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DETERMINATION OF THE OPTIMUM INTERPROVINCE FLOW AND DIFFERENCES OF PRICES FOR FLUID MILK IN SPAIN

By

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I. INTRODUCTION

The present world alimentary situation requires the production of more food and with greater efficiency; special importance is being attached to animal products in general and to milk in particular. Spain is no exception to this and her milk supply should be made to correspond with the demand and efficiency should be increased.

Milk production in Spain in 1972[1] was about 3,784 million liters[2]--a low figure when the facts that her population is more than 34 million and that the number of visitors she receives each year keeps increasing are taken into account. This relatively low production prevails despite the fact that some regions of Spain are very suitable for milk production. A priori, structural problems, migration, limited capacity of existing plants and the pricing system seem to be negative factors with respect to increased production.

Prices, in particular, play a central role in economic theory in guiding production and consumption. Of course, prices alone do not determine the production decisions of farmers in general or dairymen, in particular--nor the buying

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[1]Ministerio de Agricultura. "La agricultura española en 1972"

[2]One liter of milk is equivalent to 1.056 liquid quarts or 2.27 pounds.

decisions of consumers. Government programs, personal preferences, climatological and edaphic conditions, the availability of equipment or credit, etc. also have a strong influence on production. But prices, and especially relative prices, do influence human behavior.[3]

Although milk prices in Spain are not entirely determined by the free play of market forces, the pricing decisions, whether made on the basis of market forces or political or welfare considerations, have important economic consequences. The pricing mechanism can, in fact, play a decisive role in the improvement of the performance of the dairy sector of Spain and an attempt to understand some of the basic forces in milk pricing seems to be necessary. Thus, it is important, in the first place, to understand the basic forces shaping the present system in order to assist the participants in their planning and also to assist in developing relevant public policy that would help to improve the performance of the system.

Objectives of the Study

This paper is designed to analyze the present milk pricing system of Spain and to identify opportunities for its improvement. The general objectives of providing descriptive, diagnostic, predictive or projective and prescriptive

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[3]However, neither producers nor consumers respond to price changes in a mechanical way. The degree of responsiveness of quantity taken to give size price changes may change with the passage of time.

information will include the following: (1) to describe the more important characteristics of the milk pricing system of Spain; (2) to diagnose some of the shortcomings of the present system; and (3) to prescribe possible changes in the pricing system leading to improved performance. However, no attempt will be made to project the future configuration of significant economic variables.

More specifically, the objectives of the study will be:

(1) to analyze the present milk pricing regulation of Spain, trying to provide answers to such questions as: What price regulations are used and how do they work? What is their economic rationale? How are farmer prices established? How are consumer prices established? Have there been innovations in milk pricing over the last seven years?

(2) To determine the optimum flow of raw milk destined to fluid consumption from the surplus to the deficit provinces in order to minimize transportation costs, and to determine the optimum differences of prices among provinces.[4]

Methodology

The first step in attempting to achieve these objectives will involve a comprehensive description of the existing

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[4]This will present an alternative to the present system of differences of prices based on real costs of production, and ecological, edaphic and farming characteristics of the different regions.

system of pricing milk in Spain. This will be directed at evaluating its performance.

The second step will include the construction of a linear programming transportation model that will take into account production, consumption, surpluses and deficits of each of the forty-seven peninsular provinces of Spain and the transportation costs among them. This model will be chosen instead of a more elaborate one due basically to the limited availability of data.

The specific pieces of information required will include:

(1) Actual quantity of milk destined to fluid consumption produced in each province;

(2) consumption of fluid milk in each province, and

(3) a transportation cost matrix which specifies the cost of transporting a unit (liter) of raw milk between each point of origin and destination.

Analytical Framework

The marketing system has been defined as "the complex pattern of institutions and physical facilities which relate human beings and things in the transfer of goods and services." The part of the social system governing the transactions (which result in the exchange of property rights of future control of assets) is the exchange system, the actual transfer of goods being associated with it.[5]

[5]Schmid, A. A. and J. D. Shaffer. "Marketing in Social Perspective," in Agricultural Market Analysis, edited by V. Sorenson, Michigan State University, 1964.

The exchange systems of different societies have been classified in three broad types: status, administrative and bargained or market system. It may be better, however, to think of this in terms of a dichotomy between "market" and "central planning" economies. In any case, there is no pure type and a mixed economy, with both free enterprise and planning, is a fairly common alternative. The solution of the problem of allocating scarce resources is determined either by an authoritarian system or by the pricing system or by some combination of the two.

In a mixed economy, in a very simplified way, the market[6] is a system of adjustment in which the quantities supplied and demanded are equaled through the price mechanism, with room for marginal changes, i.e., changes in the variables defining the market. The intervention of the government makes, on the contrary, structural changes (directed toward making the performance of the market correspond with the objectives of the economy, or even to substitute for the market in the functions which it cannot perform adequately).

This is basically the context of the milk market of Spain, where the price that every dairy farmer receives for

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[6]The market is considered here as a conceptual more than a physical term, that is, a sphere of influence where exchanges are made rather than the concrete concentration of demanders and suppliers of a sector in a determined place and period of time.

his milk and the price that every consumer pays for hygienized milk are affected by legislation under which the Presidency of the Government, at the request of the Ministers of Agriculture and of Commerce, and taking into account information provided by several government agencies[7] is required to take certain price actions. There exist, thus, partial governmental intervention in the system, through setting of minimum prices to the farmers for raw milk and maximum prices for hygienized milk at the consumption level, and through some degree of control over the processing plants. At the same time, there is freedom to buy raw milk for different uses and to price sterilized milk and other dairy products. It is in this context or environment that this study is undertaken.

The major concern will be the milk pricing system at the different stages of the marketing system, but especially at the farm level. Marketing will be viewed as a part of a set of activities coordinating the different steps in the production-distribution system, the distinction between production and distribution processes being a matter of degree along the transformation process. Marketing activities, by their part, will be considered as a "system," connected in a meaningful way and interacting among them. Marketing is, thus, conceived in a broad context, including both the

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[7]For example, the Ministry of the Interior; FORPPA--an organism unifying the measures relative to agricultural market arrangements whose functions are to control the regulations of prices and productions--CAT--Board of Supplies and Transporation--, etc.

physical aspects of the different marketing services and social variables in exchange.[8] The milk system, therefore, includes all the participants involved in the production, processing and distribution of milk, in the milk flow from the initial inputs to the final consumers; it will include also all the institutions which affect and coordinate the succesive stages of milk flow.[9]

Price Equilibrium in Spatially Separated Markets

Geographical price relationships can be analyzed in a formal way by using spatial equilibrium models, which make possible the estimation--under somewhat rigid assumptions--of the net price that will prevail in each region and the quantity of a given commodity that any region will sell or

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[8]This conceptualization of market activities as a functioning system can help to see how each activity is related to others and how actions taken to affect one activity within the system may affect the previous and posterior ones; it also suggests that functions take place internally and that there may be forces external to the system influencing it.

[9]Shaffer, J. "On the Concept of Subsector Studies," (Mimeo), Michigan State University, 1970. In this sense, it will also be necessary to deal with some other aspects of the milk subsector, where a subsector is defined as a "meaningful grouping of economic activities related vertically and horizontally by market relationships". The milk subsector includes the production and distribution of basic inputs to dairy farming, production and assembly of raw milk, processing and transportation of fluid milk and dairy products, retailing and consumer acquisition. It could also be expanded to include some of the inputs of these processes, such as the wholesale prepack distribution industry as an input to pasteurized milk, for example. However, the boundaries of a subsector have to be arbitrarily set to make the research manageable, the main characteristics of these kinds of studies being their conprehensiveness, since they include both vertical and horizontal relationships in significant parts of a subsector.

purchase from every other region. The optimum[10] trading pattern (given supply and demand conditions within each region) can be then determined with such models. From this optimum trading pattern, moreover, an appropriate set of prices for all regions can be obtained.

The general principle involved in developing inter-regional trade models can be illustrated with the aid of diagrams showing the supply and demand functions for each of two regions. At this point, prices for raw milk in several spatially separated markets and the flow of raw milk in inter-market (interprovince, in this case) trade will be considered.

The Two-Province Case

This simple case involves milk produced and consumed[11] in two provinces. Supply and demand curves are taken as given for each province and, in the absence of trade, these curves determine the price of milk in each province (Figure 1). Without trade, therefore, these prices and the corresponding quantities produced and consumed will represent equilibrium conditions.

However, if contact between provinces A and B is made, it will be found that the price of milk is lower in B than in A. If the price of B plus the transfer cost from B to A

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[10] Where optimum is defined as the "least-cost" trading pattern.

[11] Processing costs will not be considered here, since it will be assumed that they are the same in each province.

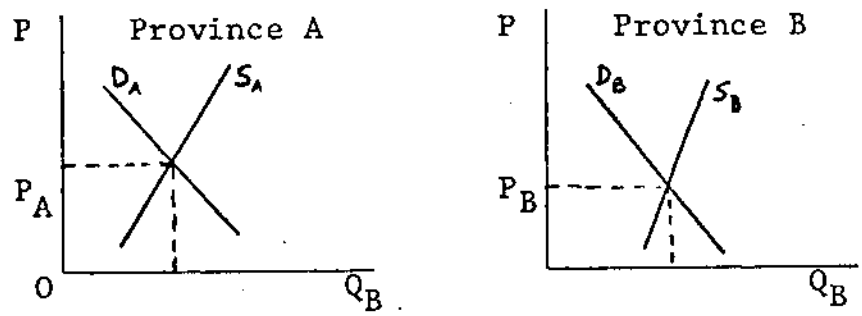

Figure 1. Equilibrium in two provinces, without trade.

is lower than the price in A, it will be possible to buy milk in B, transfer it to A and sell it there at a profit. As part of the supply of milk available at B is transferred to A, however, the price in A will decrease while the price in B will increase. Arbitrage will continue so long as the price in A exceeds that in B plus transfer cost from B to A. Eventually, the flow of milk from B to A will be just large enough to move prices in the two provinces toward each other until they differ exactly by the transfer cost.

Equilibrium prices, however, will be lower in the exporting province than in the importing one, the difference equaling the transfer cost. The opening of trade between provinces has the effect of bringing the combined demand of the provinces to bear on the combined supply conditions. However, to add supply and demand curves it will be necessary to displace them to reflect transfer costs. In Figure 2, the supply and demand curves for province B--the exporting province--have been moved upward an amount t, representing the cost of transporting one unit (liter) of milk from

province B to province A. With this construction, any horizontal line across the diagram does not represent equal prices in the two provinces, but prices that differ by transfer costs. The combined supply and demand curves have been expressed in terms of prices in province A but the contributions of province B are included at the lower level of prices prevailing in it.

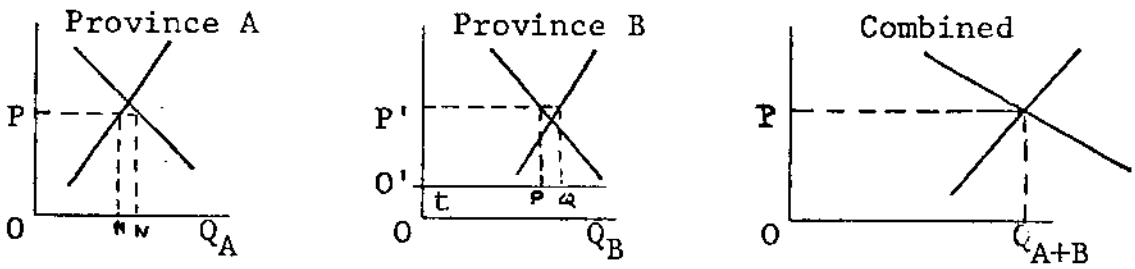

Figure 2. Equilibrium in two provinces, with trade.

An alternative representation is the back to back diagram of Figure 3. Here, the supply and demand curves for province B are plotted on the right half of the diagram in conventional form, but displaced upward by an amount t which represents the cost of interprovince transportation. Supply and demand curves for province A, however, have been reversed on the left half of the diagram. Quantities are measured to the right of the origin O for province B but to the left for province A. Any horizontal line on this diagram represents prices in the two provinces that differ exactly by transfer costs.

If excess supply curves, ES_A and ES_B, are plotted for each province showing the amount by which the quantity offered

for sale exceeds the quantity demanded at various levels of prices, their intersection I defines the equlibrium prices with trade (equal to OP in A and O'P in B) which differ by t (or OO'). PI represents the volume traded and is equal to the quantity PQ shipped by B and the quantity MN received by A.

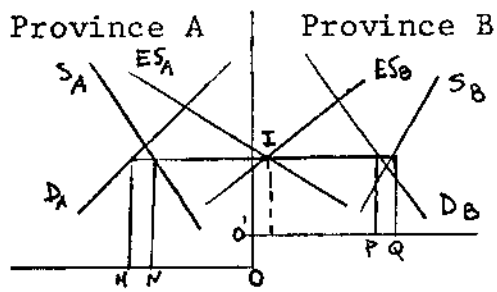

Figure 3. Equilibrium in two provinces, with trade; back to back diagram.

By simple extension of the argument it should be clear that trade will take place between two provinces only if the prices in isolation differ by more than transfer costs, and that prices in one province can differ from prices in another by an amount within the range of plus or minus transfer costs without giving rise to milk movements.

A change in the volume of trade or in the price relationships between provinces may occur if (1) any province's demand or supply curve shifts or (2) the transfer costs change.

Multi-province Model: Programming Solution

When more than two provinces are involved it is necessary, in order to obtain a solution, to know the supply and demand

schedules and solve for the prices at which aggregate demand and supply will be equaled. Linear programming techniques are used to determine the optimum--or least cost--transfer system.

A broader class of regional trade problem, therefore, can be analyzed by using a relatively simple model in which it is assumed that given quantities of a homogeneous product are produced at m supply points and that given quantities of the same product are consumed at n demand points. Each pair of supply-demand points is assumed to be connected by transportation facilities over which any amount of the product can be shipped at a given cost per unit (which is specified for each pair of trading points).

The "transportation problem"[12] is a special case of linear programming which has certain features that allow a short cut solution. It was conceived to give a minimum transfer cost in satisfying a given set of needs from a given set of sources. The needs of each point and the capacity of each source are predetermined, total needs equal total capacity and thus, all coefficients of the matrix can be converted to one or zero.[13]

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[12]The transportation problem was originated by F. L. Hitchcock. "The distribution of a product from several sources to numerous localities" (Journal of Mathematics and Physics, 20:224-230(1941)).

[13]This may seem unduly restrictive, but it is not difficult to generalize the procedure to cover a large group of problems where the objective is to give a minimum cost in satisfying any set of outputs from a given set of

The problem, then, is one of determining the lowest transportation cost in satisfying fixed consumption needs of given regions from fixed production levels within the same regions, determining how much of the product from each location should be shipped to each destination. The method may also be used normatively to show how the output of numerous producers at many locations "should" flow to many consumer centers, if competitive conditions are to be attained and costs are to be minimized.

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inputs. This can be applied to any problem meeting the following characteristics: (1) One unit of any input can be used to produce one unit of any output, (2) the cost resulting from converting one unit of a particular input into one unit of a particular output can be expressed by a single figure regardless of the number of units converted, (3) the quantity of each individual input and output is fixed in advance and the total of the inputs equal the total of the outputs.

II. THE DAIRY SECTOR OF SPAIN

Livestock production in Spain accounted for 38.6 percent of the total agricultural production in the 1971-72 agricultural year (Table I). Production of milk made up 23.8 percent of the livestock production, or 9.1 percent of total agricultural production (Table II). The contribution of milk and dairy products to total agricultural production was 35.1 billion pesetas,[14] plus the value of the in-farm consumption, estimated at 7.6 billion pesetas.

Table I. Value of Agricultural Production, Spain 1971-72 (Not Including in-farm Consumption).

Subsectors	Value (Billion Pesetas)	Percentage of Total
Crops	221.5	58.0
Livestock	147.7	38.6
Forestry	12.9	3.4
Total	382.1	100.0

Source: Ministerio de Agricultura. "La Agricultura española en 1972."

Milk Production

Since 1959 there has been a gradual increase in the quantity of cow milk produced in Spain (Figure 4). Total cow milk production in Spain in 1971 was 3.57 billion liters plus .69 billion liters which were fed to the calves.

Production in 1959 was 1.89 billion liters (Table III).

Table II. Value of Livestock and Livestock Products Produced in Spain, 1971-72.

Products	Value (Billion Pesetas)	Percentage of Total
Livestock	94.3	63.9
Milk	35.1	23.8
Eggs	17.2	11.7
Wool	0.7	0.5
Honey & Beeswax	0.2	0.1
Total	147.5	100.0

Source: Ministerio de Agricultura. "La Agricultura española en 1972."

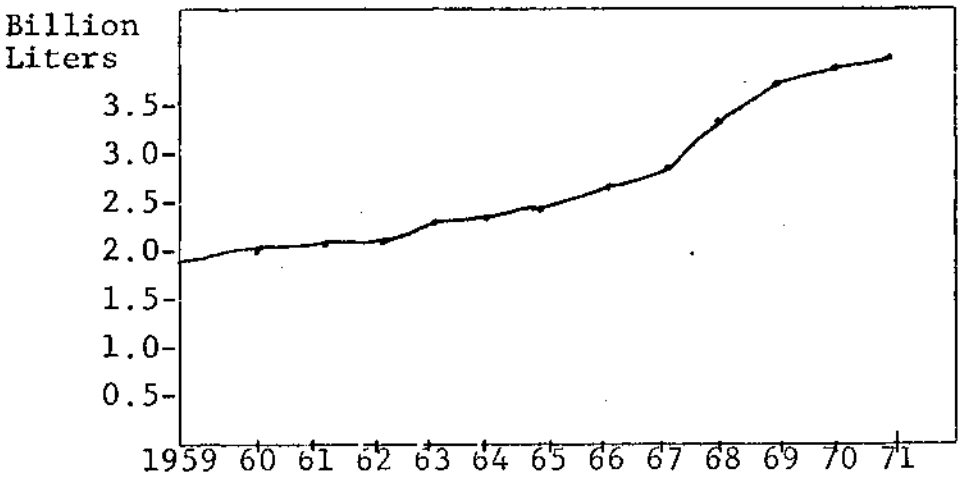

Figure 4. Cow milk production in Spain, 1959-71 (Billion liters).

Most milk sold by farmers in 1971 was in the form of whole milk and 66.5 percent of the milk marketed that year was consumed as fluid milk (Table IV).

Table III. Cow Milk Production in Spain, 1959-71 (1959 = 100).

Year	Amount Produced (Billion Liters)	Production as a Percentage of 1959
1959	1.89	100.0
1960	2.01	106.3
1961	2.15	113.7
1962	2.17	114.8
1963	2.29	121.1
1964	2.31	122.2
1965	2.34	123.8
1966	2.64	139.5
1967	2.92	154.5
1968	3.27	1972.8
1969	3.54	187.3
1970	3.55	187.8
1971	3.57	188.8

Source: Ministerio de Agricultura. "Anuario estadistico de la produccion ganadera 1971."

Table IV. Use of Milk in Spain, 1972.

Use	Amount (Billion Liters)	Percentage of Total
Fluid milk	2.34	65.5
Cheese	0.45	12.7
Butter	0.19	5.3
Condensed milk	0.23	6.4
Powder milk	0.15	4.2
Others	0.21	5.9
Total	3.57	100.0

Source: Ministerio de Agricultura. "La agricultura española en 1972."

The number of dairy cows on farms in September, 1972, (Table V) was 1,193,982 (872,302 of them being Friesians). There were also 676,649 cows of double aptitude (meat and milk or labor and milk). The number of heifers was 534,865.

Table V. Number of Milk Cows on Farms in Spain, September, 1972, by Breeds.

Breed	Number	Percentage of Total
Friesians	872,302	45.8
Brown Swiss	170,160	9.1
Other Breeds	151,514	9.0
Total Dairy Cows	1,193,982	63.9
Double Aptitude	676,649	36.1
Total	1,870,631	100.0

Source: Ministerio de Agricultura. "Censo de la Ganaderia Española" September 1972.

Milk output per cow was extremely variable, depending on breed and feed conditions. The existence of both exclusive dairy cows (63.9 percent) and double purpose cows (36.1 percent) makes the average national milk output per cow less meaningful.

Milk production tends to be concentrated in the Northern part of the country. Oviedo, with 468.65 million liters, was the leading producer province in 1971, followed by Santander with 393.41 and La Coruña with 234.85. These three provinces contributed more than thirty percent of the

total milk production of the country's fifty provinces in that year (not including milk fed to the calves).

Table VI, finally, gives the the leading producer provinces of the Peninsula in 1971.

Table VI. Ten Leading Producer Provinces of Spain, 1971.

Province	Production (Million Liters)			
	Fed to Calves	For Fluid Milk	Manufacturing Quality	Total
1. Oviedo	54.13	292.45	176.20	522.78
2. Santander	65.82	134.13	259.28	459.23
3. La Coruña	107.80	160.62	74.23	342.65
4. Lugo	110.11	83.71	100.22	244.04
5. Leon	18.34	151.71	68.21	238.26
6. Pontevedra	28.38	123.45	71.59	223.42
7. Madrid	9.16	82.05	52.07	143.28
8. Vizcaya	17.70	111.46	10.01	139.17
9. Gerona	25.73	61.00	48.11	134.84
10. Orense	1.63	68.50	48.27	118.40

Source: Ministerio de Agricultura. "Anuario Estadistico de la produccion ganadera, 1971."

Milk Consumption

Per capita consumption of milk and dairy products has been increasing since 1965 (Figures 5 and 6). In 1971 consumption of fluid milk was about 84.2 liters per person, which represented a 41.7 percent increase with respect to that of 1965.[15] Consumption of dairy products in the same

[15] This figure (Ministeriode Agricultura: "La agricultura española en 1972") seems to include also condensed and powdered milk. Computation of the per capita consumption using production destined to fluid consumption, imports and exports of fluid milk and population for 1971 gives only 73.2 liters per person.

year was 6.3 kilograms[16] per person, a 25 percent increase with respect to 1965 (Table VII).

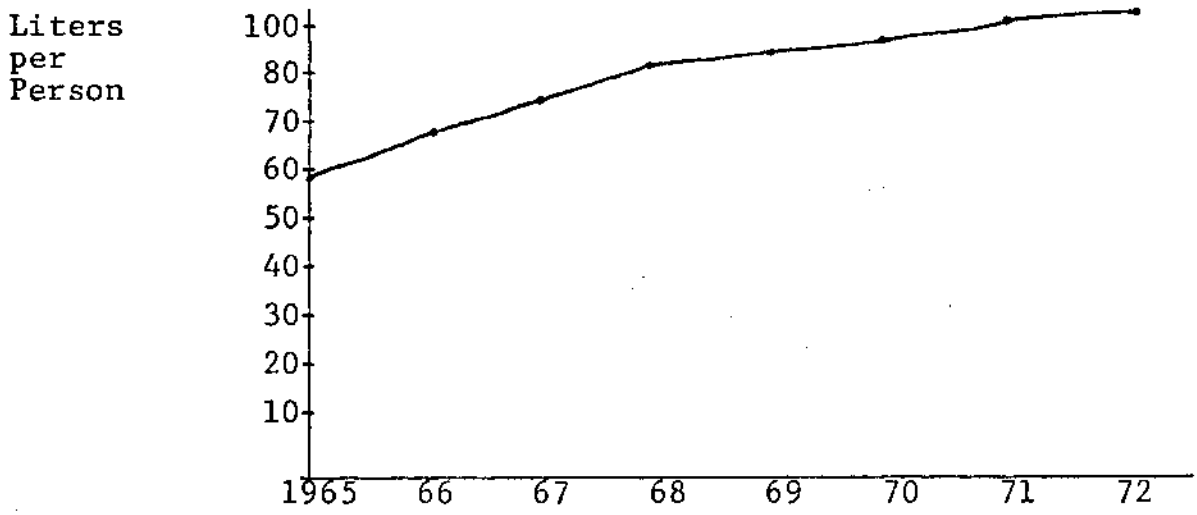

Figure 5. Per capita consumption of fluid milk, Spain 1965-1972.

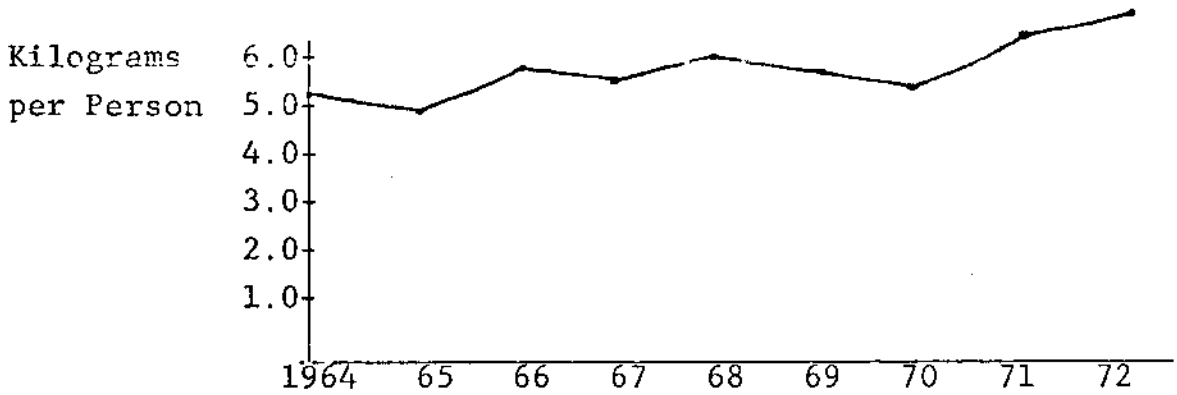

Figure 6. Per capita consumption of dairy products, Spain, 1964-1972.

The demand for fluid milk and dairy products is generally considered to be inelastic at current price ranges, that is, a given change in prices will produce a less than proportionate

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[16]One kilogram = 2.2 pounds.

change in quantity. Fluid milk is considered to have a more inelastic demand than the other dairy products, in which higher prices can lead more readily to the substitution of lower cost products (e.g., margarine for butter). However, retail prices of fluid milk and dairy products are important in determining consumption and the demand side, including the use of substitutes, is also to be taken into account.

Table VII. Per Capita Consumption of Fluid Milk and Dairy Products, Spain, 1964-72 (1965 = 100).

Year	Milk per Capita (Kilograms)	Consumption as a Percentage of 1965	Per Capita Consumption of Other Dairy Products (Kilograms)	Consumption as a Percentage of 1965
1964	63.5	106.9	5.2	104.0
1965	59.4	100.0	5.0	100.0
1966	67.0	112.8	5.8	116.0
1967	75.0	126.2	5.5	110.0
1968	78.8	132.6	5.9	118.0
1969	80.1	134.8	5.8	116.0
1970	80.9	136.1	5.5	110.0
1971	84.2	141.7	6.3	126.0
1972[a]	85.0	143.0	6.5	130.0

[a]Advance.

Source: Ministerio de Agricultura. "La agricultura española en 1972".

Prices of substitutive or competitive products also influence consumption of fluid milk and dairy products. For example, the price of margarine does influence consumption of butter, the price of sheep milk cheese affects consumption of cow milk cheese and, to some extent, the prices of wine

and soft drinks affect consumption of fluid milk.[17] The quality of these substitutive or competitive products also influence milk and dairy products consumption.

The age distribution of the population is also generally believed to affect milk consumption.

Finally, income, tastes, habits, etc. also affect the level of consumption of fluid milk and dairy products, putting, in the case of Spain, a fairly low ceiling on them.

International Trade

Spain is still a net importer of milk and dairy products (except butter), although imports, and especially those of fresh milk, are declining (Table VIII). Imports of milk and dairy products in 1972 showed a 53 percent decrease with respect to those in 1971, the sharper decrease being that for fresh milk in which imports were reduced 64.5 percent with respect to 1971 (from 175,337 metric tons[18] in 1971 to 2,221 metric tons in 1972).

Marketing Channels for Fluid Milk and Dairy Products

Milk moves from the farm to the consumer in three main stages. The first involves the assembly and transportation of raw milk from the farms to the processing plants, the second

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[17] Through diminution or increase of its importance as a drink accompaning meals.

[18] One metric ton = 1.10 short tons or .98 long tons.

includes the processing and packaging of fluid milk or its transformation to other dairy products and the third, finally involves the distribution of processed and packaged milk and dairy products to the consumers.

Table VIII. International Trade in Milk and Dairy Products, Spain, 1971 and 1972.

	1971			1972		
	Imports	Exports	Net	Imports	Exports	Net
Fresh milk	175,347	477	174,870	62,221	1,289	60,932
Powdered milk	7,324	---	7,324	4,234	200	4,034
Denatured powdered milk[a]	39,214	---	39,214	34,805	---	34,805
Butter	1,401	---	1,401	---	12	-12
Cheese	5,562	102	5,460	4,398	134	4,264

[a]Powdered milk destined to mixed feed manufacturing denatured by mixing with alfalfa, generally.

Source: Direccion General de Aduanas. "Estadistica del Comercio Exterior de España."

The marketing channels for fluid milk and dairy products in Spain are fairly simple (Figure 7). The more important one is that from farmers to processing plants, to retailers and to consumers. The farmer to consumer direct channel is legally restricted to certified milk.[19] Cooling tanks, distributors and home delivery have a very reduced importance.

Regulations

A knowledge of certain characteristics of cow milk seems to be helpful in understanding some of the pricing and

[19]Although it surely includes some raw milk, too.

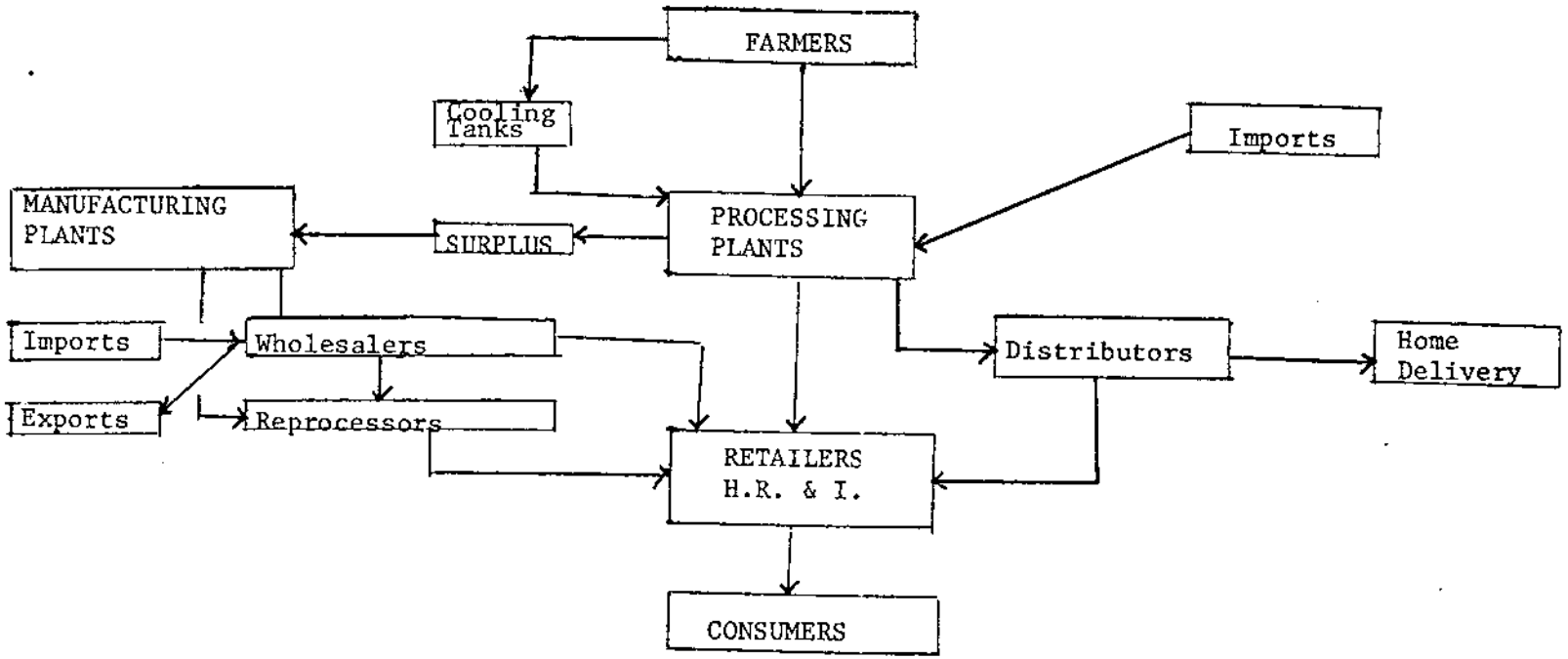

Figure 7. Marketing channels for fluid milk and dairy products.

marketing problems which have developed. Examples of these include: (1) milk is of primary importance in the human diet, especially for children, given its content in proteins, lipids, carbohydrates and minerals--especially calcium; (2) by its richness in nutritive substances, milk is an appropriate medium for the development of all kinds of microorganisms and thermal processing is required to avoid transmitting pathogenic microorganisms to the consumers; (3) the seasonal pattern of milk supply is variable, as opposed to the stable seasonal pattern of demand for fluid milk; (4) the demand for fluid milk is highly inelastic at current price ranges. These and other special features have traditionally caused great public concern in milk supply and, as a result, the system has become closely regulated.

The basic administrative regulation of the dairy sector in Spain is the regulation of fluid milk processing plants and other dairy industries which defines and regulates milk production, establishes the norms for the industry, determines the way in which the prices to farmers and the distribution and selling margins of pasteurized milk are to be set and creates the Dairy National Advisory Committee.[20]

Milk production is dealt with in Parts I (General), II(Milk for Direct Consumption) and III(Preserved Milk) of the regulation, which defines the different types of milk

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[20]Boletin Oficial del Estado. No. 240. October 6, 1966, pp. 12690-9.

and their characteristics and the requisites for their production. Part IV (Hygienizator Plants) establishes the implantation of compulsory hygienization of milk in every population nucleous.[21] It also regulates the processing plants, defining their functions, the technological and sanitary conditions of both plants and equipment, their minimum processing capacity, the administrative requirements for their authorization, etc. Finally, Part V (Milk Prices) deals with minimum farmer prices, maximum consumer prices of pasteurized and concentrated milk and prices of manufacturing milk, which generally are changed every year.

There are also Parts VI (General Dispositions) and Part VII (Dairy National Advisory Committee) and some transitory dispositions.

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[21]With high priority for the more populated ones.

III. ANALYSIS OF THE MILK PRICING SYSTEM OF SPAIN

The Pricing System

Considering, in a very simplified way, three alternative methods of regulating a fluid milk market, namely: (1) free market, (2) partial government intervention, and (3) total intervention, the present regulation of the fluid milk market of Spain comes under the heading of partial government intervention. At the present time minimum prices to the farmers for their raw milk and maximum prices to consumers for pasteurized and concentrated milk are established by regions. There is also some control over the fluid milk processing plants, with the government intervening on their establishment and on the production and sale of pasteurized and concentrated milk. On the contrary, there is no intervention on the plants' acquisition of raw milk for either fluid milk or manufacturing quality, or on the sale of sterilized milk and other dairy products.[22]

The basic acts regulating the pricing of milk in Spain are:

(1) The Decree of October 6, 1966, which established a new "Regulation of fluid milk processing plants and

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[22]Prices of cheese, butter, yogurt, flavored milk drinks, etc. and those of sterilized milk have no price ceiling.

other dairy industries and especially its fifth part (milk prices).[23]

(2) The Order of August 14, 1967, establishing the pricing of milk in accordance to its quality, and its annual extensions or modifications.[24]

(3) The annual orders determining the minimum prices to farmers, and,

(4) The annual orders determining the maximum selling prices of pasteurized and concentrated milk.

The Decree of October 6, 1966

The Decree of October 6, 1966, which established a new regulation of fluid milk processing plants and other dairy industries, is the basic administrative regulation of the milk market of Spain. It replaced the Decree of April 18, 1952, which provided for the creation of the fluid milk processing plants, and the Order of July 31 of that same year approving the regulation developed in the previous decree. In turn, the Decree of March 9, 1972 modified some articles of the 1966 regulation.

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[23]Boletin Oficial del Estado. Decreto 2478/1966 de 6 de Octubre por el que se aprueba el Reglamento de Centrales Lecheras y otras Industrias lacteas. (No. 240, Oct. 7, 1966, pp. 12690-99).

[24]Boletin Oficial del Estado. Orden de 14 de Agosto de 1967 por la que se establece el pago de la leche por calidad parael año lechero 1967-68. (No. 198, August 19, 1967, pp. 11719-20).

The more important reform of the new regulation of 1966 is:

> "The creation of a system for the determination of marketing prices and margins of milk that, first, stimulates the dairymen to increase and improve the quality of their product and, on the other hand, allows for the absorption of that product for the industry at profitable conditions."[25]

Two new concepts introduced in the regulation are:

> "The pricing of milk in accordance to its quality and the differentiation of prices by zones and time periods."[26]

Milk prices are dealt with in the Fifth Part of the 1966 Regulation (Appendix). A first section deals with the minimum prices to dairymen, a second one with selling prices of pasteurized and concentrated milk and finally, a third section deals with the prices of manufacturing quality milk.

In the first section (Minimum Prices to Farmers) article 74 defines the dairy marketing year and the deadline (two months prior to the start of each marketing year) for the Dairy National Advisory Committee to submit to the Ministry of Agriculture its proposal of minimum prices which will be based on the real costs of production and the ecological, edaphic and farming characteristics of each region. No

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[25] Boletin Oficial del Estado.Decreto 2478/1966 de 6 de Octubre (No. 240, October 7, 1966, p. 12690).

[26] Ibid., p. 12690.

specification is made, however, about how the necessary data for this are to be obtained. The prices will be different for the two seasonal periods and will also be different according to the use made of the milk.

Article 75 states that the Ministry of Agriculture, according to the proposal of the Dairy National Advisory Committee, and after consideration of the reports of the Ministries of the Interior and of Commerce, will approve it, when appropriate, publishing the order determining the minimum seasonal and zonal prices for the next year in the Offical Journal of the State.[27] However, no specification is made with respect to the determination of the minimum prices if the proposal of the Dairy National Advisory Committee is not appropriate.

Article 76 defines the characteristics of milk in order that these prices can be applied to it, and the premiums or discounts also to be approved by the Ministry of Agriculture at proposal of the Dairy National Advisory Committee to be applied to milk with different characteristics.

Article 77 authorizes the Dairy National Advisory Committee to propose changes in the accorded prices during the marketing year when necessary.

With respect to selling prices, Article 78 gives a

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[27]Boletin Oficial del Estado. Orden del 14 de Agosto de 1967 por la que se establece el pago de la leche por calidad para el año lechero 1967-68. (No. 198, August, 19, 1967, pp. 11719-20).

formula for computing maximum prices for hygienized milk, taking into account prices of raw milk, assembly and transportation costs, processing costs, distribution costs and commercial margins. Article 79 deals with maximum prices of homogenized milk, while Article 80 deals with maximum prices of concentrated milk and Article 81 with the plants to which these prices will be applicable.

Articles 81 and 82, finally, deal with prices of manufacturing milk, also to be proposed by the Dairy National Advisory Committee and to be approved by the Ministry of Agriculture.

Pricing of Milk by Quality

The Order of August 14, 1967[28] establishes the pricing of milk by quality (where quality refers to its physiochemical characteristics), according to what is anticipated on Article 76 of the Regulation of Fluid Milk Processing Plants and Other Dairy Industries:

> "Article 76 of the Regulation of Fluid Milk Processing Plants and other Dairy Industries, approved by Decree 2478/1966, of October 6, anticipates the application of a system of premiums and discounts for the pricing of milk in accordance with its quality.
>
> "This implantation makes possible for the first time, a system of pricing milk by quality based upon simple and clear data. The hygienic and bacteriological qualities are not considered at this time. Only the physiochemical qualities

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[28] Ibid., p. 11719.

> are considered in the interest of simplicity. The measures of such quality will come as a function of the fat content and specific weight."[29]

The first article of this order defines the minimum monthly quantity that farmers must sell to a plant to be eligible for this system, although the processing plants can freely apply the system to any farmer, independently of the volume of milk sold by him. Article 2 gives the premimums for the marketing year 1967-68 and article 3 the discounts for the same year. Article 4 deals with the methods of analysis for fat and specific weight and the sampling methods while Article 5 specifies the number of analyses of each sample and the number of monthly analyses for each farmer--or group of farmers--Article 6 establishes the obligation of the Dairy Plants to have a record of these analyses and Article 7 states the effective date of the order (October 1, 1967).

This order has to be renewed or modified every marketing year.[30]

Annual Minimum Prices to Farmers

With respect to the minimum prices, the more important features are: (1) the division of the marketing year in two

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[29] Ibid.

[30] It has been renewed or modified by orders of September 23, 1968; February 11, 1969; February 18, 1970; February 18, 1971--posteriorly modified by order of March 23, 1971, etc.

periods, with different prices in each of them, (2) the division of the Spanish provinces in several zones, also with prices differences among them, and (3) the existence of different prices for the different uses of the milk.

The dairy marketing year and its two seasonal periods were established, for the marketing years from 1967-68 to 1972-73, as follows:

Marketing Year	First Period	Second Period
1967-68	April 1-September 30	October 1-March 31
1968-69	April 1-September 30	October 1-March 31
1969-70	April 1-August 31	September 1-February 28
1970-71	March 1-July 15	July 16-February 28
1971-72	March 1-August 31	September 1-February 28
1972-73	March 1-July 31	August 1-February 28

With respect to the zones, Table IX gives the forty-seven peninsular provinces of Spain and the zones to which they belonged from 1967-68 to 1972-73.

The minimum prices to the farmers during these years are given by Table X (for milk destined to fluid consumption) and Table XI (for milk destined to manufacured dairy products).

Annual Maximum Selling Prices

With regard to the maximum selling prices for pasteurized and concentrated milk, Articles number 78, 79 and 80 of the 1966 Regulation establish that the Ministries of Agriculture and of Commerce (through the CAT) will determine the maximum prices of sale on the processing plants and in retail stores

Table IX. Dairy Pricing Zones, Spain, 1967-68 to 1972-73.

Province	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73
1. Oviedo 2. Coruña 3. Leon 4. Santander 5. Pontevedra 6. Vizcaya 7. Lugo 8. Navarra 9. Orense 10. Guipuzcoa 11. Alava	ZONE I					
12. Badajoz 13. Caceres 14. Zamora 15. Salamanca 16. Burgos 17. Ciudad Real 18. Palencia 19. Logroño 20. Soria 21. Albacete 22. Cuenca 23. Segovia 24. Avila 25. Toledo 26. Valladolid 27. Guadalajara	ZONE II					
28. Huesca 29. Zaragoza 30. Teruel	ZONE III					
31. Madrid	Subzone of II			Subzone of III		Zone V
32. Lerida	ZONE IV					
33. Sevilla 34. Cordoba 35. Cadiz 36. Huelva	ZONE V	ZONE IV				
37. Murcia 38. Valencia 39. Tarragona 40. Alicante 41. Castellon				ZONE V		
42. Jaen 43. Granada 44. Almeria 45. Malaga	ZONE V					Subzone of V
46. Barcelona	Subzone of IV					
47. Gerona	Zone IV					

Source: B. O. del Estado: Orders determining the minimum prices of milk to farmers in Spain for the appropriate years.

Table X. Minimum Prices to Farmers for Milk Destined to Fluid Consumption, Spain, 1967-68 to 1972-73, by Periods. (Pesetas per Liter).

Zones	1967-68		1968-69		1969-70		1970-71		1971-72		1972-73	
	PERIODS											
	I	II	I	II	I	II	I	II	I	II	I	II
I	5.25	6.25	5.25	6.25	5.25	6.50	5.50	6.50	7.00	7.25	7.50	8.50
II	5.50	6.50	5.50	6.50	5.50	6.75	5.75	6.75	7.25	7.50	7.75	8.75
III	5.75	6.75	5.75	6.75	5.75	7.00	6.00	7.00	7.50	7.75	8.25	9.25
IV	6.25	7.00	6.25	7.00	6.25	7.25	6.25	7.50	8.00	8.25	8.60	9.60
V	6.00	6.75	---	---	6.50	7.50	6.75	7.50	8.00	8.25	8.75	9.75
Subzone Madrid	6.25	7.25	6.25	7.25	6.25	7.50	6.50	7.50	---	---	---	---
Subzone Barcelona	6.50	7.25	6.50	7.25	---	---	---	---	---	---	---	---
Subzone Barcelona & Malaga	---	---	---	---	---	---	---	---	---	---	9.00	10.00

Source: Boletin Oficial del Estado. Orders determining the minimum prices of milk to farmers in Spain for the appropriate years.

of pasteurized and concentrated milk in the places where the system of compulsory hygienization of milk is established.

Table XI. Minimum Prices to Farmers for Milk Destined to Manufactured Dairy Products, Spain, 1967-68 to 1972-73 (All Zones) (by Periods) (Pesetas per liter)

1967-68		1968-69		1969-70		1970-71		1971-72		1972-73	
Periods											
I	II	I	II	I	II	I	II	I	II	I	II
5.25	6.25	5.25	6.25	5.25	6.50	5.50	6.50	7.00	7.25	7.50	8.50

Source: Boletin Oficial del Estado. Orders determining the minimum prices of milk to farmers in Spain for the appropriate years.

Every year, therefore, the Presidency of the Government considering the annual order of the Minister of Agriculture that determines the minimum prices to farmers and the reports of the Ministry of the Interior, FORPPA and CAT on the matters about which they have to inform, and at proposal of the Ministries of Agriculture and Commerce, establishes the maximum prices of pasteurized and concentrated milk--homogenized or not--at the plants and at retail stores by zones.

For concentrated milk sold to the consumers of towns where the system of compulsory hygienization of milk is in effect, but which comes from processing plants located in a different place, an increment of prices is added to take into account the transportation costs.

Shortcomings of the System

At this point it will be dealt specifically with the establishment of minimum prices to dairymen.[31] Since the new concepts introduced by the present regulation are the differentiation of zones and periods of time and the pricing of milk in accordance to its quality, these points will be considered in some detail.

Differences of Prices

The regulation establishes differences of prices by zones, by periods of time and by use of the milk.

Differences by Zones

The regulation of fluid milk processing plants and other dairy industries establishes that:

> "The minimum prices will be proposed considering the real costs of production and by zones of similar ecological, edaphic and farming characteristics."[32]

However, these basic criteria do not seem to lead to the objectives of the regulation. In effect, the criterion

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[31] Maximum selling prices for the regulated products are derived from the minimum prices to farmers according to a given formula.

[32] Boletin Oficial del Estado. Decreto 2478/1966 de 6 de Octubre. (No. 240, October 7, 1966, p. 12697).

of the real costs of production to determine prices is opposed to the specialization of the different provinces in those products in which they have a comparative advantage. In fact, the existence of geographical prices based on production costs in a market in which raw milk moves freely has created some problems since the differences in costs of production between any two provinces does not necessarily coincide with the transfer cost between them.

This criterion, moreover, is not consistent with the existing regulations of Spain for other agricultural products[33] and is applied only to milk. Finally, it does not seem that this criterion of costs of production has been entirely followed. In the first year of the present system (1967-68) prices for Madrid and Barcelona, the largest deficit provinces, were higher than those for their neighboring provinces, of similar production costs structure. The same was done with respect to Malaga[34] and Gerona[35] in 1969-70 and with respect to the neighboring provinces to Madrid the next year. The criterion of costs of production in which the regulation is based, thus, has yielded in some cases to commercial criteria based on transfer costs.

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[33] In the case of wheat, e.g., spatial premiums with respect to the minimum support price (in addition to the already existent time premiums) have been introduced for the first time in 1971-72, but these premiums are based entirely on transfer costs. In other cases (olive oil, hogs, wheat itself) zonal price differences respond to differences in quality.

[34] A highly populated and touristic low producer province.

[35] A highly specialized, relatively low cost producer province, whose proximity to Barcelona requires high prices.

With respect to the ecological, edaphic and farming characteristics, on the other hand, the extreme variability of Spain has also caused difficulties. There have been changes in the constitution of the zones every year and in some cases provinces of very different characteristics have been included in the same zone. Matching the 1972-73 Dairy Zones with the Agricultural regions of Spain defined by her Ministry of Agriculture it can be observed that: Dairy Zone I includes provinces of the Agricultural regions I (Galicia), II(North), III(Ebro) and V (Duero); Dairy zone II provinces of region III, V, VI (Center) and VIII (Extremadura); Zone III, provinces of regions III, V and VI; Zone IV, provinces of region IV (Northeast) and X (Western Andalucia) and Zone V, finally, provinces from regions IV, VI, VII (Levante) and IX (Eastern Andalucia).

However, according to the theory, spatial price relationships should be determined largely by transfer costs between provinces, provided competitive conditions prevail. The principles underlying price differences between provinces[36] are: (1) differences of prices between any two provinces that trade with each other will just equal transfer costs, and (2) Differences of prices between any two regions that do not engage in trade with each other will be less than or equal to transfer costs.

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[36]Assuming a competitive market structure, including homogeneous product, perfect knowledge and no barriers restricting trade.

Differences of prices between provinces, therefore, cannot exceed transfer costs. The reason should be obvious. Anytime the price difference is greater than transfer costs, buyers will purchase raw milk from the low priced province and ship it to the higher priced province, thereby raising the price in the former and reducing it in the latter. This form of arbitrage will continue until it is no longer profitable to ship milk between provinces, that is, until the price difference between them no longer exceeds transfer costs.

Differences by Periods of Time

Different prices in different periods have been established to take into account the variable seasonal pattern of milk production as opposed to the relatively stable seasonal pattern of demand for fluid milk.

In effect, milk is characterized by some seasonality in production, arising from diverse reasons, including seasonal variation in climatological conditions--which produce seasonality of feed supplies--and the biological character of the milk production process. Seasonality in demand for fluid milk, on the contrary, does not seem to exist.

The pricing regulation, therefore, considers two different periods, establishing different prices for each of them. Then while production varies in general in a continuous way, prices change abruptly and this has caused

difficulties in the past. The two annual periods, moreover, have changed four times in the last six years,[37] manifesting the difficulties involved in finding a clear cut point.

However, it would also be very difficult to change the prices continuously during the year, following the changes in production, and therefore the division of the dairy marketing year in two periods used in many countries is a logical alternative.

Differences Based Upon Use

The present pricing regulation makes the practice of price discrimination possible. Processors of milk are required to pay higher prices for milk which is destined to fluid use than for milk of equal quality which is converted into cheese, yoghurt, etc. The regulation, therefore, clearly assumes that the demand for fluid milk is more price inelastic than the demand for manufactured dairy products.

As a result of this regulation, in most provinces there exist two prices for the same product--raw milk--and this can cause anomalies in the system, especially in zones where local monopolies may exist.[38]

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[37] In 1971, for example, the original division of the year (March 1-August 31 and September 1-February 28) was changed during the so called "milk war" when many farmers--specially in Navarra and Vizcaya--dumped their milk and slaughtered dairy cows, protesting low prices.

[38] The extent of these anomalies, however, may be reduced by the fact that the established prices are minimum prices, not necessarily equal to the market price.

Pricing by Quality

The pricing of milk in accordance with its quality only takes into account its physiochemical characteristics and, among these, only its fat content and specific weight. However, diet-conscious consumers are putting more emphasis on low-fat diets (low fat dairy products and animal fat substitutes) and the trend is to reduce the demand for high fat milk. The pricing of milk, therefore, should start shifting from the present predominant emphasis on butterfat to major emphasis on non-fat solids, especially protein which is one of the major components in non-fat solids.[39]

On the other hand, protein is, together with calcium, one of the nutrients most often deficient in diets and milk is one of the best sources for both; this also increases the justification for protein pricing of milk.

Although milk contains important and variable non-fat solids other than protein (such as lactosa and minerals), nevertheless protein is (along with fat) the only variable constituent of milk.[40]

Furthermore, the protein content of milk can be influenced by breeding and culling programs, while the content of other non-fat solids cannot. Thus, dairymen can

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[39] An average of 3.3 percent protein in milk testing 3.5 percent butterfat.

[40] Lactose remain constant at about 5 percent and minerals at about .7 percent, while the protein content varies between 2.8 and 4 percent and the fat about 3 to 5.5 percent.

produce a higher protein milk if provided with a price incentive. Also, reliable relatively inexpensive protein tests (including electronic tests) are not available and protein content determination does not present any problem.

Finally, the hygienic and bacteriological qualities of the milk should also be taken into account.

Minimum Prices

Agricultural product prices in general, are important both economically and politically since they strongly influence the level of farmers' income, the well-being of consumers, etc. They are, moreover, much more volatile than the prices of most nonfarm goods and services.

The biological nature of milk production is a principal cause of price instability. Unlike most nonfarm industries, actual milk production may exceed or fall short of planned production. Milk output per cow may vary because of the presence or absence of diseases, the level of feed prices, etc. Seasonal variations in production likewise contribute to price instability, together with the perishable nature of the milk.

The sequential events in producing milk are also separated by significant time intervals. Substantial time lags exist between a decision to produce and the realization of the final output.[41]

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[41] Two years, e.g., seem to be required to increase the supply of milk.

The decentralized nature of milk production and its geographical dispersion complicates the pattern of price determination and also makes it costly to assemble raw milk and to estimate accurately the supplies available.

The existence of minimum prices is, therefore, considered to be necessary to avoid oscillations on prices from one period to another. The main shortcoming of the system, however, is that the present regulation is not enough to guarantee the farmers that all the milk they produce will be finally picked up. Since there is no intervention on the quantities, when there are excedents of milk in relation to demand, processors, although they will buy raw milk at the minimum legal prices, will not buy all the quantity produced but only the amount they need.[42]

A possible solution consistent with the objective of maintaining a minimum level of income for the dairymen could be the establishment of a minimum support price, with the state buying the excedents, if produced, and transforming them into nonperishable products (cheese, powdered milk, etc.).

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[42]This has happened in the past, for instance for the Spring of 1972 in La Coruña.

IV. THE TRANSPORATION MODEL

The Problem

The forty-seven peninsular provinces of Spain (Map I) will be considered,[43] adding one more region to account for the imports (which will be assumed to come from France). A point in each province, its capital, will serve as a point of both production and consumption for the province.

In order to specify the given production and consumption requirements for each province, production for each will be taken as that of 1971,[44] where only milk destined to fluid consumption will be considered. The imports will also be taken as those of 1971.[45] The consumption figures will be computed on the assumption that per capita fluid milk consumption is homogeneous throughout the country. Total production destined to fluid use plus imports of fluid milk minus exports of fluid milk in 1971, divided by total population in the same year[46] gives an average per

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[43] The Baleares and Canarias Islands, the towns of Ceuta and Melilla in North Africa and the Spanish Sahara will be excluded.

[44] Ministerio de Agricultura. "Anuario estadístico de la produccion ganadera 1971."

[45] Dirección General de Aduanas. "Estadística del Comercio Exterior de España."

[46] III Plan de Desarrollo Economico y Social. Desarrollo Regional. 1972-75. Cuadro 20. Poblacion proyectada en miles, p. 63.

Map I. Peninsular provinces, Spain, 1971.

capita consumption of 73.2 liters per year. Consumption in each province, therefore, has been computed by multiplying per capita consumption times population of the province. Then, by subtracting consumption from production, surpluses or deficits for each province were computed. Table XII gives production, consumption, surpluses and deficits for each province.

Furthermore, it will be assumed that, as far as possible each province meets her demand for her own domestic production.[47] Hence, only surpluses and deficits will actually enter interprovince trade.

With regard to transportation costs, the one-way distance between each origin and destination will be determined by road distances between the capitals of the provinces of origin and destination. For imported milk, two possible origins in the South of France, Bayonne and Perpignan, will be considered, choosing the closest to the destination point. The transportation costs for raw milk will be a function of distances and the functions to use will be those calculated by Caldentey.[48]

$T_{ij} = .35 + .0017\ D_{ij}$ for long distances, and

$T_{ij} = .0017\ D_{ij}$ for shorter distances (120 kilometers[49] or less).

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[47] Since milk is a homogeneous product, this would generally be true.

[48] Caldentey Albert, Pedro. "Estudios sobre precios geograficos de la leche" (REAS; No. 83, April-June, 1973, pp. 81-82.

[49] One kilometer - .62137 miles.

Table XII. Production, Consumption, Surpluses and Deficits, Fluid Milk, Spain, 1971 (Thousand Liters).

Province	Production	Consumption	Surplus	Deficit
1. Alava	23,581	15,448	81,133	------
2. Albacete	3,008	24,473	----	21,465
3. Alicante	6,752	69,056	----	62,304
4. Almeria	7,192	27,547	----	20,355
5. Avila	38,577	14,710	23,867	------
6. Badajoz	52,715	50,503	2,212	------
7. Barcelona	90,123	296,388	----	206,265
8. Burgos	31,761	26,316	5,445	------
9. Caceres	40,505	32,971	7,544	------
10. Cadiz	15,158	70,109	----	54,951
11. Castellon	4,014	28,519	----	23,505
12. Ciudad Real	24,936	36,748	----	11,812
13. Cordoba	22,021	52,525	----	30,504
14. Coruña	160,617	73,442	87,175	------
15. Cuenca	1,850	18,148	----	16,298
16. Gerona	61,000	30,716	30,284	------
17. Granada	13,057	53,679	----	40,622
18. Guadalajara	11,808	10,624	1,184	------
19. Guipuzcoa	49,765	47,160	2,605	------
20. Huelva	11,461	29,155	----	17,694
21. Huesca	25,059	15,983	9,076	------
22. Jaen	15,094	47,981	----	32,887
23. Leon	151,712	39,998	111,714	------
24. Lerida	23,906	25,465	----	1,559
25. Logroño	10,839	17,289	----	6,450
26. Lugo	83,709	29,863	53,846	------
27. Madrid	82,049	288,190	----	206,141
28. Malaga	27,866	69,891	----	42,025
29. Murcia	14,836	61,121	----	46,285
30. Navarra	74,648	34,566	40,082	------
31. Orense	68,499	29,904	38,595	------
32. Oviedo	292,454	77,070	215,384	------
33. Palencia	17,398	14,315	3,083	------
34. Pontevedra	123,449	55,106	68,343	------
35. Salamanca	34,099	27,050	7,049	------
36. Santander	134,131	34,523	99,608	------
37. Segovia	47,170	11,682	35,488	------
38. Sevilla	56,830	96,579	----	39,749
39. Soria	16,587	8,230	8,357	------
40. Tarragona	8,933	32,088	----	23,155
41. Teruel	12,507	12,202	305	------
42. Toledo	38,237	34,144	4,093	------
43. Valencia	13,969	132,240	----	118,271
44. Valladolid	31,375	30,792	583	------
45. Vizcaya	111,459	77,539	33,920	------
46. Zamora	39,719	18,169	21,550	------
47. Zaragoza	22,876	56,547	----	33,671
48. Net Imports	136,984	------	136,984	------
Total	2,248,825	2,248,824	1,056,446	1,056,445

Source: op. cit., computed from data shown.

Where:

T_{ij} = transportation cost, in pesetas per liter, from province i to province j

D_{ij} = Distance, in kilometers, between capital of province i to province capital of j.

The estimated refrigeration cost of .35 pesetas per liter has been added for long distances.

The problem, then is to find a pattern of shipments from the surplus to the deficit provinces that will involve the least possible total transportation cost.

Let X_{ij} denote the non-negative number of a thousand liters of milk shipped from the surplus province i to the deficit province j and let T_{ij} the transportation cost (in pesetas per liter) for shipments of raw milk between these termini. The total transportation cost, the sum to be minimized, is:

$$TTC = \sum_i \sum_j T_{ij} X_{ij}, \quad i = 1,2,\ldots,27; \; j = 1,2,\ldots,21$$

To achieve this minimum, any value of X_{ij} which satisfy three sort of restrictions can be selected:

(1) the shipments planned for each surplus province must equal her surplus $\sum_j X_{ij} = S_i, \quad i = 1,2,\ldots,27$

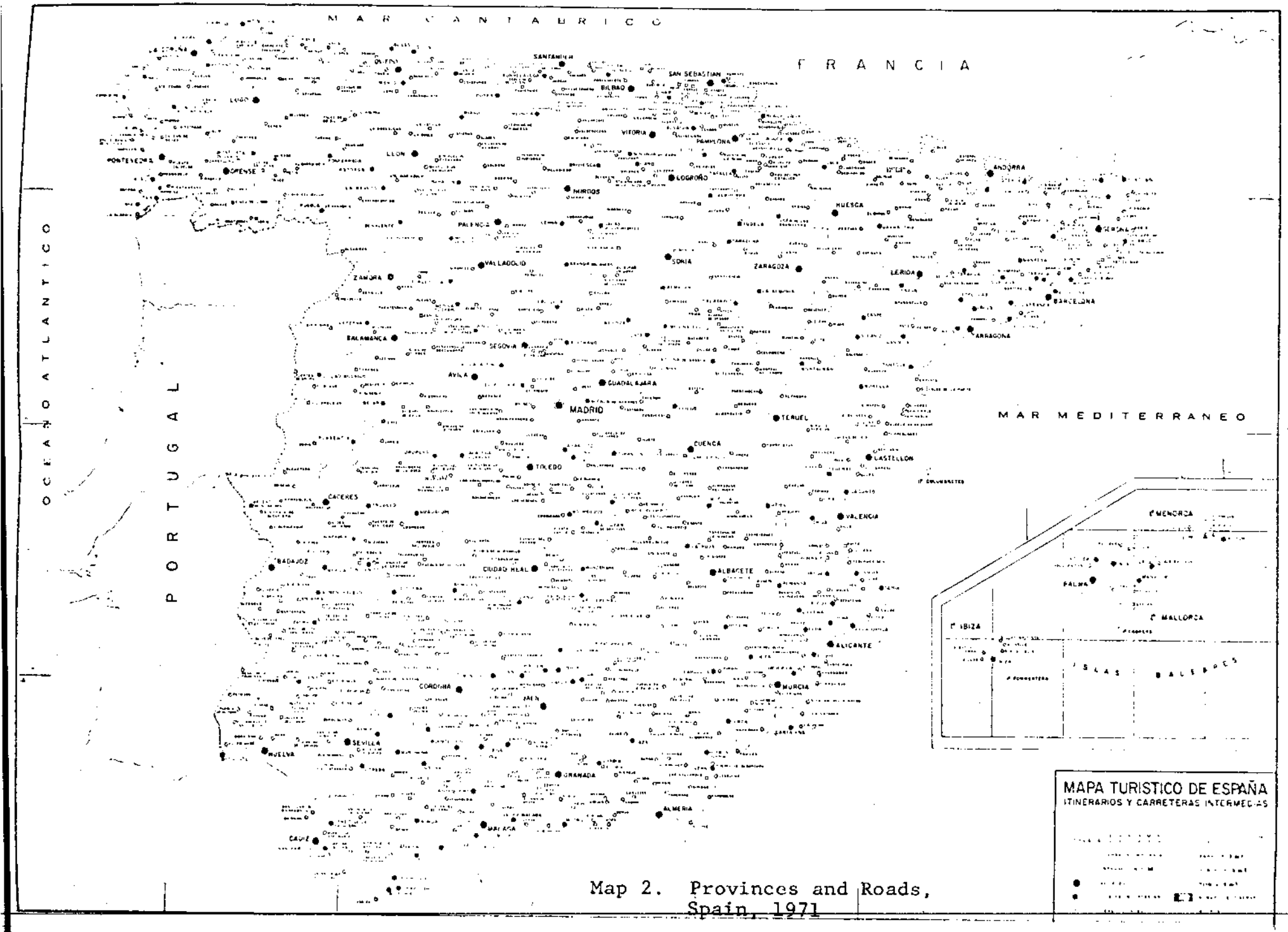
where S_i is the surplus of province i

(2) the total shipments to each deficit province must equal its requirements $\sum_i X_{ij} = D_j, \; j = 1,2,\ldots,21$

where D_j = requirements of province j.

(3) the quantities shipped cannot be negative

$X_{ij} \geq 0 \quad i = 1,2,\ldots,27; \quad j = 1,2,\ldots,21.$



Map 2. Provinces and Roads, Spain, 1971

These equations suggest why the computations required by the transportation problem are simple: all the choice variables enter the restraining equations with coefficients equal to unity.

Assumptions

The important assumptions for the transportation model are:

(1) products are homogeneous, that is, the supply of any one region serves equally well to satisfy the demand of any consuming center.

(2) The supplies of product available at the various origins and the demands of the various destinations are known, and total demand is equal to total supply.

(3) The cost of moving the commodity from origin to destination is known and is independent of the number of units moved.

(4) There is an objective cost to be minimized.

(5) Transportation from origins to destinations can be carried on only at non-negative levels.

The transportation problem, therefore, differs explicitly from the general problem in at least two ways: (1) Any input can satisfy any output in the transportation problem, although this is usually not true in the general problem, and (2) Total inputs must equal total outputs in the transportation problem, but this need not be true in the general problem. The transportation problem procedure, thus, makes

for a simpler formulation of a given problem than the general procedure.

The Data

Table XIII summarizes transfer costs (in pesetas per liter) from the 27 surplus to the 21 deficit provinces. Total quantities available are shown in the last column (S_i) and quantities demanded in the last row (D_j).

Given these data, the problem becomes one of moving 1,056,445 thousand liters of production to consumption at a minimum total cost.

The problem matrix will have forty-eight rows and five hundred sixty seven columns.

Empirical Results

The optimum interprovince flow is provided by the model. Optimum price differences among all provinces can be computed from it.

Optimum Interprovince Flow

The first useful piece of information provided by the application of the model is the shipments of raw milk consistent with the minimization of total transfer cost for all shipments. They are as follows (Table XIV and Map 2).

(1) Milk from Alava should go to Logroño (6,450 thou.), and Zaragoza (1,683).

(2) Milk from Avila to Madrid (23,867)

(3) From Badajoz to Sevilla (2,212)

(4) From Burgos to Valencia (5,445)

Table XIII. Milk Transportation Costs Matrix, Spain, 1971, (Pesetas per Liter).

Deficit \ Surplus	Albacete 28	Alicante 29	Almeria 30	Barcelona 31	Cadiz 32	Castellon 33	Ciudad Real 34	Cordoba 35	Cuenca 36	Granada 37	Huelva 38
1. Alava	1.38	1.62	2.00	1.31	2.02	1.27	1.30	1.64	1.13	1.69	1.92
2. Avila	0.94	1.25	1.58	1.61	1.50	1.25	0.79	1.23	0.82	1.28	1.40
3. Badajoz	1.27	1.56	1.52	2.56	0.98	1.75	0.94	0.80	1.22	1.23	0.88
4. Burgos	1.19	1.47	1.79	1.39	1.83	1.27	1.10	1.45	1.05	1.50	1.73
5. Caceres	1.28	1.57	1.54	2.13	1.06	1.57	1.06	0.89	1.14	1.25	0.98
6. Coruña	0.80	2.08	2.41	2.25	2.23	2.09	1.71	2.06	1.66	2.11	2.13
7. Gerona	1.45	1.44	1.95	0.17	2.76	1.01	1.78	2.05	1.48	2.06	2.66
8. Guadalajara	0.87	1.15	1.47	1.32	1.62	1.05	0.78	1.13	0.59	1.18	1.52
9. Guipuzcoa	0.58	1.58	2.29	1.33	2.22	1.28	1.49	1.84	1.26	1.89	2.12
10 Huesca	1.18	1.24	1.05	0.83	2.20	0.94	1.36	1.70	1.04	1.77	2.10
11 Leon	0.32	1.60	1.93	1.72	1.76	1.60	1.23	1.58	1.17	1.63	1.67
12 Lugo	1.64	1.92	2.39	2.09	2.17	1.92	1.53	1.90	1.50	1.95	1.97
13 Navarra	1.37	1.52	2.03	1.10	2.18	1.13	1.41	1.76	1.14	1.81	2.09
14 Orense	1.71	2.00	2.32	2.17	2.01	1.90	1.63	1.83	1.67	2.02	1.92
15 Oviedo	1.52	1.80	2.14	1.89	1.97	1.80	1.47	1.78	1.38	1.83	1.87
16 Palencia	1.17	1.46	1.79	1.48	1.70	1.36	1.09	1.43	1.03	1.48	1.61
17 Pontevedra	1.89	2.17	2.49	2.34	2.88	2.17	1.80	2.01	1.74	2.20	2.09
18 Salamanca	1.13	1.42	1.75	1.68	1.43	1.47	1.05	1.18	0.99	1.44	1.53
19 Santander	1.45	1.74	2.07	1.61	2.05	1.54	1.37	1.72	1.35	1.77	1.95
20 Segovia	0.93	1.22	1.55	1.46	1.64	1.22	0.85	1.19	0.79	1.15	1.54
21 Soria	1.06	1.29	1.80	1.14	1.91	1.02	1.07	1.42	0.80	1.47	1.72
22 Teruel	0.75	0.90	1.61	1.06	1.84	0.63	1.01	1.35	0.60	1.40	1.75
23 Toledo	0.79	1.08	1.29	1.53	1.44	1.13	0.20	0.95	0.70	1.00	1.37
24 Valladolid	1.09	1.38	1.70	1.49	1.62	1.37	1.00	1.35	0.95	1.40	1.52
25 Vizcaya	1.45	1.73	2.08	1.42	2.09	1.38	1.37	1.72	1.24	1.77	2.00
26 Zamora	1.20	1.48	1.81	1.65	1.53	1.48	1.11	1.29	1.06	1.51	1.44
27 Net Imports	1.61	1.60	2.11	0.68	2.34	1.23	1.61	1.96	1.38	2.01	2.24
Deficits	21,465	62,504	20,355	206,265	34,951	23,505	11,812	30,504	16,298	40,622	17,694

Table XIII. Continued.

Deficit \ Surplus	Jaen 39	Lerida 40	Logroño 41	Madrid 42	Malaga 43	Murcia 44	Sevilla 45	Tarragona 46	Valencia 47	Zaragoza 48	Surplus
1. Alava	1.53	1.04	0.15	0.96	1.92	1.62	1.76	1.20	1.31	0.80	8,133
2. Avila	1.11	1.34	0.97	0.19	1.40	1.21	1.24	1.50	1.14	1.09	23,867
3. Badajoz	0.99	1.83	1.56	1.04	1.15	1.70	0.72	1.99	1.63	1.59	2,212
4. Burgos	1.34	1.11	0.47	0.77	1.73	1.43	1.57	1.28	1.13	0.87	5,445
5. Caceres	1.07	1.65	1.34	0.86	1.18	1.56	0.81	1.82	1.45	1.61	7,544
6. Coruna	1.95	1.98	1.48	1.38	2.22	2.04	1.98	2.15	2.07	1.74	87,175
7. Gerona	1.90	0.79	1.34	1.58	2.29	1.58	2.50	0.69	1.13	1.04	30,284
8. Guadalajara	1.01	1.05	0.86	0.10	1.41	1.11	1.36	1.21	0.94	0.80	1,184
9. Guipuzcoa	1.72	0.98	0.63	1.15	2.12	1.80	1.96	1.26	1.36	0.81	2,605
10 Huesca	1.59	0.21	0.77	1.02	1.98	1.48	1.96	0.72	1.03	0.12	9,076
11 Leon	1.46	1.44	0.93	0.89	1.86	1.56	1.51	1.61	1.49	1.20	111,714
12 Lugo	1.78	1.82	1.32	1.22	2.18	1.88	1.81	1.98	1.71	1.58	53,846
13 Navarra	1.65	0.83	0.16	1.18	2.06	1.66	1.93	0.99	1.21	0.66	90,082
14 Orense	1.86	1.90	1.39	1.29	2.15	1.95	1.76	2.06	1.89	1.65	33,595
15 Oviedo	1.67	1.62	1.13	1.10	2.06	1.76	1.71	1.78	1.69	1.41	215,384
16 Palencia	1.32	1.20	0.71	0.75	1.71	1.41	1.95	1.37	1.32	0.96	3,083
17 Pontevedra	2.03	2.07	1.57.	1.46	2.16	2.13	1.93	2.23	2.06	1.82	68,343
18 Salamanca	1.28	1.41	0.97	0.71	1.55	1.38	1.17	1.57	1.31	1.17	7,049
19 Santander	1.60	1.28	0.79	1.03	1.99	1.70	1.79	1.45	1.49	1.09	99,608
20 Segovia	1.08	1.19	0.85	0.16	1.47	1.18	1.38	1.35	1.11	0.96	35,488
21 Soria	1.31	0.87	0.18	0.74	1.70	1.40	1.66	1.03	0.98	0.62	8,357
22 Teruel	1.24	0.91	0.92	0.86	1.58	1.04	1.59	0.89	0.59	0.96	305
23 Toledo	0.83	1.26	1.04	0.12	1.23	1.04	1.18	1.43	1.02	1.02	4,093
24 Valladolid	1.24	1.22	0.78	0.67	1.63	1.33	1.36	1.38	1.26	0.97	503
25 Vizcaya	1.60	1.10	0.61	1.03	1.99	1.70	1.84	1.26	1.42	1.14	33,920
26 Zamora	1.34	1.32	0.94	0.77	1.66	1.99	1.28	1.56	1.37	1.14	21,550
27 Net Imports	1.84	0.95	0.75	1.27	2.24	1.74	2.08	0.84	1.29	0.93	136,924
Deficits	32,887	1,559	6,450	206,141	42,025	46,285	39,749	23,155	118,271	33,671	

Source: Computed from functions shown.

Table XIV. Optimum Shipment Pattern (in Thousand Liters).

Deficit \ Surplus	Albacete 28	Alicante 29	Almeria 30	Barcelona 31	Cadiz 32	Castellon 33	Ciudad Real 34	Cordoba 35	Cuenca 36	Granada 37	Huelva 38
1. Alava											
2. Avila											
3. Badajoz											
4. Burgos											
5. Caceres					7,544						
6. Coruña			19,722		10,717		5,654				17,694
7. Gerona				30,284							
8. Guadalajara											
9. Guipuzcoa							2,065				
10. Huesca											
11. Leon											
12. Lugo											
13. Navarra				38,997							
14. Orense					36,690			1,905			
15. Oviedo	18,382	62,304							16,298	40,622	
16. Palencia	3,083										
17. Pontevedra											
18. Salamanca								7,049			
19. Santander						4,078					
20. Segovia											
21. Soria						8,357					
22. Teruel						305					
23. Toledo							4,093				
24. Valladolid			583								
25. Vizcaya						10,765					
26. Zamora								21,550			
27. Mt. Imports				136,986							
Deficit	21,465	62,304	20,305	206,265	54,451	23,905	11,812	30,504	16,298	40,622	17,694

Table XIV. Continued.

Deficit \ Surplus	Jaen 39	Lerida 40	Logroño 41	Madrid 42	Malaga 43	Murcia 44	Sevilla 45	Tarragona 46	Valencia 47	Zaragoza 48	Surplus
1. Alava			6,450								8,133
2. Avila				23,867						1,683	23,867
3. Badajoz							2,212				2,212
4. Burgos									5,445		5,445
5. Caceres											7,544
6. Coruña						33,337					87,174
7. Gerona											30,284
8. Guadalajara				1,184							1,184
9. Guipuzcoa		1,559									2,065
10. Huesca										7,517	9,076
11. Leon	30,942			80,722							111,714
12. Lugo	1,945						11,219		40,682		53,846
13. Navarra										1,085	40,082
14. Orense											38,595
15. Oviedo				64,830		12,948					215,384
16. Palencia											3,083
17. Pontevedra					42,025		26,318				68,343
18. Salamanca											7,049
19. Santander									72,166	23,386	99,608
20. Segovia				35,468							35,488
21. Soria											8,357
22. Teruel											305
23. Toledo											4,093
24. Valladolid											583
25. Vizcaya								23,155			33,920
26. Zamora											21,550
27. Mt. Imports											136,986
Deficit	32,887	1,559	6,450	206,141	42,025	46,285	39,794	23,155	118,271	33,671	

Source: Computed from the transportation model.

(5) From Caceres to Cadiz (7,544)

(6) From Coruña to Almeria (19,722), Cadiz (10,717), Ciudad Real (5,654), Huelva (17,694) and Murcia (33,337)

(7) From Gerona to Barcelona (30,284)

(8) From Guadalajara to Madrid (1,184)

(9) From Guipuzcoa to Ciudad Real (2,065)

(10) From Huesca to Lerida (1,184) and Zaragoza (7,517)

(11) From Leon to Jaen (30,942) and Madrid (80,772)

(12) From Lugo to Jaen (1,945), Sevilla (11,219) and Valencia (40,682)

(13) From Navarra to Barcelona (38,997) and Zaragoza (1,085)

(14) From Orense to Cadiz (36,690) and Cordoba (1,905)

(15) From Oviedo to Albacete (18,382), Alicante (62,304), Cuenca (16,298), Granada (40,622), Madrid (64,830) and Malaga (12,948)

(16) From Palencia to Albacete (3,083)

(17) From Protevedra to Malaga (42,025) and Sevilla (26,318)

(18) From Salamanca to Cordoba (7,049)

(19) From Santander to Castellon (4,078), Valencia (72,144) and Zaragoza (23,386)

(20) From Segovia to Madrid (35,488)

(21) From Soria to Castellon (8,357)

(22) From Teruel to Castellon (305)

(23) From Toledo to Ciuda Real (4,093)

(24) From Valladolid to Almeria (583)

(25) From Vizcaya to Castellon (10,765) and Tarragona (23,155)

(26) From Zamora to Cordoba (21,550)

(27) The imported milk to Barcelona (136,984).

With this pattern of shipments the minimum total transportation cost would have been equal to 1,352,375,250 pesetas.

If there had been more milk destined to fluid use than needed, milk of Coruña would have not been used.[50]

Optimum Interprovince Differences of Prices

From these optimum flows, optimum price differences among all provinces can be computed considering that, when a positive flow between two provinces exists, the price in the deficit province must equal price of surplus province plus the transportation cost.

Assigning to Coruña the price 0, the optimum price differences in the different provinces with respect to Coruña are given in Table XV. and Map 3.

The lowest prices, obviously, correspond to surplus provinces situated far from the consumption centers and the highest prices to the deficit provinces situated far from the production provinces. The surplus provinces close to large deficit provinces (such as the neighbors of Madrid and Barcelona) benefit from their proximity and would get a relatively elevated price.

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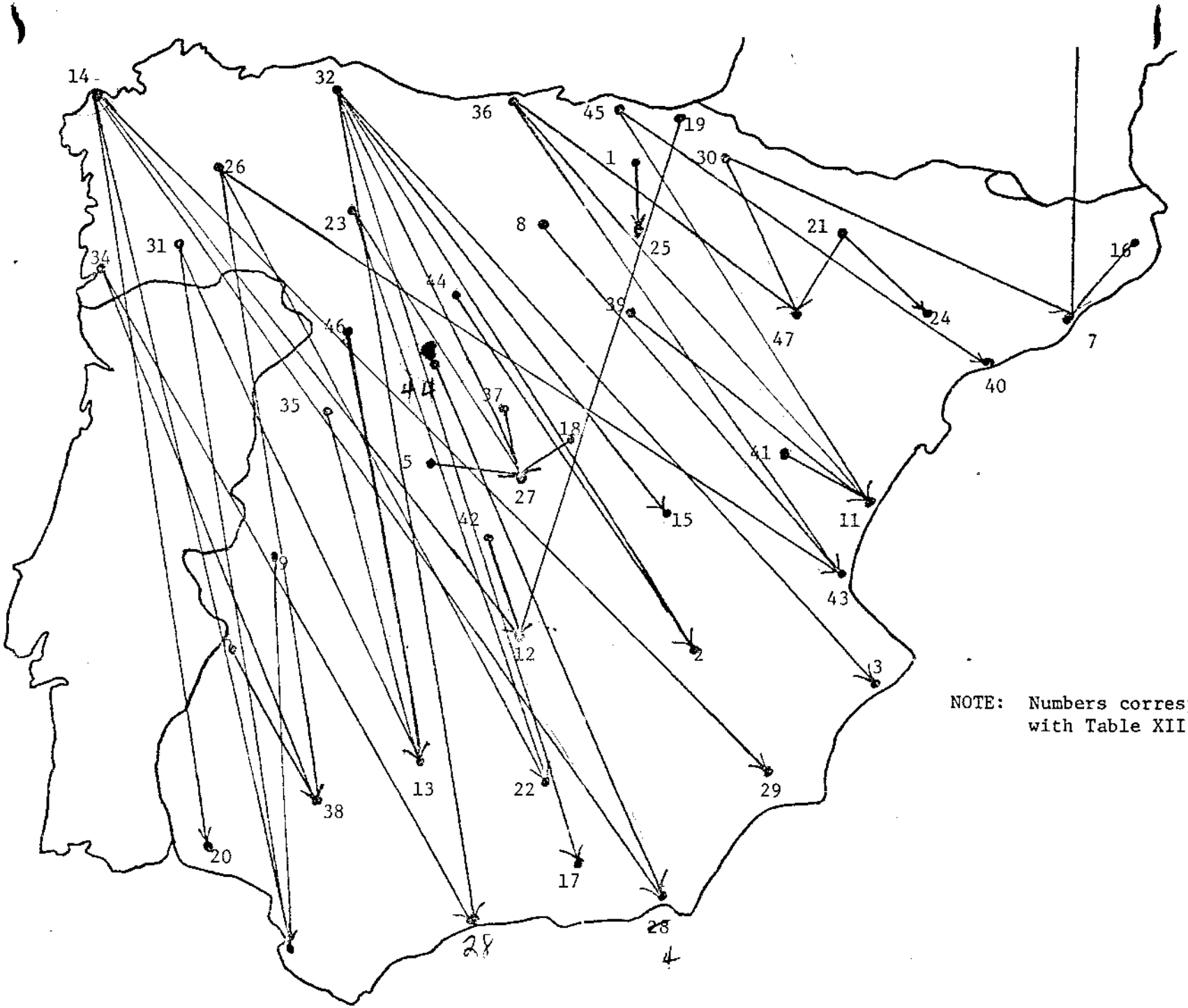
[50] To facilitate the solution of the program one more unit was considered in the total surplus than in total deficit. All others were Binding except Coruña (slack = 1).



NOTE: Numbers corresponde with Table XII.

Map 3. Optimum Interprovince Flow of Milk for Fluid Consumption from Surplus to Deficit Provinces, Spain, 1971.

Table XV. Optimum Producer Milk Price Differences With Respect to Coruña, Spain, 1971 (Pesetas per Liter)

Surplus Provinces		Deficit Provinces	
1. Alava	.68	27. Albacete	1.80
2. Avila	1.19	28. Alicante	2.08
3. Badajoz	1.26	29. Almeria	2.41
4. Burgos	.75	30. Barcelona	1.92
5. Caceres	1.17	31. Cadiz	2.23
6. Coruna	0.0	32. Castellon	1.93
7. Gerona	1.75	33. Ciudad Real	1.71
8. Guadalajara	-1.28	34. Cordoba	2.04
9. Guipuzcoa	.21	35. Cuenca	1.66
10 Huesca	1.36	36. Granada	2.11
11 Leon	- .49	37. Huelva	2.13
12 Lugo	.17	38. Jaen	1.95
13 Navarra	.82	39. Lerida	1.57
14 Orense	.21	40. Logrono	.83
15 Oviedo	- .28	41. Madric	1.38
16 Palencia	.63	42. Malaga	2.19
17 Pontevedra	.05	43. Murcia	2.04
18 Salamanca	.86	44. Sevila	1.98
19 Santander	.39	45. Tabragona	1.81
20 Segovia	- 1.22	46. Valencia	1.88
21 Soria	.91	47. Zaragoza	1.48
22 Teruel	1.30		
23 Toledo	1.51		
24 Valladolid	.71		
25 Vizcaya	.55		
26 Zamora	.75		

At this point it would be interesting to compare these optimum price differences with the actual differences on the minimum prices to farmers for 1971. Table XVI gives this comparison. Except in the case of Coruna, actual differences were always smaller than the optimum differences computed from the results of the model.

According to the theory, however, trade will take place between two provinces only if the prices in isolation differ by more than transfer costs. Therefore, the price

Table XVI. Optimum and Actual Differences in Minimum prices to Milk Producers for Milk Destined to Fluid Consumption, with Respect to La Coruña, Spain, 1971 (Pesetas per Liter).

Provinces	Minimum Price	Actual Difference	Optimum Difference	Deviation
1. Alava	7.00	0.00	0.68	0.68
2. Albacete	7.25	0.25	1.80	1.55
3. Alicante	8.00	1.00	2.08	1.08
4. Almeria	8.00	1.00	2.41	1.41
5. Avila	7.50	0.50	1.19	0.69
6. Badajoz	7.25	0.25	1.26	1.01
7. Barcelona	8.00	1.00	1.92	0.92
8. Burgos	7.25	0.25	0.75	0.50
9. Caceres	7.25	0.25	1.17	0.92
10 Cadiz	8.00	1.00	2.23	1.23
11 Castellon	8.00	1.00	1.93	0.93
12 Ciudad Real	7.25	0.25	1.71	0.46
13 Cordoba	8.00	1.00	2.04	1.04
14 La Coruna	7.00	0.00	0.00	0.00
15 Cuenca	7.25	0.25	1.66	1.41
16 Gerona	8.00	1.00	1.75	0.75
17 Granada	8.00	1.00	2.11	1.11
18 Guadalajara	7.25	0.25	1.28	0.78
19 Guipuzcoa	7.00	0.00	0.21	0.12
20 Huelva	8.00	1.00	2.13	1.13
21 Huesca	7.50	0.50	1.36	0.86
22 Jaen	8.00	1.00	1.95	0.95
23 Leon	7.00	0.00	0.49	0.49
24 Lerida	8.00	1.00	1.57	0.57
25 Logrono	7.25	0.25	0.83	0.58
26 Lugo	7.00	0.00	0.17	0.17
27 Madrid	8.00	1.00	1.38	0.38
28 Malaga	8.00	1.00	2.19	1.19
29 Murcia	8.00	1.00	2.04	1.04
30 Navarra	7.00	0.00	0.82	0.82
31 Orense	7.00	0.00	0.21	0.21
32 Oviedo	7.00	0.00	0.28	0.28
33 Palencia	7.25	0.25	0.63	0.38
34 Pontevedra	7.00	0.00	0.05	0.05
35 Salamanca	7.25	0.25	0.86	0.61
36 Santander	7.00	0.00	0.39	0.39
37 Segovia	7.50	0.50	1.22	0.72
38 Sevilla	8.00	1.00	1.98	0.98
39 Soria	7.25	0.25	0.91	0.66
40 Tarragona	8.00	1.00	1.81	0.81
41 Teruel	7.50	0.50	1.30	0.80
42 Toledo	7.50	0.50	1.50	1.00
43 Valencia	8.00	1.00	1.88	0.88
44 Valladolid	7.50	0.50	0.71	0.21
45 Vizcaya	7.00	0.00	0.55	0.55
46 Zamora	7.25	0.25	0.75	0.50
47 Zaragoza	7.50	0.50	1.48	0.98

Source: Computed from Tables X and XV.

differences established by the Regulation for 1971 seem to hinder trade between provinces and to encourage production of milk in provinces which could have imported it under more favorable conditions.

Proposed Delimitation of Dairy Pricing Zones

The establishment of a different minimum price for milk in each province may be considered complicated and a division in zones may be preferred. According to the results provided by the model, a delimitation of dairy pricing zones might be attempted, but basing it not on costs of production and ecological, edaphic and farming characteristics, but on transportation costs.

A suggested delimitation, both normative and relative, which attempts to group together provinces between which price differences are relatively small and, at the same time, are both close to each other and of relatively similar geographical and agricultural characteristics, is as follows (Map 4).

Zone I: LaCoruña, Pontevedra, Lugo, Orense, Guipuzcoa, Oviedo and Santander

Zone II: Leon, Vizcaya, Palencia, Alava, Valladolid, Burgos, Zamora, Navarra, Logroño and Salamanca

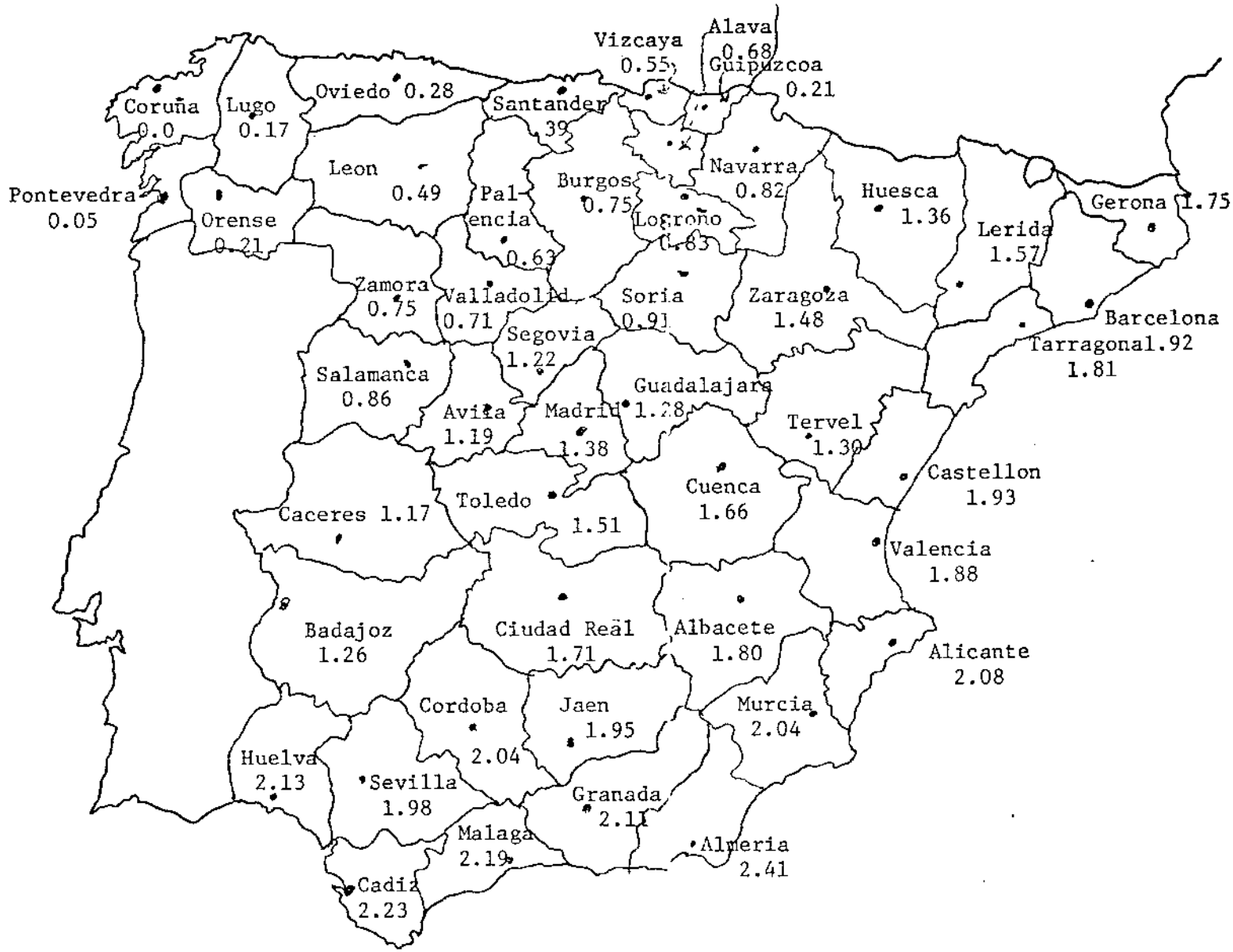
Zone III: Soria, Caceres, Avila, Segovia, Badajoz, Guadalajara and Teruel

Zone IV: Huesca, Madrid, Zaragoza, Toledo, Lerida, Cuenca and Ciudad Real

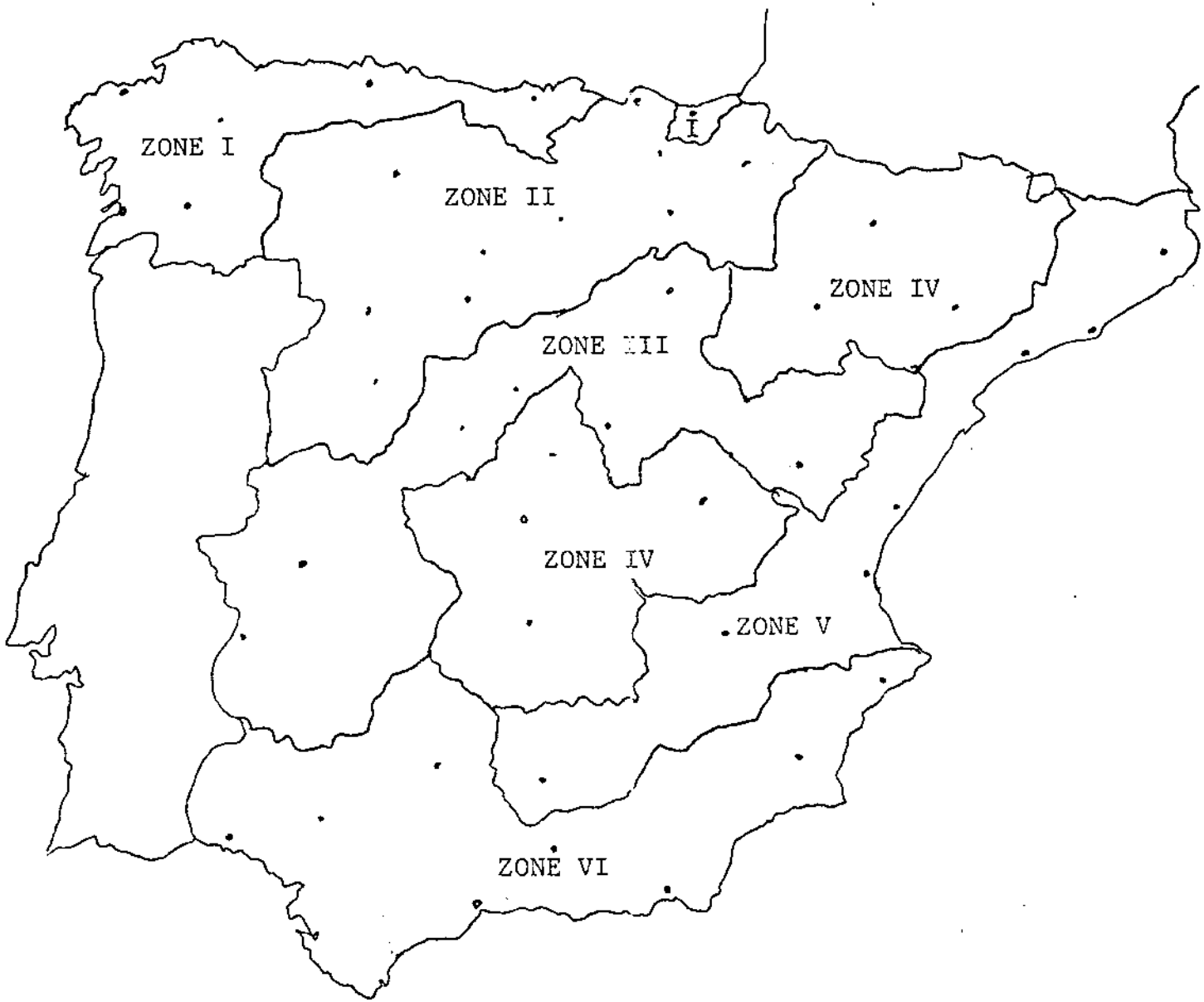
Zone V: Gerona, Albacete, Tarragona, Valencia, Barcelona, Castellon and Jaen.

Zone VI: Sevilla, Cordoba, Murcia, Alicante, Granada, Huelva, Malaga, Cadiz and Almeria

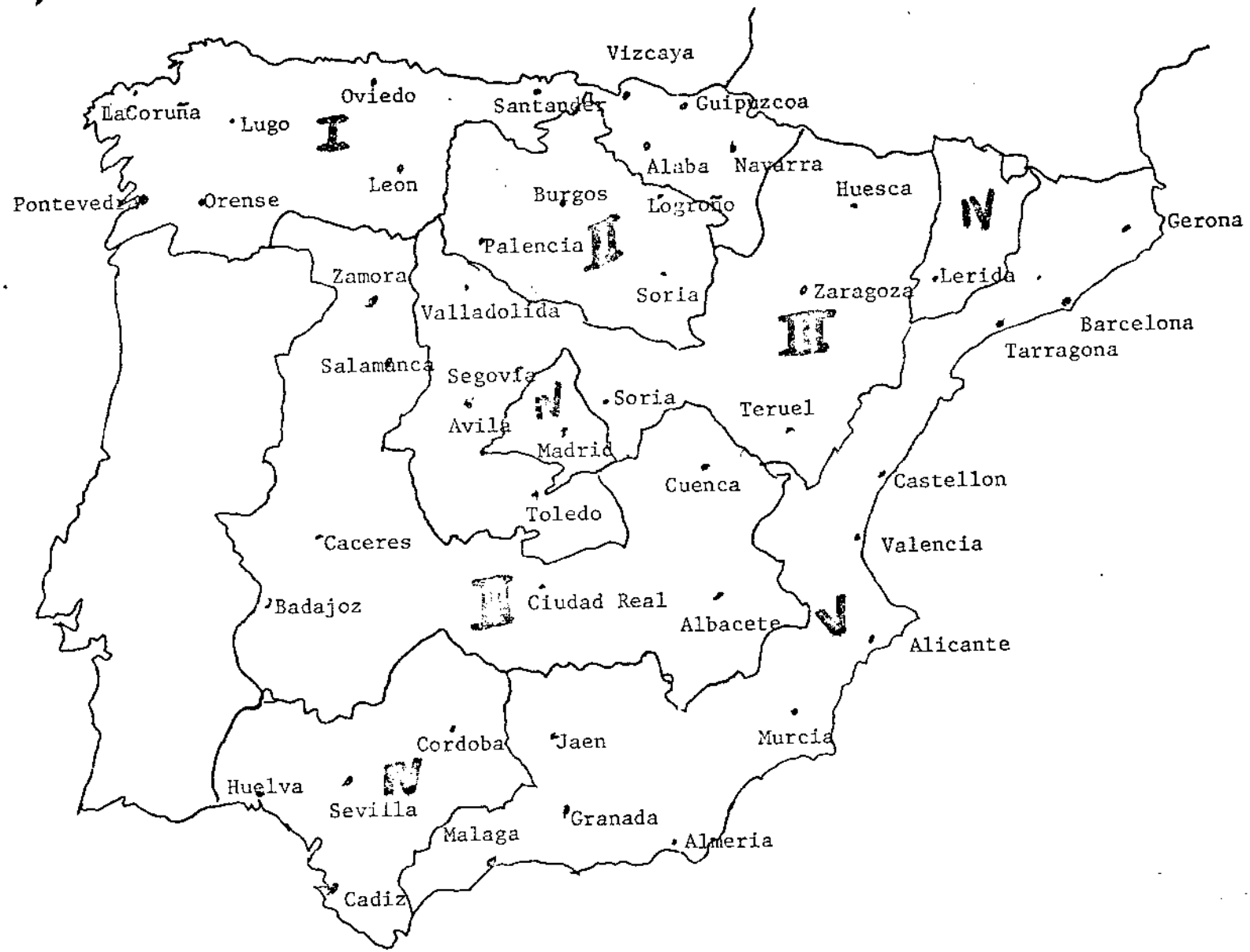
This tentative delimitation can be compared with the actual division for the dairy marketing year 1971-72 (Map 5 and 6).



Map 4. Optimum Differences in Minimum Prices to Milk Producers for Milk Destined to Fluid Consumption, with respect to La Coruna, Spain, 1971.



Map 5. Proposed Division of Six Dairy Pricing Zones for Spain, 1971.



Map 6. Actual Division of Dairy Pricing Zones, Spain, 1971-72.

V. SUMMARY AND CONCLUSIONS

This paper describes the main features of the Dairy Sector of Spain and analyzes its pricing regulations. It was hypothesized that the criterion of geographical prices of milk for fluid use based on production costs laid down by the present regulation is not efficient. In an attempt to devise a scheme which would be more efficient, a transportation model of the fluid milk subsystem of Spain was presented. This model indicates an optimum scheme for the flow of milk based on optimum differences of prices between provinces. These differences are compared with the existing differences.

The major conclusions drawn from this study can be briefly summarized as follows:

(1) The criterion of costs of production used to determine differences of prices among provinces is contrary to the specialization of the different provinces in those products for which they have a comparative advantage. This criterion, moreover, is not consistent with the regulations of other agricultural products in Spain.

(2) The pricing of milk in accordance with its quality only takes into account its physiochemical characteristics and, among these, only fat content and specific weight. The increased emphasis on use of milk protein and the existence

of reliable, inexpensive protein tests, however, suggests the increasing importance of protein pricing of milk. Hygienic and bacteriological characteristics, moreover, should also be taken into account.

(3) The present regulation make it possible to practice price discrimination. In most provinces two prices for the same product exist depending on the use to which milk is put.

(4) The present system of minimum prices does not guarantee the farmers that all their milk will be picked up since there is no intervention on the quantities.

Based on the results of the transportation model, an optimum scheme for the flow of milk destined to fluid consumption from the surplus to the deficit areas based upon transportation costs can be given. Optimum price differences among provinces are also computed and a possible delimitation of dairy zones is provided.

Finally, some policy orientations to improve the efficiency of the milk pricing system are provided. These include:

(1) the establishment of a minimum support price for raw milk, with the government buying the possible excess for transformation to non-perishable products.

(2) The establishment of different prices among provinces based on the transportation costs instead of the costs of production.

(3) The inclusion of the protein content of the milk in the system of pricing by quality and the consideration

of, other characteristics of the milk (hygienic and bacteriological quality) in addition to its richness in nutritive substances.

(4) To discourage further increases in milk production (other than those required to meet its own increase in demand) in Galicia, and specially in La Coruña.

However, it also has to be taken into account that: (1) Analysis of trade in terms of the supply and demand for a single commodity is oversimplified. Important relationships existing among commodities are ignored. (2) Efficiency is a relative concept. A pricing system cannot be judged as efficient in any absolute sense, but only with respect to alternatives or to some standards. Although competitive economic theory provides the framework for the analysis, this does not imply that prices established under purely competitive market conditions--though they do have desirable properties--are considered as inherently superior. (3) Not all the assumptions in which the final solution rests necessarily have to be fulfilled in practice. For example, production and consumption within each province are assumed to occur at precisely the same point--transfer costs within regions are ignored--and transfer costs are assumed to be uniform per unit of product, and to remain constant regardless of volume or direction of movement. (4) The data concerning supply, population and transfer costs may not be entirely reliable.

Therefore, the differences between actual and calculated prices may be due to one or a combination of the following:

(1) Market imperfections

(2) Weaknesses in the model (such as the assumption that all supplies originate or are consumed in a single point in each province), and

(3) Inadequate or inaccurate data.

APPENDIX

APPENDIX

FIFTH PART OF THE REGULATION OF FLUID MILK PROCESSING PLANTS AND OTHER DAIRY INDUSTRIES: MILK PRICES

I. PRICES TO THE FARMERS.

Art. 74. According to the functions given by Article 94 of the present regulation to the Dairy National Advisory Committee, they will propose to the Ministry of Agriculture the minimum prices to the farmer, attending the following norms:

(a) The Dairy year will be the period from April 1 to March 31 of the following year, except for the zones in which special climatological characteristics advise a modification of this period.

(b) For each dairy year the proposal will be made by the Dairy National Advisory Committee to the Ministry of Agriculture two months in advance of the starting date of the established period.

(c) The minimum prices will be proposed based on the real costs of production and by zones of similar ecological, edaphic and farming characteristics.

(d) The zonal minimum prices will also be seasonal, being proposed for the periods going from April to September 30 and from October 1 to March 31, or on the corresponding

dates for the exceptions referred to in point (a).

(e) For each zone and period, different minimum prices will be proposed for milk destined to be hygienized or sterilized in fluid milk processing plants, approved plants or other industries, or to manufacturing ends.

Art. 75. The Ministry of Agriculture, examined the proposal of the Dairy National Advisory Committee and previous reports of the Ministries of the Interior and of Commerce (Board of Supplies and Transportation), will approve it if it is appropriate. The corresponding order by which the zonal and seasonal minimum prices for the following marketing year are determined will be published in the Official Journal of the State.

Art. 76. The minimum prices to the farmers will be those for milk of the characteristics specified in Art. 6. When these characteristics are different, the premiums and discounts that were proposed by the Dairy National Advisory Committee and approved by the Ministry of Agriculture who has previously heard the report of the Ministry of the Interior, will be applied.

The Ministry of Agriculture, after hearing the report of the Ministry of the Interior, will establish the analyses necessary to evaluate the amount of the premiums and deductions.

For the application of the system of premiums and deductions, the milk will respond to the characteristics defined

in Article 6 for natural milk and, therefore, shall have not suffered any alteration nor adulteration. In case of fraud the penalties specified by the present legislation on the matter will be applicable.

Art. 77. The Dairy National Advisory Committee must propose, if the circumstances advise it, the necessary modifications in the minimum prices during the dairy marketing year.

II. PRICES TO CONSUMERS.

Art. 78. The maximum selling price to the consumers of hygienized and packaged milk will be determined by the Ministry of Commerce through the Board of Supplies and Transportation, who has previously heard the reports of the Ministries of the Interior and of Agriculture.

To compute the prices corresponding to a liter of hygienized milk bottled in glass bottles, the following formula will be used:

$$1.042\ (P + R + I) + D + M$$

where:

P = Price to the farmers corresponding to the zonal and seasonal prices approved following articles 75 and 76.

R = Average cost of assembly of a liter of milk in the different production zones and transportation from them to the hygienizator plants.

I = Hygienization margin of a liter of milk. The formula

$$\frac{G + .06C}{L}$$

will be used for its determination, applied to a typical fluid milk processing plant and where

G = annual expenses, computing: wages, social security, energy and the different raw materials, general expenses, depreciation, insurance and interests.

C = Total budget of the plant

L = Quantity processed annually, in liters.

D = Distribution cost of a liter of milk to retailers

M = Commercial selling margin of a liter of milk.

The coefficient of the formula includes the losses for possible shrinkages, returns, acid milks, etc. and therefore these concepts will not be computed among the annual expenses of hygienization.

The maximum selling prices of a liter of hygienized and bottled milk on dock of the processing plant, whose determination will be made by the Ministry of Agriculture after hearing the reports of the Ministries of the Interior and of Commerce, will result from the application of the first part of the formula, that is, 1.042 (P+R+I) approximating them by excess up to the next fraction of five cents. The maximum selling prices to consumers for retailers will be calculated applying the complete formula and will be the same for all the plants in a population center.

For the packages of different capacities and different nature to glass the corresponding prices will be determined comparatively with those for a liter in glass bottles, taking into account the modification produced on the expenses.

Art. 79. For homogenized hygienized milk the prices will be that resulting from application of the previous formula,

incremented in a quantity proportional to the volume of the packages and independently of its nature, quantity which will be determined by the Ministry of Agriculture, who has previously heard the reports of the Ministries of the Interior and of Commerce, in the same order cited in the previous article.

Art. 80. The maximum selling prices of concentrated milk, of the characteristics fixed in the Article 1, will also be determined by the order to which Article 78 refers, applying a correction factor proportional to the process and types of concentration.

Art. 81. The prices stated in the previous article will be also applicable to the hygienizator plants supplying the population centers or areas subject to the system of sale of compulsory hygienized milk.

Those prices can be reviewed when the circumstances require it, at the judgement of the corresponding Ministries.

III. PRICES OF MANUFACTURING MILK.

Art. 82. The Dairy Industries whose products do not have maximum selling prices will be also subject to the minimum buying prices to farmers that are proposed by the Dairy National Advisory Committee and approved by the Ministry of Agriculture, after hearing the report of the Ministries of the Interior and of Commerce for this type of industries.

Art. 83. The fluid milk processing plants will be required to buy only the milk they need to attend the demand with its

normal fluctuations, paying for it the approved prices. The milk destined to other uses, different from the hygienization or sterilization, will be acquired at the prices given under (a) of the Article 74 of the present regulation.

BIBLIOGRAPHY

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Bressler, R. G. and R. A. King. Markets, Prices and Interregional Trade. (John Wiley and Sons, Inc. 1970).

Boletin Oficial del Estado (several issues)

Caldentey, P. "Estudios sobre precios geograficos de la leche" (Revista de Estudios Agro-sociales, No. 83, April-June, 1973).

Dorfman, R. P. Samuelson and R. Solow. Linear Programming and Economic Analysis (McGraw-Hill Book Co., Inc., New York, 1958) Chapter V.

Graf, T. F. "Can the Pricing of Milk be Made on the Basis of its Protein Content?" (Staff paper series, Cooperative Extension Programs, Department of Agricultural Economics, Wisconsin, April 1971, No. 32).

Heady, E. O. and W. Candler. Linear Programming Methods. (The Iowa State University Press, 1958).

Ministerio de Agricultura. "Anuario Estadistico de la Produccion Ganadera 1971"

Ministerio de Agricultura. "La agricultura española en 1972"

Snodgrass, and C. French. "Simplified Presentation of Transportation--Problem Procedure in Linear Programming," Journal of Farm Economics, Feb. 1957, pp. 40-51.

Tomek, W. and K. Robinson. "Agricultural Product Prices," Cornell University Press, 1972.