patsis, P., "Supply and Demand Balances for Agricultural Products," Ministry of Agriculture, Athens, 1975.

(2) FAO Production Yearbook Series. Rates have been calculated by the author.

(3) FAO Trade Yearbook Series. Rates have been calculated by the author.

TABLE B-4

PER CAPITA CONSUMPTION OF MEAT AND MILK IN KGS
PER YEAR GREECE, 1962-1972

Year	Beef and Veal	Veal	Beef	Pork	Mutton and Lamb	Poultry	Meat Total	Cow Milk[1]
1962	6.5	2.5	4.0	4.0	9.9	3.0	26.0	51.57
	8.8	3.2	5.7	4.7	10.5	3.5	29.5	51.22
	8.8	3.9	4.9	4.7	11.4	3.8	30.7	51.92
	10.9	4.8	6.1	5.7	13.0	4.4	36.3	57.16
	12.1	6.3	5.8	5.9	13.5	5.5	39.4	62.31
	13.0	6.8	6.7	5.4	13.7	6.7	41.1	66.09
	14.8	7.9	6.9	5.0	13.4	6.1	41.6	65.30
	16.1	8.1	8.0	5.2	14.2	7.3	45.4	65.24
	18.0	8.3	9.7	5.9	14.9	8.4	49.8	65.42
	16.3	8.5	7.8	6.1	17.5	9.2	51.6	61.36
	16.9	9.6	7.3	6.9	17.1	10.2	54.0	61.43

[1]Cow milk: Calculations carried out by the author.

Sources: (1) OECD, "Meat Balances in OECD Member Countries," Paris, January 1974.

(2) National Statistical Service in Greece. Statistical Yearbook of Greece, Athens, February 1974.

(3) N.S.S.B. Agricultural Statistics of Greece, Years 1964,...,1972.

TABLE B-5

EXPENDITURE ON FOOD. MILLION DRACHMAE AT 1958 PRICES

									AVERAGE RATE OF GROWTH			
	1950	%	1956	%	1963	%	1969	%	50-56	56-63	63-69	50-69
Total Food Consumption	23179	100	29857	100	37665	100	47180	100	4.3	3.4	3.8	3.8
Bread Cereal	6393	28	6373	21	5828	15	5702	12	-0.1	-1.3	-0.4	0.6
Meat	2046	9	3796	13	6386	17	9868	21	10.8	7.7	7.5	8.6
Fish	1134	5	1331	5	2419	6	2704	6	2.7	8.9	1.9	4.7
M-C Eggs	2776	12	4472	15	6379	17	8178	17	8.3	5.2	4.2	5.8
Oil-Fats	3020	13	3616	12	3943	10	3948	8	3.1	1.2	0.2	1.4
Fruit and Vegetables	6148	27	8050	27	9315	25	12493	26	4.6	2.1	5.0	3.8
Other	1662	7	2219	7	3395	9	4287	9	4.9	6.3	4.0	5.1

Source: National Accounts of Greece, Adopted from: N. Tsoris, "The Greek Economu, The Two Decades, 1950-1970," Center of Planning and Economic Research (Athens, 1975).

TABLE B-6

MEAT IMPORTS IN THOUSAND METRIC TONS
SELECTED YEARS. GREECE, 1962-1972

Year	Beef and Veal	Mutton and Lamb	Poultry	Pork	Total Meat
1962	17	1	10	2	30
1963	28	1	15	6	50
1964	22	1	20	6	49
1965	31	2	32	11	76
1966	31	-	34	11	76
1967	37	1	35	12	85
1968	45	4	33	8	90
1969	55	1	36	6	98
1970	68	-	40	3	111
1971	51	-	60	3	114
1972	45	-	46	3	94

Source: O.E.C.D., "Meat Balances in OECD Member Countries," (Paris, January 1974).

TABLE B-7

INDICES OF LIVESTOCK AGGREGATE OUTPUT GREECE, BY PRODUCT GROUPING, 1954-63 (1957/59 = 100)

Year	Product Grouping						Total livestock Productivity
	Cattle	Sheep	Goats	Hogs	Poultry	Rabbits	
1954	81	92	85	98	83	132	87
1955	91	100	98	100	98	130	95
1956	96	97	93	95	100	108	96
1957	96	95	93	102	97	112	98
1958	103	101	98	95	100	100	100
1959	101	103	110	103	102	120	101
1960	106	102	103	105	101	132	103
1961	120	107	108	120	106	160	112
1962	138	110	115	133	113	124	126
1963	150	110	116	139	116	128	134
1954/56	89	97	92	98	94	122	93
1957/59	100	100	100	100	100	100	100
1961/63	136	109	113	130	112	124	125

Source: Lawrence H. Shaw: Postwar Growth in Greek Agricultural Production (Athens, 1969), p. 219.

TABLE B-8

RATES OF GROWTH IN LIVESTOCK AGGREGATE OUTPUT, GREECE, BY REGIONS AND PRODUCT GROUPINGS, 1954/56 TO 1961/63

Product Grouping	Region											Total Greece
	Peloponnese	Central Greece	Thessaly	Epirus	Macedonia	Thrace	Aegean Islands	Cyclades	Crete	Ionian Islands	Dodecannese	
Cattle	7.5	3.3	9.5	9.4	6.8	10.4	11.0	2.1	14.0	3.5	6.8	6.3
Sheep	2.8	2.0	1.7	3.0	1.7	2.9	.5	.5	1.3	4.4	1.4	1.8
Goats	4.9	4.1	1.5	2.4	3.5	1.0	6.7	1.0	1.7	3.1	2.0	3.0
Hogs	6.2	9.9	3.0	8.6	4.2	1.2	1.3	3.1	2.6	5.4	4.0	4.2
Poultry	2.8	5.2	1.5	3.6	2.3	2.3	3.2	1.1	2.1	1.3	1.8	2.5
Rabbits	-.8	-.2	-8.9	-	-1.7	-	-	-	-3.1	-3.2	-	.2
Total Livestock	6.3	6.5	5.7	6.0	4.9	3.4	5.8	-.2	6.2	3.6	4.9	4.3

Source: Lawrence H. Shaw: Postwar Growth in Greek Agricultural Production (Athens, 1969), p. 220.

TABLE B-9

INDICES OF LIVESTOCK AGGREGATE OUTPUT, GREECE, BY REGIONS 1954-63 (1957/59 = 100)

Year	Region											Total Greece
	Peloponnese	Central Greece	Thessaly	Epirus	Macedonia	Thrace	Aegean Islands	Cyclades	Crete	Ionian Islands	Dodecanese	
1954	78	85	89	75	87	87	82	104	82	96	84	87
1955	83	104	102	95	91	96	93	106	89	92	89	95
1956	91	96	95	95	94	95	88	100	92	104	100	96
1957	96	99	97	100	99	99	96	98	96	99	96	98
1958	98	100	99	106	97	98	96	102	103	106	99	100
1959	105	101	104	95	103	102	108	100	101	95	105	101
1960	107	100	110	99	108	110	104	82	113	104	106	103
1961	116	112	127	112	117	117	123	93	117	113	131	112
1962	128	130	143	127	128	119	130	103	136	123	130	126
1963	142	136	152	136	135	116	139	109	148	138	132	134
1954/56	84	95	95	88	91	93	88	103	88	97	91	93
1957/59	100	100	100	100	100	100	100	100	100	100	100	100
1961/63	129	126	141	125	127	117	131	102	134	124	128	125

Source: Lawrence H. Shaw: Postwar Growth in Greek Agricultural Production (Athens, 1969), p. 222.

APPENDIX C

TABLE C-1

AREA, PRODUCTION AND AVERAGE YIELD OF FEED-GRAIN SELECTED YEARS

Year	Wheat			Rye			Barley			Oats			Maize			Fodder Seeds			Fodder Plants		
	A	P	AY	A	P	AY	A	P	AY	A	P	AY	A	P	AY	A	P	AY	A	P	AY
1954	1,045	1,219	1,167	02	51	818	211	233	1,015	135	150	1,083	253	254	1,005						
1960	1,142	1,666	1,457	29	28	965	181	240	1,325	128	149	1,164	210	288	1,371						
1965	1,258	2,072	1,647	16	16	1,000	203	338	1,665	120	150	1,250	144	249	1,729	170			901		
1966	1,132	2,020	1,784	14	15	1,070	284	563	1,982	118	167	1,415	139	275	1,978	151			937		
1967	1,051	1,936	1,746	11	13	1,181	351	774	2,205	111	153	1,378	133	313	2,353						
1968	1,098	1,568	1,428	8	8	1,000	332	471	1,418	92	98	1,065	148	344	2,324						
1969	1,078	1,723	1,598	8	9	1,125	282	447	1,585	84	102	1,214	149	413	2,771						
1970	985	1,930	1,959	7	9	1,285	241	718	2,015	80	106	1,325	170	481	2,829						

Source: (1) N.S.S.G. Statistical Yearbook of Greece, Athens, 1971, p. 167.

A: Acres in thousand.

P: Production in thousand tons.

AY: Average Yield in Kg/hectare.

(2) For Fodder Seeds and Fodder Plants: N.S.S.G. Agricultural Statistics of Greece, Year 1966, Athens, pp. 16-17.

BIBLIOGRAPHY

BIBLIOGRAPHY

Alt, L.F. "Distributed Lags." Econometrica 10 (1942):113-128.

Ananikas, L. "Potential Livestock Production Adjustments on Family Farms in Central Macedonia, Greece." (Ph.D. Dissertation, Michigan State University, 1975).

Brandow, G. Interrelations Among Demands for Farm Products and Implications for Control of Market Supply. Penn State Univ. Ag. Exp. Sta. Bul. 680, 1961.

Branson, H.W. Macroeconomic Theory and Policy. New York: Harper and Row Publishers, 1972.

Brunner, Karl (ed.). Problems and Issues in Current Econometric Practice. Columbus: The Ohio State University, College of Administrative Science, 1972.

Chen, Dean, Courtney, R. and Schmitz, Andres. "A Polynomial Lag Formulation of Milk Production Response." American Journal of Farm Economics 54, No. 1 (Feb. 1972).

Cochrane, D. and Orcutt, G.H. "Application of Least Squares Regressions to Relationships Containing Autocorrelated Error Terms." Journal of the American Statistical Association 44 (1949).

Cochrane, W.W. "Conceptulaizing the Supply Relation in Agriculture." Journal of Farm Economics 27 (Dec. 1965).

Cromatry, W. "Economic Structure in American Agriculture." Ph.D. Dissertation, Michigan State University, 1975.

Dhrymes, Phoebus. Distributed Lags. Problem of Estimation and Formulation. San Francisco: Holden Day, Inc., 1971.

Evelpidis, C. Chronia Georgiki Krisis is tin Ellada. Athens: Papazisis, 1953, pp. 3, 18, 42, 43). "The Permanent Farm Crisis in Greece" (in Greek). Athens: Papazisis, 1953.

F.A.O. Production Yearbooks 1948 to 1973.

F.A.O. European Breeds of Cattle, Vol. II (Rome, 1966).

F.A.O. Trade Yearbooks 1951 to 1973.

Ferris, J.N. "Dynamics of the Hog Market with Emphasis on Distributed Lags in Supply Response." Ph.D. Dissertation, Michigan State University, 1960.

Fisher, Irving. "Note on a Short Cut Method for Calculating Distributed Lags." Bulletin de L'Institut International de Statistique 29 (La·Haye, 1937).

Foote, R., Klein, J., and Clough, M. The Demand and Price Structure for Corn and Total Feed Concentrates. USDA Techn. Bull., No. 1061, Oct. 1952.

Fox, Karl A. Econometric Analysis for Public Policy. Ames: Iowa State College Press, 1958.

Frost, P. "Some Properties of the Almon Lag Technique when One Searches for Degree of Polynomial and Lag." Journal of the American Statistical Association 70 (1975).

George, S.P. and King, G.A. "Consumer Demand for Food Commodities in the United States with Projections for 1980." Giannini Foundation Monograph 26, California Agric. Exp. Station, March, 1971.

Gemmill, Gordon. "The World Sugar Economy: An Econometric Analysis of Production and Policies." Ph.D. Dissertation, Michigan State University, 1975.

Grilliches, Zvi. "Distributed Lags: A Survey." In Readings in Econometric Theory, Edited by J.M. Dowling and F.R. Glahe. Colorado Associated University Press, 1970, pp. 109-142. This paper was first published in Econometrica 35 (Jan. 1967).

Halvorson, H. "The Response of Milk Production to Price." Journal of Farm Economics 40 (1958).

Harlow, A.A. Factors Affecting the Price and Supply of Hogs. USDA Technical Bulletin, No. 4, 1962.

________. "The Hog Cycle and the Cobweb Theorem." Journal of Farm Economics 42 (1960).

Hicks, T.R. Value and Capital. Second Edition. Oxford: Oxford University Press, 1953.

Hirschman, O.A. Exit, Voice and Loyalty. Boston: Harvard University Press, 1970.

Kalaitzis, V.C. "Economic Consequences of the Grain Storage Program in Greece." SYGHRONDS GEORGIA (May-June, No. 3/1977), Athens, Greece (in Greek).

Kalaitzis, V.C. "Observations on the New Institution of Group Farming Enterprises." Hellenic-Agricultural Economic Review 9, No. 2 (July 1973).

Kelejian, E.E. and Oates, W.E. Introduction to Econometrics: Principles and Applications. New York: Harper and Row, Publishers, 1974.

Kitsopanidis, G. "The Economics of Milk Production in Central Macedonia, Greece." Reprint from the Hellenic Agricultural Economic Review, 6, No. 1 (Thessaloniki, 1970).

Kmenta, Jan. Elements of Econometrics. New York: The Macmillan Company, 1971.

Koopmans, T. "Identification Problems in Economic Model Construction." Cowles Commission Monograph, No. 14, 1945.

Koutsoumaris, G. "Resource Productivity and Development Policy for Greek Agriculture - An Illustrative Study." Journal of Farm Economics 36 (1954).

Koyck, M.L. Distributed Lags and Investment Analysis. Amsterdam: North Holland Publishing Company, 1954.

Kulshreshtha, N.S. "Canadian Cattle and Calves Industry: A Distributed Lag Analysis." Dept. of Ag. Econ., Univ. of Saskatchewan, Saskatoon, Canada, March 1975.

Lard, C. "Profitable Reorganization of Representative Farms in Lower Michigan and Northeastern Indiana with Special Emphasis on Feed Grains and Livestock." Ph.D. Dissertation, Michigan State University, 1963.

Mariadis, S. and Kalaitzis, V.C. "Collective Farming. A Solution to the STructural Problem of Small Farm Acreage in Greece." Geoponika (July-Aug. 1976) (in Greek).

Myrdal, Gunnar. An International Economy. Problems and Prospects. New York: Harper and Row, 1956.

National Accounts of Greece, 1948-1970, No. 21 (Athens, 1972).

National Statistical Service of Greece. Statistical Yearbook of Greece. Athens: Several years.

Nerlove, M. "Estimates of the Elasticities of Supply of Selected Agricultural Commodities." Journal of Farm Economics 28 (1956).

_______. The Dynamics of Supply: Estimation of Farmer's Response to Price. Baltimore: John Hopkins University Press, 1958.

OECD. Agricultural Policy Reports. Agricultural Policy in Greece. Paris, 1973.

Oury, B. A Production Model for Wheat and Feed Grains in France (1946-1961). Amsterdam: North Holland Publishing Company, 1966.

Papaioannou, M. "An Analysis of the Supply and Demand Condition in the Animal Breeding Industry in Greece." Ph.D. Dissertation, Oxford University, 1970.

Pepelasis, A. "To Provlima Tou Mikrou Klirou," "The Problem of Small Farm Holdings" (in Greek). Agrotiki Trapeza, Tephchi 10-12, 1976. And by the same author: "Agrotiki Politiki Kai Anaptixi." Athens: Papazisis, 1976.

Petit, Michel J. "Econometric Analysis of the Feed-Grain Livestock Economy." Ph.D. Dissertation, Michigan State University, 1964.

Pezmadjoglou, J. "I Ellas Enanti ton Taseon Evropaikis Ikonomikis Enopiiseo." Athens, 1958 (in Greek), "Syndesis tis Ellados Meta tis Evropaikis Ikonomikis Kinotitos." Athens, 1962.

Reuttinger, S. "Short-Run Beef Supply Response." American Journal of Agricultural Econmics 48 (Nov. 1966).

Rojko, A.S. The Demand and Price Structure for Dairy Products, USDA Technical Bulletin 1168, 1957.

Shaw, L.H. "The Effect of Weather on Agricultural Output: A Look at Methodology." Journal of Farm Economics (1964):218-30.

Shaw, Lawrence H. Postwar Growth in Greek Agricultural Production. Athens: Center of Planning and Economic Research Special Studies Series, 1969.

Shumway, C.R., Bentley, E., and Barric, E.R. "Economic Analysis of a Beef Production Innovation: Dairy Beef Cross-breeding." North Carolina State University, Dept. of Economics, ERP-26, March 1974.

Theil, H. Principles of Econometrics. New York: John Wiley and Sons Inc., 1971.

________. Economic Forecast and Policy. Amsterdam: North Holland Publishing Company, 1965.

Thomas, James. Notes on the Theory of Multiple Regression. Athens: Center of Economic Research, 1976.

Thompson, K. Farm Fragmentation in Greece. The Problem and Its Setting. Athens: Center of Planning and Economic Research, 1963, p. 29.

Trapp, J.N. "A Polynomial Distributed Lag Model of Pork Production Response." Dept. of Ag. Econ. Staff Paper No. 75-29. East Lansing: Michigan State University, 1975.

________. "An Econometric Simulation Model of the United States Agricultural Sector." Ph.D. Dissertation, Michigan State University, 1976.

Triantis, S. "Common Market and Economic Development. The EEC and Greece." Athens: Center for Planning and Economic Research 1965, p. 48.

Trimble, Richard L. "An Economic Analysis of the Effect of Monetary Policy on the Beef Industry." Ph.D. Dissertation, Michigan State University, 1973.

Tryfos, Peter. "Canadian Supply Functions for Livestock and Meat." American Journal Farm Economics 56, No. 1 (Feb. 1964).

United Nations Economic and Social Council, World Food Conference, Notes by the Secretary General, November 22, 1974. "Hunger and Diplomacy: A Perspective on the U.S. Role at the World Food Conference." Submitted to the Subcommittee on Foreign Agriculture, Committee on Agriculture and Foresty, United States Senate. Washington, D.C.: U.S. Government Printing Office, 1975.

United States Department of Agriculture. "Western Europe's Beef Production Consumption and Trade." ERS-Foreign 367, Sept. 1974.

Waugh, F. Demand Price Analysis: Some Examples from Agriculture. USDA, ERS, Technical Bulletin, 1964.

________. Demand and Price Analysis. USDA Technical Bulletin 1316, Nov. 1964.

Wallace, T.D. and Judge, G.G. "Econometric Analysis of the Beef and Pork Sectors of the Economy. Oklahoma Agricultural Experiment Station, Technical Bulletin 75, 1958.

Wilson, R. and Thomson, R.G. "Demand, Supply, and Price Relationships for the Dairy Sector, Post-World War II Period." Journal of Farm Econmics (May 1967).

Working, Womer J. Demand for Meat. Chicago: University Press, 1954.

Yotopoulos, P. Allocative Efficiency in Economic Development. Athens: Center of Planning and Economic Research, 1976.

Zolotas, X. "I Ellas Kai i E.O.K." Oikonomikos Tachydromos, 1976.