An econometric study of future trends in demand for soybeans and soybean products in France

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AN ECONOMETRIC STUDY OF FUTURE TRENDS IN DEMAND FOR SOYBEANS AND SOYBEAN PRODUCTS IN FRANCE

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ABSTRACT

AN ECONOMETRIC STUDY OF FUTURE TRENDS IN DEMAND FOR SOYBEANS AND SOYBEAN PRODUCTS IN FRANCE

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The purpose of this study is three-fold:

i) to provide an econometric model of the French soybean economy;

ii) to forecast the demand for soybeans and its by-products, oil and meal; and

iii) to examine the impact of some policies for improving high-protein self-sufficiency.

The model structure is of the Houck-type, but takes into account the specific factors inherent to the EEC and French agricultural sectors, namely the role of the compound feed industry in the animal feed market and the Common Agricultural Policy.

The main characteristics of the model are:

i) it assumes that France is a small country with respect to soybeans and soyoil;

ii) due to its significant consumption of soymeal, France is assumed to influence the world soymeal market; accordingly, the price of soymeal is endogenous;

iii) because other kinds of edible oils are consumed in France and compete directly with soyoil, demand functions for rapeseed and peanut oils are specified;

iv) the demand structure of the French soymeal market is split into the demand for soymeal by compounders and the demand for soymeal by farmers.

As a result of this separation, a representation of the French compound feed industry is included in the model. Demand and price relationships for the main classes of formula feeds have been estimated. This formulation of the French soymeal market is fruitful in the sense that it captures the changes in feeding practices which the French feed livestock sector has undergone in the last two decades.

Related to the former feature of the model is the specification of the demand for feedgrains by compounders and farmers. A modelling of the feedgrain sector with exogenous feedgrain prices is necessary to analyze first the interrelationships between commercially mixed feeds and the on-farm consumption of feedgrains, and second, to take into consideration the CAP grain policy which affects the consumption of soymeal in France.

Four policies for improving French self-sufficiency in high protein feeds are analyzed:

i) an increase in crushing capacity;

ii) imposition of a tariff on soymeal imports;

iii) decrease in the price of feedgrains; and

iv) the effect of developing the consumption of other high protein sources such as rapeseed.

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CHAPTER I

INTRODUCTION

1.1 General Characteristics of the French Feed-Oilseed-Livestock Economy

Endowed by good climate and soil conditions for agricultural production, and with 37% of the arable land in the EEC9,[1] France is the largest agricultural producing country in Western Europe. After a long period characterized by stagnant production and protected markets,[2] French agriculture has progressed rapidly since the end of World War II. Tables 1.1 and 1.2 display the magnitude of this change in cereal and livestock output, which are the backbone of the French agricultural sector,[3] representing 70% of the total agricultural production in 1975.[4]

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[1] Eurostat.

[2] As shown by Ruttan (pp. 716-717), the performance of French agriculture relative to other West European agricultural sectors was very low between 1880-1930. Agricultural output grew at an annual rate of 0.76 in France, compared to 1.32 in Germany and 2.07 in Denmark.

[3] To have a more exhaustive and objective idea of French agriculture, it would be necessary to analyze the evolution of other agricultural products such as wine, vegetables and fruit production which have also expanded very significantly between 1950 and 1975. However, crop and livestock sectors are only considered in order to limit the scope of this overview. For a similar reason, sheep activities, while important in some regions of France, are not dealt with.

[4] Eurostat.

TABLE 1.1. Evolution of total production of cereals

	1948-1952	1958-1962	1968-1972	Increase 1958-1962=100
Area (million ha)	8.39	9.16	9.45	91.6 to 103.2
Average Yield (100 kg/ha)	16.35	23.83	37.33	68.6 to 156.7
Production (million tons)	13.73	21.60	35.09	63.6 to 162.4

Source: For years 1948-1952, data were computed from Oury (1966, p. 290). From 1958 onwards, OECD (1974b).

TABLE 1.2. Development of livestock production

population ?

		1950	1955	1960	1965	1970	1975
Cattle Production[1]	(1000 head)	15,800.6	17,571	19,501	20,516	21,542	23,641
Pig Production[1]		1,824	7,729	8,603	9,149	10,239	11,890
Poultry Inventories[1]	(1000 head)	85,000	90,000	103,000	114,770	157,213	155,335
Beef Production[2]	('000 tons)	459.8	783.3	861	947.8	1,183	1,468.2
Pork Production[2]	('000 tons)		541	721	840	903	1,129
Milk Production	('000 tons)		18,636	23,291	27,733	28,325	30,910
Poultry Production[2]	('000 tons)	250	283	339	555	637	823
Egg Production	('000 tons)	431	391	506	582	658	768
Milk Yields[3]	(100 kg/ha)			2,145	2,529	3,110	3,241

Source: Oury (1966), Bergmann (1977), Eurostat, SCEES and Leflambe.

Notes: [1] Prior to 1965, pig and cattle populations were estimated in October of the given year. From 1965 onwards, they were computed in December. Statistics referring to poultry inventories for 1950, 1955 and 1960 are unofficial estimates reported by Oury (1966, p. 301).

[2] From 1955 onwards, beef, pork and poultry productions are inspected slaughter reported by the SCEES. For 1950, data are from the data bank compiled by Leflambe (INRA).

[3] From 1970 onwards, the yields are for a dairy cow, while the yield for previous years is an average of dairy and beef cows.

1.1.1 Cereal Production

Among cereals, corn is the crop that has evolved the most rapidly. Almost non-existent in 1950, average corn production has multiplied nine times in twenty-five years. Wheat and barley have also experienced a similar upward trend, but at a slower pace, whereas oats production is declining as in many other temperate zone countries. Despite the rapid increase in corn production, wheat is still the main cereal harvested in France. In terms of agricultural production, wheat, corn and barley represented, in 1975, 52.3%, 18.9% and 23.2% of the total production of cereals, respectively.[5]

Because the area planted to cereals has been relatively unchanged, this huge expansion of crop production results from a continuous increase in yields which have more than doubled during the same period. A rapid diffusion of technical progress among farmers, mainly reflected by rapid mechanization, higher consumption of fertilizer and the adoption of hybrid corn varieties have been the factors contributing to this improvement in yields (Klatzman, pp. 12-13).

1.1.2 Livestock Production

Livestock production has experienced a growth pattern similar to that of cereals (Table 1.2). Thus, beef and poultry output quadrupled from 1950 to 1975, whereas milk and egg production approximately doubled. A steadily increasing demand for animal products by consumers,

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[5] Eurostat.

linked with an increase in the standard of living, has caused this expansion in livestock production.[6] Since the turn of the century, consumption of dairy and meat products has doubled or tripled, thereby inducing an enormous drop in the demand for bread which was the basic food item.

The historical pre-eminence of livestock in the French agricultural sector is now decreasing. From 1965 onwards, the contribution of livestock production to total agricultural output fell from 65% to a constant rate which gravitates around 55%.[7] A more rapid application of technology and mechanization into the crop sector, a higher need for labour in livestock operations and Common Agricultural Policy regulations, which are more favourable to cereal markets, are the main reasons for this reversal. All these factors combined together have led to productivity and resource use higher in cereal production than in livestock production.

However,this global picture of efficiency in the French livestock economy masks very different situations existing for each type of livestock. In fact, poultry and, to a lesser extent, the pork sectors have undergone the most substantial changes involving: noticeable technological innovation; horizontal concentration and growth of units;

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[6] It should be pointed out that the importance of livestock in French agriculture started at the end of the last century with the occurrence of an agricultural crisis which depressed the price of cereals. In addition, with a secular fall in the agricultural labour force, labour was not available to produce labour intensive crops. As a result, farmers substituted grazing for arable land (Spindler, p. 5).

[7] Eurostat.

and, vertical co-ordination (Bergmann, p. 10). On the other hand, the dairy and beef sectors, which account for 63% of French livestock output,[8] are characterized by low productivity and an under-utilization of available resources. The French cattle herd utilizes half of the total agricultural land, but production density is low in relation to the area under grass and fodder crops at about one cattle unit[9] per hectare (OECD, 1974b, p. 14).

Dairy production is a vital activity for 800,000 out of 1.4 million farms, mainly with small herds. Dairying often provides 80% of cash receipts, thereby hindering the possibility of substituting other activities for milk production (Bergmann, p. 8). Despite the existence of some efficient dairy farms, the improvement of this sector constitutes one of the key objectives of the Common Agricultural Policy.

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1.1.3 Location of Livestock-Cereal Production

Another important feature of the French livestock and cereal sectors is their location throughout the country (Fig. 1.1). Although livestock activities are scattered, they are concentrated in the western part of France, including Brittany, Normandy and the Loire Valley regions; Brittany being the first producer of hogs, poultry and cattle. In contrast, the Paris Basin, representing, in a wider sense, one-fourth of the whole area of France, is specialized and highly efficient

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[8] Eurostat, including beef, calves and dairy.

[9] One cattle unit (Unité Gros Bovin) corresponds to the feed requirements of an average cow (about 2,500 feed units).

Figure 1.1 Share of Animal Production in the Final Agricultural Production by Region

More than 75%

35 to 55%

55 to 75%

Less than 35%

Source: Spindler (p. 7)

in crop production. Except for the Mediterranean regions, other regions are characterized by mixed farming systems in which small farms with small cattle herds dominate. Whereas grazing and forage lands are located in livestock areas, cereals are separated from livestock producing areas.

1.1.4 Agricultural Policy Considerations

As in any other agricultural country, public involvement in French Agriculture involves the regulation of agricultural prices, production and incomes. But, in addition, France has policies aimed at accelerating the structural adjustments required to improve the efficiency of the agricultural production system and to adapt this sector to the current economic situation. In order to promote modernization, renovation and the consolidation of land, the government provides financial aid to farmers, thus facilitating the expansion of farm holdings. Policies also deal with social problems inherent to the French Agricultural sector relating to income disparities between farm and non-farm groups. All of these policy measures are contained in a group of laws passed in the early 1960's, called "loi d'Orientation Agricole" and "loi complémentaire", which represent a decisive move towards improving French agriculture.[10]

The creation of the European Community with the signing of the Rome Treaty by France, West Germany, Italy, Netherlands, Belgium and

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[10] For a more detailed account of French Agricultural Policy, see OECD (1974b, pp. 45-78).

Luxembourg in 1957-1958, and the inception of the Common Agricultural Policy ten years later permitted another step towards better performance and expansion of French agriculture. The removal of trade barriers between EEC countries and the widening of market potentials involving trade creation and specialization in each country according to their resource use and endowments, stimulated French agriculture.[11] Another subsequent outcome of the Common Agricultural Policy has been the improvement in the degree of self-sufficiency in agricultural production which, among other things, was one of the objectives of the Rome Treaty (Article 39).[12]

Relative to these two criteria, specialization and degree of self-sufficiency, Table 1.3 indicates that France has expanded remarkably its crop production, thereby inducing a specialization in France towards arable land production. For beef, poultry and eggs, self-sufficiency has increased, while the pork sector displays a fall of 14% in the self-sufficiency ratio over fifteen years. This also reflects the emergence of structural problems inherent to the pork sector and its lack of competitiveness relative to other EEC members' hog industries (Mahé, pp.66-68).

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[11] For a full account of the effects of EEC integration on trade, see Balassa. In agricultural trade, empirical work has shown the existence of trade diversion as well as trade creation.

[12] In this article, it is stated that one of the purposes of the CAP was to "ensure the availability of supplies for all the Community". As long as degree of self-sufficiency is measured by the extent to which domestic production in a country meets total consumption, this objective seems to be unrealistic for some commodities, and more particularly for oilseeds (Ritson and Parris, 1977, pp. 54-58).

TABLE 1.3. Degree of self-sufficiency in livestock, crop and oilseeds products in France

	1956-1960	1969-1970	1974-1975
Crop Products[1]			
Total cereals (except rice)	110	147	167.9
of which Wheat	109	134	205
Barley	117	156.8	162.5
Corn	120.5	161.3	144.7
oilseeds	11.6	53	55
Livestock Products			
Butter	106	107	111
Cheese	104	111	116
Beef and Veal	102	107	117
Pigmeat	101	83	87
Poultry	101	103	110
Total meat	101	103	98
Eggs	96	98	105
Vegetable Fats and Oils	9	19	28

Source: FEDIOL, OECD, Eurostat.

Note: [1] The rate of self-sufficiency for barley, wheat and corn corresponds to the crop year 1959-1960.

With regard to oilseeds, the degree of self-sufficiency has improved remarkably because of the incentives provided by the European Community Authorities to subsidize farmers in producing these crops. But, despite these efforts to promote the domestic production of oilseeds, the dependence of France on imported supplies of oilseeds has remained high.

With the numerous changes which have struck the World Economy in the seventies, new directions are being sought by the French Government towards the French agricultural sector. Aware of the fact that French agriculture has considerable unused production capacity, policymakers want to pursue the following goals in the next five year VIIIth Plan[14] (BIMA, no. 871-873, pp. 9 & 15).

The first goal is to adapt the agricultural sector to the new economic environment. Due to regional disparities and heterogeneous systems of production, French agriculture must improve its productivity which lags, compared to other West European countries. Agricultural activities must become more intensive. A more efficient use of domestic resources, transformation of structures in the food industry and greater

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[14] It should be borne in mind that since World War II, long and medium range policies which are part of the Plan are defined and set up every five years by a State body called Commissariat Général au Plan. Once formulated, these policies are proposed, modified if necessary, and applied by the Government. These plans have not the same role as imperative planning programs and policies existing in centrally planned economies. They are rather indicative in spirit and provide a useful and effective framework for the French Government to co-ordinate public investment and define economic and social structural policies. Other original features are also attributable to the French planning system (for a broad overview, see Deleau, M. and Malgrange, P.).

efforts in research and agricultural training will be the means to reach this target. The second goal is to increase exports and find new outlets for French agricultural products. To do this, French agriculture must become more competitive relative to other European agricultural sectors. The third goal is to reduce imports and develop domestic agricultural production, using domestic resources.

These above goals will be pursued in the light of general economic policies that emphasize balanced growth, full employment, the continuation of past agricultural policies, and an European orientation.

1.2 The Problem

The significant role in economic development played by livestock in the French agricultural sector generates a growing need for high protein commodities to feed animals. High protein ingredients which are inexpensive and have good nutritional qualities in terms of a high protein and amino-acid content are preferred by farmers. Soymeal is a product which fulfills these two conditions. In 1955, the French consumption of soybean meal was 75,800 metric tons, representing only 18.9% of total oilcake demand. Twenty years later, consumption of soymeal accounts for 75% of the total high protein consumption, amounting to more than 2 MMT per year.

By contrast, the other major soybean by-product, soyoil, has not had a similar growth pattern with demand remaining small relative to the total demand for vegetable oils. In 1977, soyoil accounted for less than 20% of the French consumption of edible oils. The traditional structure of the French oil market in which supplies from ex-French African countries predominate, and the persistence of eating habits among French households with regard to the use of peanut oil are the major factors that have hindered the growth in the demand for soybean oil.

As indicated by Table 1.3, the low degree of self-sufficiency in oilseeds requires a continued flow of soybeans and soymeal from the U.S.A. and, more recently, Brazil. Since the French soybean economy is open to the world soybean economy, any changes occurring in the world market have repercussions on the demand for soybean products in France. Until 1972, the great stability of soybean prices and the large supplies of soybeans benefitted French feed manufacturers and farmers. Recent developments illustrated by the sharp increase in food prices during 1972-1975, the increased foreign demand for U.S. exports and the international monetary crisis suggest that trade in agricultural products will be characterized by instability and a reinforcement of the interdependencies among countries. This has caused many in France to question the degree of dependence on imported protein supplies.

The "protein" problem became an important issue in France and other EEC countries when the United States imposed an embargo on the exports of soybeans and soybean products in the summer of 1973. This embargo revealed the strategic problem caused by French dependence on imported supplies and the likely disastrous effects on the EEC livestock sector if it were applied over a longer period (Poly, p. 2).

Subsequently, France and, to a lesser extent, other EEC member countries, attempted to set up a "protein" policy to remedy a growing dependence on U.S. soybeans and meal. Three general orientations are the basis of this policy.

The first objective is to diversify imports. However, in this field, feasible actions are limited. The only plausible one is an increase in imports from the southern hemisphere countries, mainly Brazil and Argentina. This option has been pursued during the last three years. In addition, increased storage capacities for imported protein substances will help prevent a recurrence of a situation similar to the 1973 soybean crisis.

Greater self-sufficiency is also attainable through economies in consumption, in changes in the composition of feeding rations and in the improvement of livestock efficiency. A relevant policy consists of gradually replacing the use of soybean protein by other sources derived from agricultural and industrial products. The main orientation focuses on developing feed rations based on the greater employment of cereals.

The development of greater domestic production of soybeans and other vegetable proteins is also possible. Emphasis on the increased production of rapeseed, soybeans and vegetable protein products such as green peas and alfalfa constitute the main objective.

The completion of such a protein policy will tend to change the feed ration pattern based on a combination of soymeal and corn toward a greater use of feedstuffs produced domestically such as cereals and rapeseed meal (Poly, p. 7).

An analysis of future trends in the demand for soybeans and soybean products must encompass all the aspects of French dependence on imported protein sources. In addition, to evaluate the evolution of this dependence and to adjust it to the future demand level, it is imperative to identify the main factors which influence the French demand for soybeans and soybean products.

The consumption of soymeal is influenced by two main structural elements. First, as a factor of production, the demand for soymeal depends on the evolution of livestock production. However, soymeal is not used primarily by farmers, but by feed compounders who can or cannot blend this raw material with other feed inputs, depending on the level of input prices. Consequently, the important decisions with regard to the consumption of soymeal occur in the compound feed sector. Furthermore, French hog and poultry producers are dependent on mixed feeds for a large portion of their protein supply. In that context, the degree of penetration of the feed market by compound feeds influences directly the determination of the future consumption of soymeal.

Second, interrelationships between soymeal and other agricultural commodities may affect the future pattern of the demand for soymeal and hence, the rate of protein self-sufficiency. It is evident that other protein sources might substitute for soymeal as long as they are technically and economically attractive to French livestock producers. In addition, despite the existence of a complementary relationship between soymeal and feedgrains, the setting and application of the

C.A.P. which, among other things, aims at fixing prices for feedgrains higher than the world price level has modified this relationship. As a result, any change in the C.A.P. implying a decrease of feedgrain prices by whatever means would have a direct impact on the demand for soymeal.

1.3 Research Objectives

The primary objectives of this study are:

i) to identify and quantify the economic factors influencing the demand for soybeans and soybean products in France;

ii) to project the future requirements for imported soybeans and its by-products; and

iii) to appraise the effectiveness of various economic policies in reducing the French import demand for soybeans and soybean products.

To achieve the above objectives, an econometric model of the French animal feed industry is utilized. Four potential policies to improve the French dependence on soybean imports are analyzed. They are:

1) an increase in French crushing capacity;

2) a reduction in feedgrain prices;

3) an increase in the consumption of domestic protein products; and

4) the imposition of a tariff on soymeal imports.

1.4 Scope of the Study

The model used to describe the functioning of the French soybean economy relies on the three product market model[15] developed by Houck et al. and applied to the U.S. soybean economy. More specifically, it is a joint multi-commodity market model in which a set of technical and behavioural relationships, along with identities, represent:

- i) the interrelated price mechanism of the soybean, oil and meal markets;
- ii) the fixed linkages existing between soybean products; and
- iii) the influence of factors specific to the European Community, namely, the behaviour of the compound feed sector and the impact of the Common Agricultural Policy.

With regard to the incorporation of the compound feed sector in the analysis, the scope of the underlying model is extended and encompasses explicitly the compound feed production process. In operating in such a way, a sub-system is created, which does not represent a market equilibrating mechanism, but rather provides an overall explanation of the process linking the compound feed output with with inputs such as soymeal, feedgrains and other feed ingredients. This sub-model falls in the subset of commodity models classified by Labys as process models (Labys, pp. 114-116).

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[15] Knipscher (1979a) employs this terminology to differentiate the Houck model from the "two market approach" presented by Vandenborre where only soyoil and soymeal are considered (Vandenborre, 1967).

Because of the emphasis in this model on the trade-offs between the French soybean economy with other commodity sectors of the French economy, the model is domestically-oriented as opposed to an international trade model in which trade flows are the major variables of interest. Adopting such an approach does not mean that all the factors representative of the world soybean and other oilseeds economies are excluded from the French soybean model. Indeed, it is implicitly recognized that the French soybean market is influenced by conditions prevailing in the world soybean and other oilseeds markets. For that reason, a simultaneous price mechanism linking French and world prices is incorporated in the model, when necessary.

The representation of interrelationships between the French soymeal and feedgrain sectors constitutes a key element of this model. In doing so, it is admitted that the scope of the French soybean model goes far beyond the analysis of the French soymeal market per se and is preliminary to work leading to the elaboration of a more extensive model of the French feed livestock sector in which additional components of the French feedgrain and livestock sectors would be endogenized.

The most common approach adopted by model builders in explaining a commodity market is to develop a model structure which is invariant over time. This is accomplished by estimating parameters which remain constant during the study period. In view of the rapid expansion in the demand for soymeal in France, and given the importance of the formula feed industry, the traditional approach is invalid for modeling the demand for soymeal. In order to deal with this problem, the model proposed includes both static and evolving structural components.

The econometric model developed in this research work aims at studying demand relationships at an aggregate level and does not deal with all the specific substitution relationships which are also important in solving the protein dependence problem. Policy measures in favour of domestic protein sources other than soybeans are analyzed as a whole. Thus, the question of evaluating the impact of cassava imports on the demand for soymeal in France cannot be handled by this model. However, owing to the dominant position of soybeans in the French oilseed and protein economy and in spite of the level of aggregation, this study provides essential insights into the French protein economy.

Although the problem of dependence on soybean imports is an European one, and France has to apply Common Agricultural Policy, this work analyzes only the French soybean economy. In fact, many additional factors would appear if the study was extended to all the Community.

1.5 Organization of the Thesis

Chapter II gives a description of the main elements of the French soybean economy. Special attention is given to the various agricultural policies aimed at reducing imported protein supplies and to the structure of the French feed livestock industry, in which soymeal plays a central role.

Chapters III and IV develop the theoretical framework which underlies the econometric model, including the behaviour of the formula feed industry. Estimation of the model and discussion of empirical results are presented in Chapter V.

The reliability and performance of the econometric model is tested in Chapter VI by simulation over the sample period. In addition, this section includes an analysis and evaluation of the future trends in soybean and soybean product demand over the next five years.

Chapter VII deals with the different policies aimed at improving France's protein self-sufficiency, while Chapter VIII presents the study's conclusions.

CHAPTER II

AN OVERVIEW OF THE FRENCH SOYBEAN COMPLEX

2.1 Introduction

The purpose of this chapter is to provide a descriptive overview of the French soybean complex, thus providing the setting for the quantitative analysis undertaken later. Given the nature of the French soybean industry and the objectives of the research, the description includes four different elements. First, the structure of French soybean imports are examined in order to show the degree of dependency of France on foreign supply sources. It also helps to identify the main linkages existing between France and the rest of the world soybean economy. Second, an historical account of trends in consumption of soybean products and of factors explaining its evolution is undertaken. Third, the issue of reducing soybean imports and the likely impacts on the French soybean complex are discussed. In so doing, the development of potential domestic supplies of protein crops and oilseeds and the application of adequate agricultural policies are examined and reviewed. Fourth, as pointed out by Knipscher (1979a, pp. 4-5), the demand for soymeal in the EEC is directly influenced by so-called "EEC specific factors". Mainly generated by the inception of the Common Agricultural Policy in the mid-sixties, these factors also comprise structural issues and, more particularly, the role of the compound feed sector. Section 2.7 contains a thorough description of the formula feed industry and the relationships existing between feed manufacturers and livestock producers. Related to this aspect of the soybean sector is the evolution of the French oilseed crushing industry.

The reader will not find a description of the Common Agricultural Policy for commodities or an examination of the Agri monetary system existing within the EEC. Information on these questions is available and well documented elsewhere [Paarlberg (1977), Knipscher and Hill (1980), Griffith (1979), OECD (1974a)].

2.2 French Trade in Soybeans and Soybean Products

An examination of statistics contained in Table 2.1 displays two basic features with regard to the structure of French oilseeds imports.

First, not all of the domestic production of sunflower and rapeseed is sold in the French market. In fact, a significant trade surplus appears because of exports to other EEC countries and some other parts of the world. The direct outcome of this outflow of rapeseed from France is to lower the overall degree of self-sufficiency in oil and protein.

Second, the existence in the past of important ties between the French oilseed industry and French African colonies has deeply affected the French oilseed industry. Essentially made up of oilseed imports by the mother country, these ties were gradually severed with the independence of most African countries in the early sixties. This historical trend is reflected by the importance of tropical oilseed imports in the French total, including peanut, copra and palm kernel. Despite the survival of this influence in the French edible oil market,

TABLE 2.1. Production and net imports of oilseeds and oilmeals in France, 1938-1977 ('000 metric tons)

	Soybean		Peanut		Copra		Palm Kernel		Rapeseed		Sunflower		Linseed		Fishmeal
	Bean	Meal	Bean	Meal	Bean	Meal	Bean	Meal	Bean	Meal	Bean	Meal	Bean	Meal	
PRODUCTION															
1938									13	13			12	131	
1955									107	49	4	1	23	72	
1960									52	39		1	24	68	
1965									333	82	13	5	26	58	13
1970									580	182	49	8	16	36	14
1973									662	330	70	40	21	34	31
1974	2								664	233	60	46	26	20	16
1975	2								484	230	99	30	30	27	
1976	3								525	210	63	34	44	18	
1977	2								385	246	70	32	44	21	18
NET IMPORTS															
1938	13		749		143		88		13				203		
1955	87	18	364	31	90		137	-33[1]	187				115	53	
1960	196	91	438	46	87		95	9	185	-8		16	80	65	28
1965	109	479	499	177	96	-2	66	-3	-121	-25	1	27	55	132	94
1970	442	832	309	227	54	3	60	5	-138	-59	-20	59	31	129	90
1973	508	1186	231	322	47		18	19	-119	-50	13	52	33	82	
1974	564	1477	231	181	49	-4	18	4	-220	9	31	9	8	43	22
1975	416	1476	184	232	64	-2	12	8	-7	8	14	8	5	62	47
1976	509	1696	250	416	71	7	9	6	-133	22	-32	22	-15	95	43
1977	549	1688	146	428	61	-2	12		-13	-31	-24	31	11	68	41

Source: FEDIOL

Notes: [1] Includes copra and palm kernal.

and given the steadily growing demand for high protein, soybeans and soymeal have supplanted tropical oilseeds as the main source of protein supply. Of these two latter products, more soymeal is imported (Tables 2.1, 2.2 and 2.3).

From 1965 to 1975, the quantity of soybean meal shipped to France increased approximately five-fold, accounting for 14.9% of world soymeal imports in 1973. However, the small crushing capacity devoted to soybeans in France constitutes a limiting factor in developing soybean imports and has favoured the direct shipment of soymeal from soymeal producing countries. Table 2.2 indicates that French soybean imports are a very small fraction of world soybean exports, representing 2% of the total. A similar feature also characterizes the French soyoil market. As opposed to soymeal, France does not affect the price of these two latter products and can be considered a price taker.

The other striking characteristic of the structure of French imports of soybeans and soybean products is the reliance on one source of supply, namely the U.S.A., the main producer and exporter of soybeans and soybean products. Although this trend has historically predominated, it is now declining for soymeal. Thus, in 1965, the United States provided 81.5% and 85% of soymeal and soybeans imported by France, whereas these shares in 1973 were 65% for soymeal and 86% for soybeans. However, the latter figures do not reflect the real dependence of France on U.S. soybean shipments which is even more accentuated when imports of soymeal from other EEC countries are taken into consideration.

In fact, large crushing plants located in the Northern Sea ports

TABLE 2.2 Linkages between the French and World soymeal markets (in '000 metric tons)

	World Exports	U.S. Exports	Brazilian Exports	EEC[1] Exports	French Imports	French Imports from Brazil	French Imports from U.S.	French Imports from Other EEC Countries
1965	2848	1969	105	359	485.85	1.149	395.75	85.97
1966	3141	2271	185	338.6	619.03	2.6	495.72	103.89
1967	3397	2465	129	440	625.93	0.89	527.33	91.62
1968	3785	2698	236	501	739.52	5.30	625.34	107.98
1969	4235	2996	286	603	802.79	2.94	625.78	142.20
1970	5380	3660	525	780	843.31	9.16	638.34	188.85
1971	6212	4086	901	834	939.39	24.09	694.84	210.86
1972	6557	3619	1405	1145.05	1047.52	31.09	773.54	224.38
1973	8101	4415	1581	1793	1147.26	84.66	745.92	305.63
1974	9239	4817	2031	2020.4	1512.82	55.9	1020.99	424.55
1975	8339	3783	3134	1520.8	1499.42	185.03	844.01	461.29
1976	11348	4862	4374	1686.8	1718.4	428.05	749.23	497.45
1977	11850	4207	5329	1760.6	1703.75	1913.02	208.59	476.64
1978	14880	4862	5419	2455.4	2276.22	1197.82	371.98	608.374

Source: (FAO), FORMA, Charles Robert.

Notes: [1] From 1973 to 1978, including Denmark, United Kingdom and Ireland.

TABLE 2.3 Role of the French soybeans and soybean oil sectors in the World soybeans and oil economies (in '000 metric tons)

	Soybeans						Soyoil		
	World Exports	Brazilian Exports	U.S. Exports	French Imports	French Imports from U.S.	French Imports from Brazil	U.S. Exports	World Exports	French Net Imports
1965	6575	75.2	6196	108.5	92.3	6.1	545	691	-2.8
1966	7505	121	6688	117.7	116.1	1.4	387	512	
1967	8143	304	7169	136.4	133.2	2.8	512	670	5.9
1968	8756	686	8012	50	49.9		427	595	12.2
1969	9328	3101	8468	57	56.6		397	668	18.7
1970	12621	2896	11839	441.6	441.4		674	1120	7.9
1971	12282	2134	11521	479.3	449.6		778	1289	1.4
1972	13817	1037	11993	458.4	394.2	58.4	587	1102	-19.4
1973	15626	1786	13222	507.8	390.7	99.6	436	1053	-14.8
1974	17228	2724	13940	564	489.1	73.8	758	1546	4.7
1975	16459	3333	12496	416.2	328.6	84.9	353	1364	9.5
1976	19753	3639	15332	508.9	394.6	113.4	506	1836	13.2
1977	19996	2587	16196	549.3	497.8	37.2	768	2104	8.8
1978	24051	658.5	20710	782.1	694.5	22.0	914	2596	-17

Source: FAO, FORMA, French Customs.

such as Antwerp and Rotterdam produce soymeal destined for France and are derived from soybeans imported from the U.S. It should be noted that this soymeal is exported mainly to the Northern and Eastern parts of France, which are connected with the Northern Sea by navigable channels and rivers.

These linkages between the French soybean complex and other elements indicate the traditional role of France in the World Soybean Economy. Since the early seventies, they have been altered by the increasing influence of Brazil as a producer and exporter of soybeans and soymeal (Thompson, 1979). Although an insignificant exporter to France prior to 1973, Brazil presently furnishes 52% of French soymeal imports. A third producer and exporter of soybeans, Argentina, is emerging and may become an important exporter in the future. In 1978, Argentina shipped 65,162.5 tons of soybeans to France, representing 8.3% of total French imports. At present, there is no doubt that the role of Brazil will be maintained in the near future and even expanded.

2.3 Trends in the Consumption of Soybean Products

2.3.1 Soymeal Consumption

In the last two decades, the demand for soymeal in France has grown rapidly from an almost insignificant quantity in the 1950's to over two million metric tons by 1977 (Fig. 2.1). Such evolution is reflected by an annual growth rate of 15.6 percent over the period 1955-1977. At the same time soymeal has progressively become the most important high protein feed for French livestock producers. In 1955,

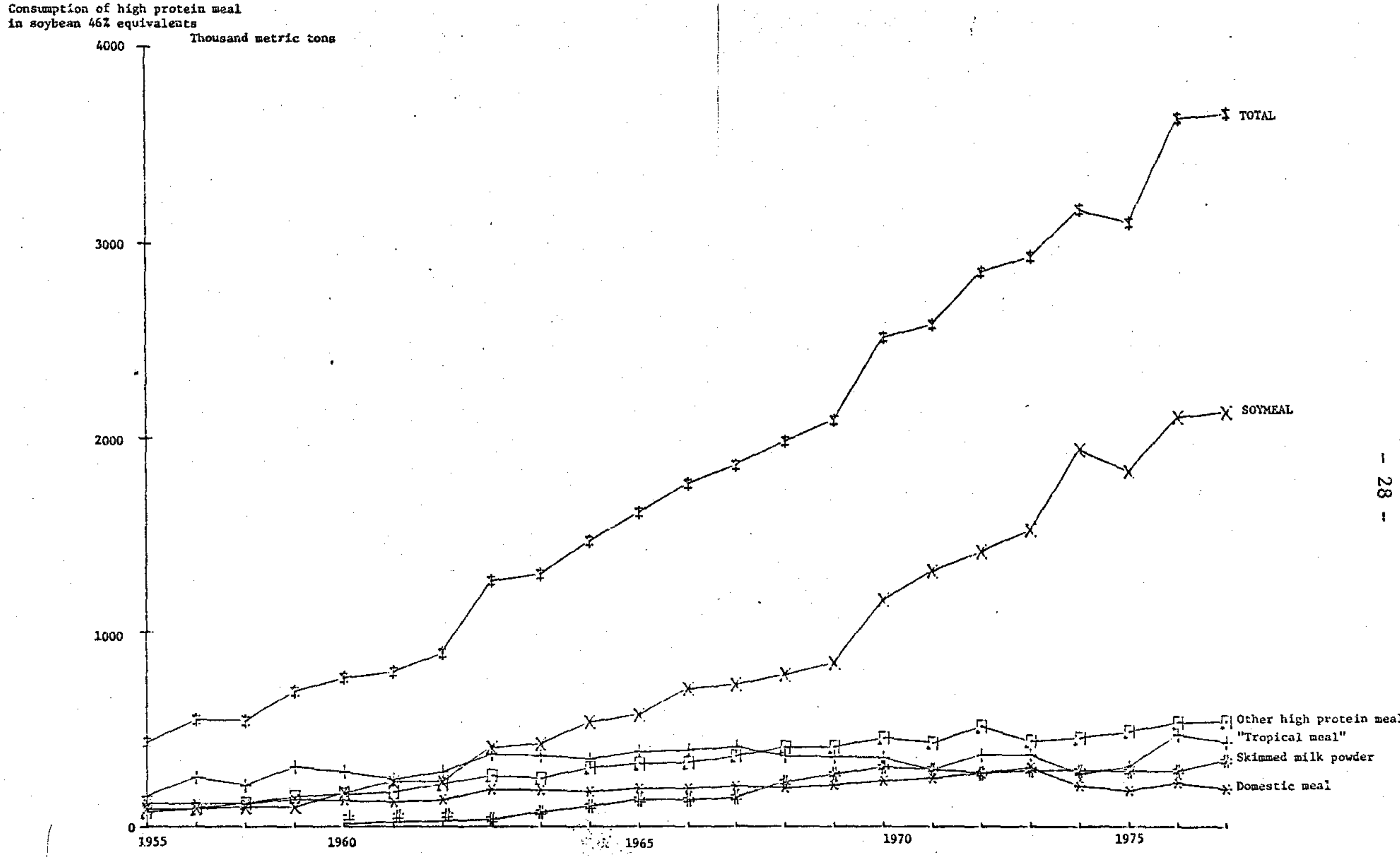

Figure 2.1: Demand for High Protein Meal in France in Soymeal 46% Equivalents

Source: FEDIOL, FFIOL.

the main contributor of high protein feeds was the "tropical meal" group which accounted for 36.2 percent of the total demand for high protein meals, while soymeals share was only 19.8 percent.[1] This trend has been completely reversed with soymeal now supplying 61.2 percent of the total, whereas "tropical meals" market share had dropped to only 13 percent of the overall demand for high protein meals. The two other groups, domestic meals and other high protein meals, provided respectively 5.8 percent and 20 percent of high protein feed products in 1977.

2.3.1.1 General Factors Contributing to the Growth of Demand for High Protein Feeds and Soymeal

Factors that influenced the rapid expansion of the demand for high protein feeds in France are numerous and both technical and economic in nature.

The total demand for high protein commodities depends primarily on the level of livestock production, which in turn is a function of disposable income and real meat prices. Table 2.4 shows that consumption of meat products has increased significantly during the last twenty years. Although the per capita demand for beef and veal has remained constant, the per capita demand for pork and poultry have risen steadily

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[1] As depicted in Figure 2.1, the total demand for high protein meal expressed in soymeal 46% equivalents is divided into four groups: soymeal, "tropical meals" including peanut meal, coconut and palm kernal meals, "domestic meal group" made up of sunflower, rapeseed and linseed meals, and a group labelled "other high protein meals" composed of animal meals,urea, skimmed milk powder and dehydrated forages. Such a classification has been used to differentiate high protein raw materials which could be supplied domestically from those that are imported.

TABLE 2.4. Per capita consumption of meat products in France in kgs/head

	1960-61[1] kgs/capita	%	1972-73[1]	%	1976	%	Income Elasticity[4]
Beef	19.9	30.3	22.1	28.3	31	36.5	0.4
Veal	8	12.2	6.3	8.1			N.S.[3]
Lamb[2]	2.6	4	3.4	4.4	4	4.7	0.7
Poultry	9.2	14	13.6	17.4	15	17.6	0.7
Pork	25.9	39.5	32.6	41.8	35	41.2	0.7 (fresh pork) 0.3 (ham)
TOTAL[5]	65.2	100	78	100	85	100	

Sources: Eurostat, Saunier and Shaller, Fouquet

Notes:
[1] average of two years
[2] the data for lamb in 1976 includes goat and lamb
[3] N.S.= non-significant
[4] income elasticities have been estimated for an average income covering the period 1956-1971
[5] these data preclude horse meats and edible offals

since 1960. This evolution is reflected in income elasticities for poultry and pork which are higher than that for beef. A cross-country analysis of developed countries shows that France is one of the largest consumers of meat products in the World.[2]

In addition to the rise of disposable income, variations in retail prices of meat are also a factor explaining changes in the consumption of meat. Because costs of producing pork and poultry have declined over time, the corresponding output prices have decreased relative to beef prices and this has increased the consumption of pork and poultry (Shaller and Saunier, 1978, pp. 49-66).

The structure of consumption patterns for meat and its evolution have evident implications for the total demand for high proteins in general and soymeal in particular. It is not surprising to find that soybean meal is used primarily for poultry and hogs (Table 2.5).[3] The examination of Table 2.5 suggests that the consumption or production of dairy products, beef and eggs has little impact on the total demand for soymeal. The use of soymeal by cattle is limited because of the existence of a large amount of grazing land and forage (see Section 2.6.1). Bergman and Hairy (p. 9) noted that concentrate feed consumption per cow

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[2] In 1973, the consumption per head for total categories of meat expressed in terms of dressed carcass weight was 168 kgs for the U.S.A., 24.8 kgs for Japan, 79.2 kgs for the EEC (total), 95.1 kgs for France, 65.3 kgs for Netherlands, 72.7 kgs for United Kingdom and 85.7 kgs for West Germany (OECD, 1978, p. 14).

[3] Because of the lack of reliable data on this question, estimates contained in Table 2.5 which have been calculated on the basis of the consumption of soymeal by French feed compounders for every class of livestock is rather indicative.

TABLE 2.5. Estimated consumption of soymeal by class of animals in France, 1970

	Estimated Soymeal Consumption ('000 tons)	%
Cattle	43.6	4
Hogs	504	46.3
Broilers	398.8	36.3
Laying Hens	87.8	8
Others	58	5.4
TOTAL	1088.2	100.0

Source: Adapted from Vachel.

per year is 0.2 tons in France versus 1.2 tons in the Netherlands and England. Despite the fact that these estimates of soymeal demand by class of livestock refer to 1970, it is believed that the structure has remained relatively unchanged except for some modifications in the consumption of soymeal by cattle, whose market share has likely increased.

This big expansion in the demand for high protein meal is due not only to increases in the absolute level of livestock production. In fact, a comparison of annual rates of growth of total livestock production and total demand for high protein meals displays a significant difference, 3.5 percent against 9.8 percent. The reason for such a growth differential is attributable to changes in feeding practices and other technological improvements occurring during the same period in the French poultry and hog sectors. Feeding rations based on a balanced combination of feed ingredients which meet the feed requirements for each type of animal and fowl have been progressively adopted by French farmers. Given the complexity of this kind of operation, which demands technical and economic expertise,[4] the task is performed largely by the manufactured feed industry. Accordingly, the production of compound feeds grew at approximately the same rate as the total demand for high protein meal and soymeal (Fig. 2.2). Changes in feeding practices are related to the expansion of the mixed feed industry and the gradual penetration of the animal feed market by

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[4] In that respect, the role of service firms in the French feed manufacturing and livestock industries is of primary importance (see Section 2.7).

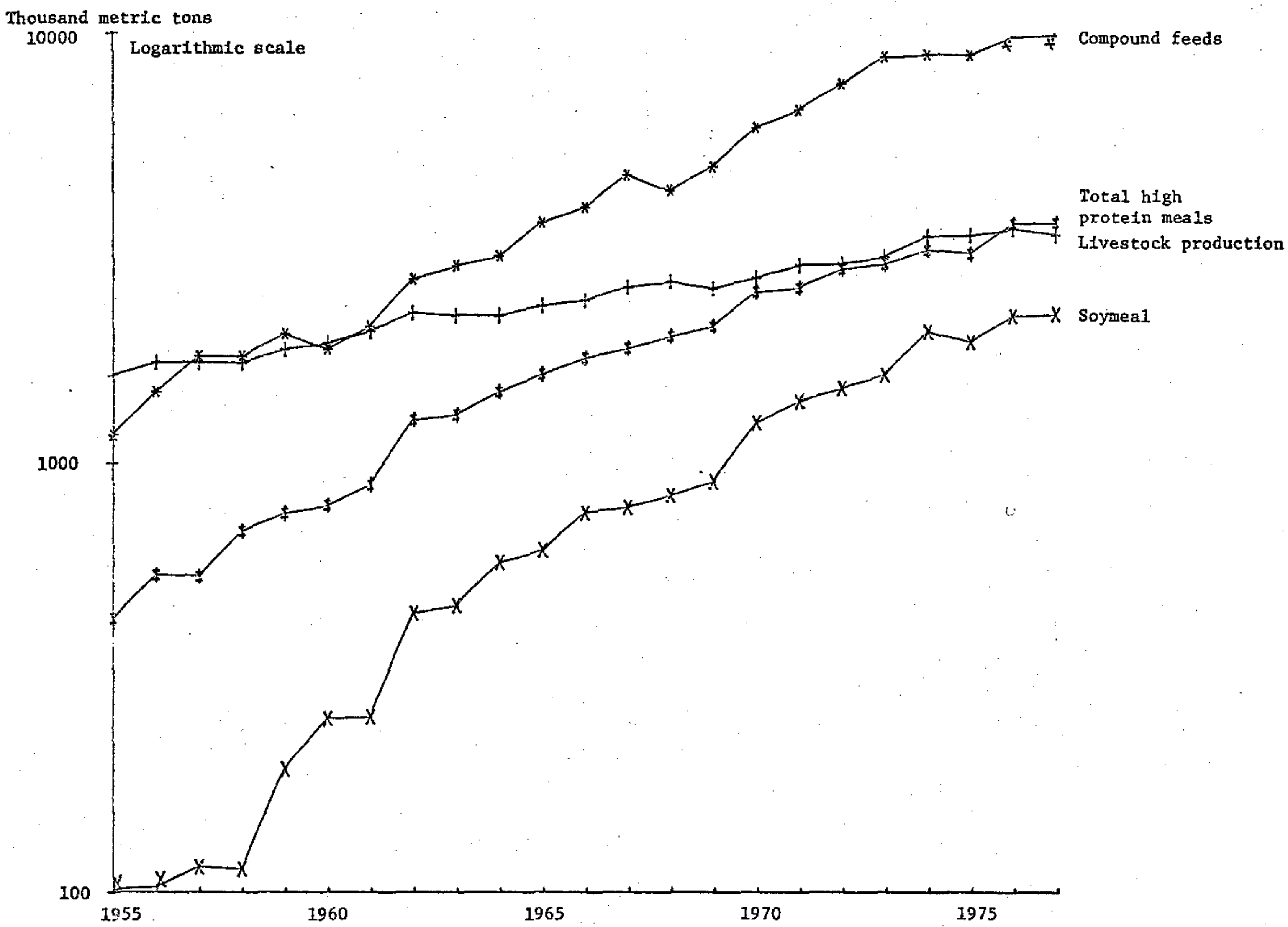

Figure 2.2: Evolution of the Main Components of the French Feed Livestock Sector in France (1955-1977)

Source: FEDIOL, SNIA

commercially mixed feeds. In that regard, several observers have mentioned that this penetration process follows an S-shaped pattern similar to the adoption process of technological innovation (Foucault, p. 72, Janet). Foucault, in particular, delineated and identified four successive stages of growth in the expansion process of the French manufactured feed industry:

> "First, there is the demand for compound feeds destined to traditional livestock farming. The basic feed ration prepared by these farmers is made up of various by-products and feed supplements.
>
> The second stage corresponds to a taking off of the demand for compound feeds due to the building of modern barns with large production capacity. This transitory period is characterized by more and more use of complete feeds.
>
> In the third stage, the market for compound feeds expands rapidly but at a constant rate of growth.
>
> Finally, there is a gradual saturation of the demand for compound feeds with a steadily diminishing rate of growth which tends to approach at the end of the period, the growth rate of livestock production."

Pork and poultry feed markets are the markets in which penetration by formula feeds has been substantial. The increasing role of the manufacturing feed industry in the livestock industry has yielded a strengthening of relationships between economic units involved in the French feed livestock system.

To meet the need for high protein feeds by feed manufacturers and indirectly livestock producers, preference has been given to soymeal due to its intrinsic properties relative to other high protein feed ingredients; namely, its inexpensive price and its high protein content in amino acids such as methionine and lysine, which are vital for livestock. High protein feeds which possess nutritional properties similar to soymeal are animal meals such as fishmeal. This latter feed ingredient is not consumed in France on a large scale, partly because of its irregular supply.

Cost considerations is the other factor that has contributed to the development of soymeal consumption relative to other protein sources. Because feed costs make up the major expense in the production of poultry and pork,[5] farmers and feed manufacturers seek the cheapest feed ingredients. In that respect, soymeal is so highly competitive that it is economically difficult to substitute for it.

2.3.1.2 The Consumption of High Quality Soymeal

Related to the cost of soymeal is the variability in protein content of soymeal in Western Europe. Depending on the origin and the processing technology used, the content of soymeal, in crude protein, can vary from 44% to 50%. Within this range, three different protein levels have been differentiated, namely 44 percent, 48 percent and 50 percent. As indicated by Table 2.6, feed manufacturers are inclined to utilize more high quality soymeal. Although soymeal 44 percent and

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[5] In the case of hogs, they account for about 70 percent of production costs [BIMA (Dec. 1978), p. 11].

Table 2.6: Consumption of Soymeal by Class of Protein Content in France in 1975-1977

Designation	Content in Crude Protein	Origin	1977 000 tons	1977 %	1976 000 tons	1976 %	1975 000 tons	1975 %
50	47 to 48	U.S.A., Belgium, West Germany, France	780.899	36.5	1251.98	59.3	1160.7	66.5
48	45 to 46.5	Brazil, France	1078.54	50.4	464.05	22	190.8	10.9
44	43 to 44	U.S.A., France, Belgium, West Germany	280.48	13.1	394.37	18.7	394	22.6
Total			2139.92	100	2110.4	100	1745.5	100

Source: Charles Robert (1976-1977) - SNIA-SYNCOPAC soymeal 50 percent were consumed equally in 1970 and 1971 (BIMA, Dec. 1977; SCEES, 1973), the share of 50 percent soymeal increased more rapidly in the early seventies, representing in 1975, 66.5 percent of the total demand for soymeal. With the development of soymeal production and crushing in Brazil, Brazilian soymeal which is 47 or 48 percent protein has supplanted the two other categories. In 1977, 48 percent soymeal accounted for 58 percent of the total consumption of soymeal. Preference for high quality soymeal by feed manufacturers is dictated by cost considerations. As pointed out by Thompson (1979, p. 394A), feed compounders in Western Europe determine feed formulae on a cost per unit of protein basis. Due to an export policy which promotes the shipment of soybean by-products, soymeal imported from Brazil is sold at a price very close to the U.S. price for soymeal 44 percent, thus making the Brazilian product a better buy.

An additional reason which favours the demand for high-quality soymeal is the development of cereal substitutes which have a protein content lower than that of cereals. Such is the case of cassava which contains only 2 to 3 percent protein. It appears now that the cost of soymeal and cassava in a feed ration is less costly than a feed ration based on a combination of soymeal and cereals.[6]

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[6] In 1978-79, the cost of a feed ration (cassava and soymeal) was 720 francs/ton including transport cost, whereas the market price of cereals was 900 francs/ton (French Ministry of Agriculture, 1979, p. 3).

2.3.1.3 The Demand for Soymeal and the EEC Cereal Policy

The demand for soymeal and the interrelationship between soymeal and feedgrains in the EEC is obvious since the creation of the European Community and the inception of the Common Agricultural Policy. It is not coincidental that the beginning of the C.A.P. was also the beginning of the period when the demand for soymeal increased significantly in the European Community. As part of concessions granted by the EEC to the U.S.A. in the successive GATT Negotiations, the European Community guaranteed free access to European markets for soybeans and high protein feeds (Tangermann, 1978, pp. 204-209), while the C.A.P. has resulted in EEC cereal prices which are 60 to 70 percent higher than world market prices. In such a context, the postulate that the real cost of buying a feed product with a high content in protein is higher than the real cost of purchasing feeds low in protein and high in carbohydrates does not hold. This imbalance between a free market for high protein feeds and a protected one for feedgrains has encouraged European farmers and feed manufacturers to use more soymeal than under free market prices and to replace cereals by other high energy feed sources that are not subject to a high import levy (Johnson, G., pp. 100-126).

Such a situation is typified by the Netherlands where the share of cereals consumed by feed manufacturers declined from 52.6 percent of the total consumption of raw materials in 1965-66 to 31.3 percent in 1974-75 (Berlan and al. Annexes). Similarly, the role played by cereal substitutes in the feed supply balance increased steadily during this period.

In France,where there is a large supply of cereals and intervention prices for feedgrains are the lowest in the EEC, this substitution between cereals and other high energy feeds has only emerged recently with the tremendous increase in the demand for cassava since 1976. While utilized in a different context, Figure 2.6 depicts very well the increase in the relative price of feedgrains with respect to the price of cassava.

2.3.1.4 Consumption of Soymeal in France

At the present time, the consumption of soymeal is still increasing steadily. After the "soybean" crisis in 1973, and the willingness of the French Government to reduce soybean imports, one might have expected a structural shift in the demand schedule for soymeal characterized by a fall in the quantity consumed. However, very favourable world soybean market conditions and the perverse effects of the EEC cereal policy have instead led to an expansion of the consumption of soymeal. Thus, in 1978 alone, the demand for soymeal rose by 33.7 percent, from 2,139,000 tons to 2,860,000 tons (Charles Robert, 1978). Furthermore, what is the most striking change in this evolution is the tremendous increase in the farm use of soymeal since 1975, now representing 32 percent of the total soymeal consumption in France (Charles Robert, 1978). While the long drought which occurred in 1976 influenced this change, the fundamental reasons are hard to establish.

In the light of this recent evolution, what will be the future demand pattern for soymeal? With the reinforcement of interdependencies, and the increasing competitiveness between European agricultural sectors, the search by farmers and feed manufacturers for the cheapest feed ingredient seem to imply a higher demand for soymeal. Its magnitude will depend not only on world market conditions, but also on any changes occurring in the EEC. Given these conditions, the French objective of reducing soybean imports will be difficult to attain.

2.3.2 Consumption of Soyoil

The consumption of soyoil in France is not as significant as in some other EEC countries (Table 2.7). In 1977, soybean oil ranked third in the total French demand for vegetable oil. This market is dominated by peanut oil whose consumption represents more than one-third of the total demand for vegetable oil. However, this historical pre-eminence of peanut oil, resulting from the relationships existing between France and former French African colonies, is gradually declining.

A large fraction of the soybean and other edible oils consumed in France are consumed directly as table oil by households. The intermediate demand for industrial usage and making margarine and shortening accounted for only one-third of the total consumption of vegetable oil in 1977 (Table 2.7). Although the data compiled in Table 2.7 do not provide an exhaustive picture of the structure of vegetable oil con-

Table 2.7: Structure of the Total Demand for Vegetable Oils in France in 1977[1]

	Peanut Oil		Sunflower Oil		Soybean Oil		Rapeseed Oil		Total Vegetable Oil	
	000 tons	%	000 tons	%	000 tons	%	000 tons	%	000 tons	%
Animal Feed									34	4.2
Industrial Uses					14	13.2			117	143
Margarine			10	8.9	15	14.2	8	17.9	113	13.8
Shortenings	3	1	4	3.6	9	8.5			32	3.9
Human Consumption	266	99	98	87.5	68	64.1	37	82.2	521	63.8
Total	269	100	112	100	106	100	45	100	817	100

Source: SCEES

[1] Including castor and linseed oils which are destined exclusively for industrial purposes.

sumption in France, it should be noted that margarine is produced using mainly palm oil, coconut oil and soybean oil, but consumption of margarine is very small. This demand pattern for vegetable oils is somewhat different than other EEC countries (Table 2.8), and as a result, the demand for soyoil depends mainly on the demand for table oil.

An examination of past trends in the demand for various vegetable oils reveals the existence of two distinct periods (Fig. 2.3): i) the fifties and sixties when all edible oils follow a steady and stable growth pattern without any significant change in market shares; and ii) the seventies when the total demand for vegetable oil stagnated and substitution played an increasing role in the oil market. As pointed out by Fouquet (1976, pp. 42-43), the usual demand shifters, that is prices, population and disposable income, did not suffice to explain the changes in market shares. Rather, factors such as consumers' habits, tastes and preferences and availability of supply were the main contributors to the changing structure of the demand for vegetable oils in France.

The consumption of edible oil in France is directly related to cooking habits which differ by regions: oil is used for cooking in Southern France, whereas this role is played by butter in Northern France (Table 2.9). Since regional patterns of consumption tend to be stable over time, it is not surprising to find weak substitution effects between oils, butter and margarine. Thus, for the period 1956-1971, Fouquet (1976, p. 43) reported that the cross elasticities between oil

Table 2.8: Consumption of Vegetable Oils in the EEC in 1977
(olive oil not considered) % of Total Consumption

	Most Important	%	Second	%	Third	%	Fourth	%	Fifth	%
Belgium & Luxemburg	Soyoil	37.7	Coconut oil	15.7	Palm oil	13.1	Sunflower oil	9.4	Peanut oil	8.4
Denmark	Soyoil	49.5	Palm oil	13.6	Palm kernel oil	11.7	Coconut oil	9.7		
France	Peanut oil	35.1	Sunflower oil	16.8	Soyoil	14.4	Coconut	10.5	Palm oil	8.9
West Germany	Soyoil	37.4	Coconut oil	17.8	Palm oil	15.4	Sunflower	11.7	Rapeseed oil	4.4
Ireland	Coconut oil	35.3	Soyoil	23.5	Palm oil	14.7				
Italy	Soyoil	51.3	Peanut oil	9.6	Corn oil	8.4	Rapeseed	7.2	Palm oil	5.8
Netherlands	Soyoil	39.8	Palm oil	20.5	Coconut	11.5			Sunflower	6.4
U.K.	Palm oil	29.5	Soyoil	25.2	Palm kernel	11.1	Coconut	10.2	Rapeseed	9.9
EEC	Soyoil	33.3	Palm oil	15.9	Coconut	12.3	Peanut oil	9.5	Sunflower	8.7

Source: Leysen (1979), p. 2.

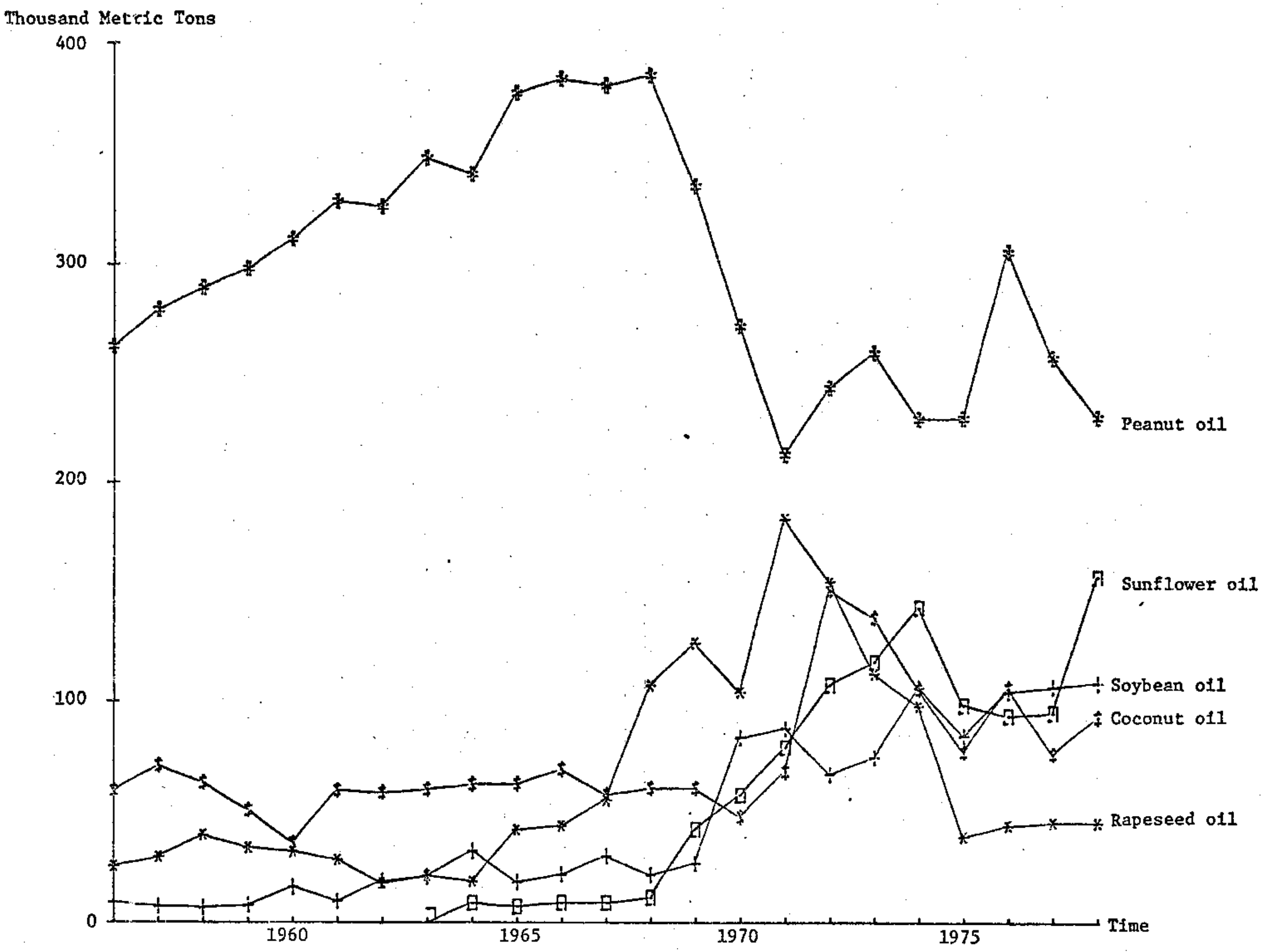

Figure 2.3: Consumption of Vegetable Oils in France (1956-1978)
Thousand Metric Tons

Source: FEDIOL

TABLE 2.9. Consumption of oils and fats in France, by region, 1970 (kg/head)

	Butter (kg)	Oil (liter)	Margarine (kg/head)
North	15.8	8.0	3.6
West	13.9	9.1	2.0
Paris Basin	8.7	10.4	2.0
Paris Region	8.0	10.8	1.3
Center East	7.3	11.6	1.3
East	6.9	11.1	2.3
Mediterranean Regions	5.4	22.0	0.8
South West	4.6	15.1	0.5
France	8.7	12.0	1.6

Source: Fouquet (1976, p. 43)

and butter, and oil and margarine were 0.2 and zero, respectively.

Consumer tastes and preferences and advertising influence greatly consumer's choices of edible oils and modify somewhat the image perceived of each edible oil (Rouffiac, pp. 38-47). An illustration of the influence of tastes and preferences in the demand for vegetable oils is given by some changes occurring in this market in the early 1970's (Fig. 2.3). For instance, the consumption of sunflower oil, while insignificant in the mid-sixties, suddenly soared in the early seventies. It is now the second most important edible oil consumed in France and competes directly with peanut oil. The main reason for this new trend is the high quality attributed by consumers to this oil (digestibility, no health hazards, etc. ...) and the role of advertising campaigns for sunflower oil.

Meanwhile, the consumption of rapeseed oil declined dramatically, since it was found that erucic acid, contained in rapeseed oil, may cause cardio-vascular problems. After this, consumer organizations launched campaigns aiming at reducing the consumption of rapeseed oil and demand fell by 80 percent between 1971 and 1975, stabilizing around 45,000 tons.

In order to protect consumers' interests, a set of new regulations on the labelling of table oils was set up by the French Government in 1973 (BIMA, 1973, pp. F1-F3). Now, food companies must sell table oils with a label mentioning the chemical composition of the product and its end-use. This latter objective aims at differentiating table oils used in dressing from table oils used for cooking and dressing.[7] By separating edible oils into two groups, these regulations tend to favour the development of high quality edible oils which can be used for both cooking and dressing purposes.

Another factor influencing the demand for various edible oils is the availability of supply. Edible oils are obtained in three different ways: i) imported directly; ii) obtained from imported oilseeds crushed domestically; and iii) derived from oilseeds produced and crushed domestically. Peanut, rapeseed and soybean oils have been most subject to changes in supply patterns since the late sixties. Due to severe climatic conditions occurring in West Africa and a steady increase in the demand for peanut oil in this part of the world, the supply of peanuts and peanut oil to France declined after 1967. As a result, the demand for peanut oil dropped significantly between 1967 and 1970. The line representing the consumption of soyoil in Figure 2.3 also exhibits a sudden variation in 1969-1970. This jump resulted from the increase in domestic crushings of soybeans due to the opening of a large capacity crushing plant in the Western part of France in 1970. Prior to the erucic acid affair, the demand for rapeseed oil was boosted by the expansion of domestic rapeseed production following the inception of the Common Agricultural Policy for oilseeds in the mid-sixties.

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[7] The distinction between the two groups of edible oils is based on the content in linolenic acid which has to be lower than 2% for oil used in cooking.

Given the above-mentioned factors, the future demand for soyoil is difficult to predict, but it does appear that market growth will be modest at best.

2.4 Domestic Supply of High Protein Vegetable Products

The favourable climatic and soil conditions in France allow the growth of a wide variety of agricultural products with a relatively high protein content. France is the most important producer of oilseeds in the EEC: of 606,000 hectares harvested in the EEC9 in 1976, 62 percent were in France[8] with rapeseed, sunflower, linseed and, recently, soybeans, the main oilseeds produced. Protein is also obtained from legumes such as peas, horse beans, clover and alfalfa. The production of these agricultural commodities has increased in conjunction with the application of French and EEC policies stimulating the domestic supply of high protein products. A brief discussion of each oilseed produced in France follows.

2.4.1 Rapeseed

Although grown in France for a long time, rapeseed production expanded with the inception of the Common Agricultural Policy for oilseeds in the mid-sixties. At that time, the basic objective of the policy was to improve self-sufficiency in the oils and fats sector. In so doing, production of oil-bearing plants such as sunflower and rapeseed were encouraged.

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[8] Eurostat.

Prior to 1965, average annual production of rapeseed amounted to 100,000 tons (SCEES, 1966). From 1965 to 1970, the acreage planted to rapeseed and the subsequent production doubled (Table 2.10), with a temporary but significant fall in production in the mid-seventies. This was essentially attributable to poor weather conditions and the use of new varieties with lower yields in order to overcome the problem of high erucic acid content.

Rapeseed is produced throughout the country, although it tends to be concentrated in the southwest and central areas (Fig. 2.4). An examination and comparison of the locations of feedgrain and rapeseed production display that regions producing both agricultural products coincide due mainly to the advantages of crop rotation.

The data in Table 2.10 also indicate that increases in the production of rapeseed in the last fifteen years is not due to improvements in yields, but rather to an expansion in acreage. In fact, yields fluctuated erratically between 1966 and 1978, not following the upward trend of wheat and other cereal crop yields. Because most of the rapeseed harvested in France is winter rape, yield results depend heavily on climatic conditions and more specifically on late frosts (CNTA, 1978, p. 66).

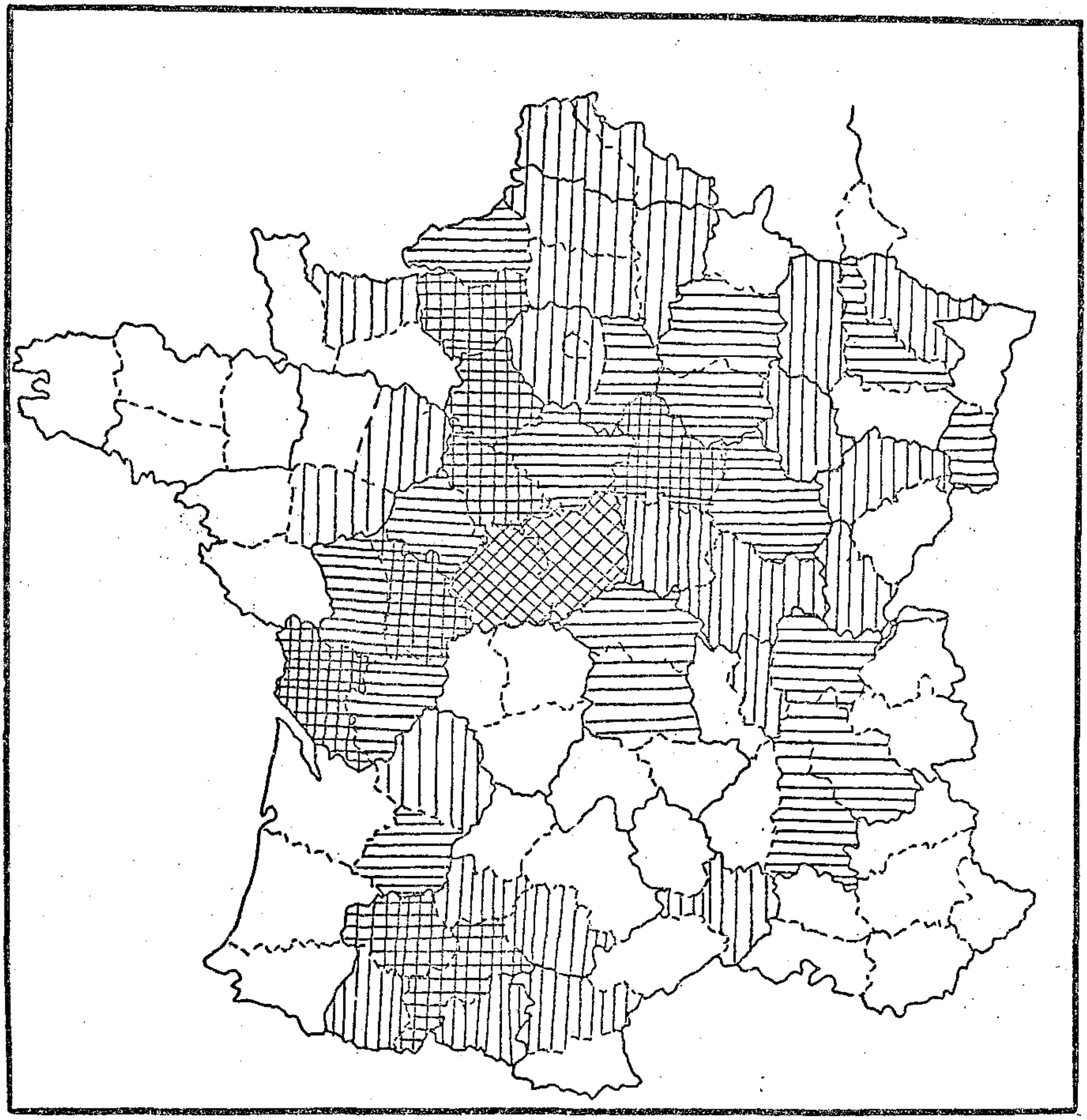
Farmers' planting decisions for rapeseed are based on the expected profitability of this crop and financial incentives must be provided to producers so that farm prices for rapeseed are as high as the returns obtained from other crops (Table 2.11).

Rapeseed in France competes for arable land primarily with wheat.

Table 2.10: Production, Yields and Acreage of Main Oilseeds Produced in France

	Rapeseed			Sunflower			Soybeans			Linseed		
	'000 ha. Acreage	100 kgs/ ha. Yield	'000 tons Production	'000 ha. Acreage	100 kgs/ ha. Yield	'000 tons Production	'000 ha. Acreage	100 kgs/ ha. Yield	'000 tons Production	'000 ha. Acreage	100 kgs/ ha. Yield	'000 tons Prod.
1965	173	19.29	334	12	15.03	18				11.17	13.94	15.57
1966	179	17.73	317	12	17.12	21				10.71	13.2	14.15
1967	202	20.12	429	12	15.33	19				8.10	14.5	11.71
1968	250	18.11	458	15	18.02	26				3.86	14.74	5.69
1969	284	17.45	512	17	17.88	30				2.84	13.	3.72
1970	301	17.54	592	27	17.7	40				1.15	13.86	1.6
1971	312	20.07	650	44	17.69	78				2.4	12.93	3.07
1972	305	22.05	713	46	15.33	71				6.7	12.55	8.45
1973	327.8	19.29	630.71	44	20.96	91				2.1	12.04	2.53
1974	318.2	20.62	655	41	17.65	73	4.3	1.9	5.4	5.09	12.41	6.32
1975	260.3	18.69	483.7	72	15.32	110	1.5	2	3.0	25.59	12.25	31.33
1976	262.	19.46	535	60	12.69	76	1.6	1.9	2	19.39	8.4	16.33
1977	273.	14.20	388	50	19.13	100.4	1.3	NA	2	7.78	14.	10.9
1978	260.5	23.4	610	40	21.94	88	3.9	na	6	3.3	15.2	5

Source: FAO production yearbook. Green Europe (Dec. 78). SIDO and Leflambe.
NA: Non Available



Source: CNTA (1978)

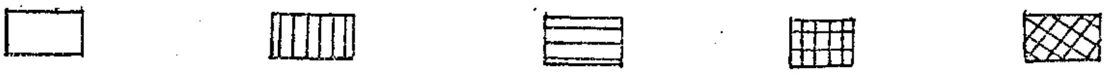


Figure 2.4: Location of Rapeseed Production in France in 1977

TABLE 2.11. Profitability of rapeseed production relative to soft wheat - 1956-1977

	Rapeseed/Wheat Price Ratio	Soft Wheat/ Rapeseed Yields	Returns Francs per hectare Rapeseed	Soft Wheat
1955 to 1963	1.8 to 1.9	1.5 to 1.6	1086.63[1]	939.69[1]
1965 to 1969 (average)	1.98	1.775	1573.97	1424.78
1974 to 1977 (average)	2.18	2.22	2537.64	2634.09

Source: Elz (p. 174), FAO, Griffith

[1] Average.

Accordingly, a comparison of the price ratio of rapeseed to wheat with the wheat/rapeseed yields ratio is the best indicator of profitability.

Prior to the application of the Common Agricultural Policy, both ratios were very similar and no real incentives were given to farmers to produce rapeseed. However, when the analysis is conducted in terms of average returns per hectare, rapeseed production tends to be more profitable than soft wheat for this period. After 1965, as a result of the higher producer prices provided by the C.A.P., the rapeseed/soft wheat price ratio increased significantly, as did acreage. This is also reflected by returns higher for rapeseed than those for soft wheat. However, this trend no longer prevailed in the seventies when yield increases for wheat were very large, thereby causing grains to be substituted for rapeseed.

Despite unfavourable conditions, rapeseed production in France is likely to expand in the near future. Not only the above-mentioned factors, but the following ones, should contribute to this expected upward trend.

i) Continuous improvement of rapeseed varieties with low erucic acid content and their gradual adoption by farmers should boost yields.

ii) Recent agricultural policies implemented in France and by the EEC will give additional incentives to farmers to grow rapeseed.

iii) What might be the most crucial condition to the development of domestic rapeseed supply and its by-products is the

> necessity of finding new outlets for these products. As discussed earlier, any increase in the demand for rapeseed oil requires a focus on the acceptability of this product by consumers. Potential demand for rapeseed meal is large and nutritional problems related to the use of rapeseed meal in feeding morogastrics can be overcome by adequate processing of rapeseed.[9]

2.4.2 Sunflower

Sunflower is the other major oilseed produced in France. Concentrated in the same areas as rapeseed production, sunflower production increased two-fold from 1965 to 1978 (Table 2.10). Factors contributing to the expansion of sunflower production are similar to those for rapeseed and production of sunflower is also expected to expand. In addition, the recent adoption of hybrid species may have a considerable impact on yields. At the same time, the search for high quality oils by consumers is a very favourable factor for the expansion of sunflowers. Due to a relatively low nutritive value, sunflower meal is less attractive for feed compounders and livestock farmers.[10]

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[9] Church (p. 102) noted that rapeseed meal usage is limited, at least in monogastrics species, by the content of mustard oils which are goitrogenic substances common to members of the mustard family. The mustard oils also make the meals unpalatable and the high tannic acid content may depress growth.

[10] Although high in protein, sunflower meal is a poor supply of lysine. In addition, its high fiber content limits its utilization in feeding poultry and hogs.

2.4.3 Linseed

Linseed is of limited interest in dealing with France's protein dependence problem. Linseed meal is employed as a straight by farmers in feeding cattle (Foucault, p. 79; SNIA-SYNCOPAC, p. 21), but it has a nutritional value much lower than that of soymeal.[11] Representing approximately 5 percent of the total demand for oilmeals in France in 1978, linseed meal is still consumed due to the persistence of feeding habits among French farmers. The best growth opportunities for linseed relate to the oil market because of its high oil content.

Production is located in the southwestern part of France, where it is produced on a small scale. After a long and continual decline, linseed production and acreage started to increase in the seventies, peaked in 1975-76 and then dropped (Table 2.10). Three reasons may explain this variation in linseed supply. First, world market prices for oilseeds were extremely high in 1973-74, thus stimulating French farmers to grow linseed. Second, the EEC policy regulations for linseed put forth in 1970 were very advantageous for linseed producers. The granting of a fixed subsidy per hectare regardless of yield encouraged the expansion of linseed production.[12] In the fear of oversupply, the EEC council introduced some changes in the linseed subsidy scheme and the aid given to farmers became variable and calculated in a way similar to that for soybeans using a target yield. Subsequently, this

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[11] Linseed meal contains 33% protein and is low in methionine and lysine.

[12] Linseed yields in France are rather low. The main explanation for this is that farmers grow this plant on poor lands (CNTA, 1974, p. 43).

new scheme which is less favourable to French producers caused a decline in the plantings of linseed. Third, the poor yields resulting from the 1976 drought also discouraged linseed producers.

Prospects for growth in linseed production are very poor. In addition to the reluctance of farmers to produce this plant, the lack of reliable outlets for linseed by-products and, particularly, linseed oil, work against efforts to increase production.

2.4.4 Soybeans

Interest in growing soybeans increased in the early seventies, particularly after the U.S. embargo on soybean exports in the summer of 1973.[13] Following this event, the French Government in conjunction with the EEC administriation tried to stimulate the production of soybeans with an objective of planting 50,000 ha by the late seventies (EEC, 1973, p. 20). This target is far from being reached. As indicated by Table 2.10, soybean acreage was only 5,500 hectares in the mid-seventies and regressed in 1976, 1977 and 1978.[14] Recently soybean acreage has expanded again to attain an estimated level of 15,500 hectares in 1979 (Green Europe, Nov. 1979, p. 11).

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[13] The fact it is feasible to grow soybeans in France was known as early as 1966, the first year in which experiments were undertaken in France (CETIOM, p. 1).

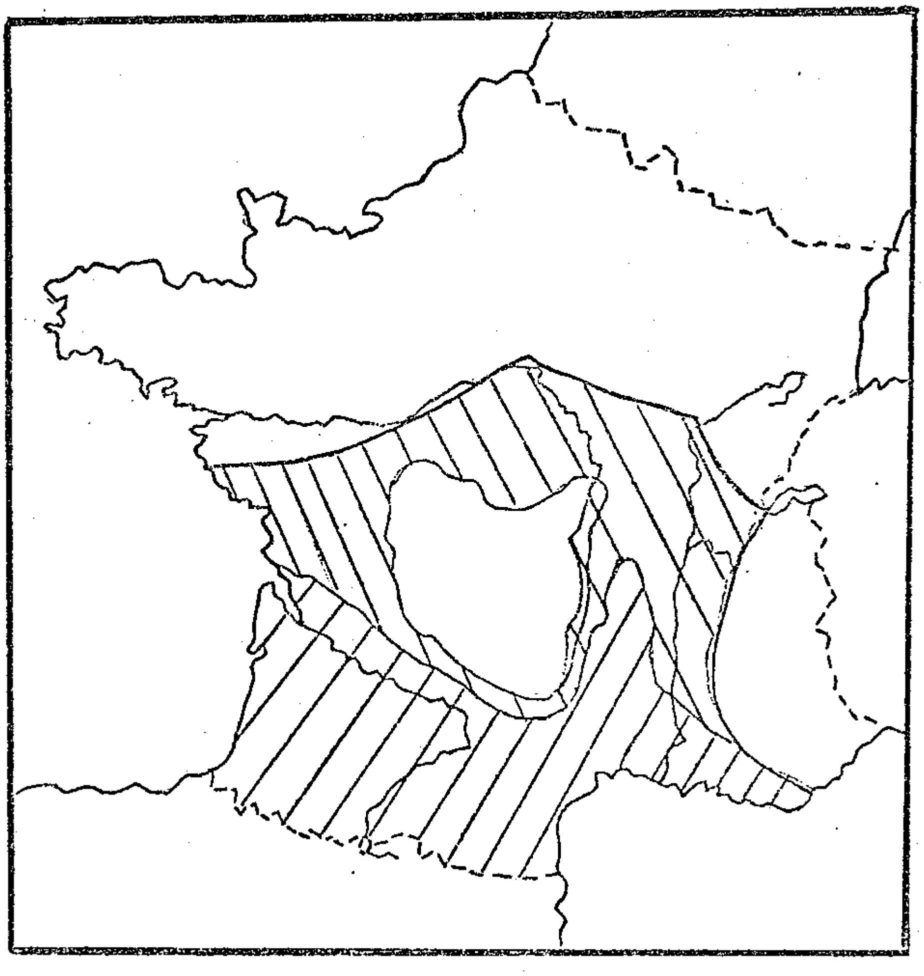
[14] This fall in soybean acreage and production was attributable to low yields, bad weather conditions and insufficient knowledge of growing methods (Green Europe, Sept. 1977, p. 23).

The potential to produce more soybeans in France exists. Figure 2.5 displays that at least all the southern part of France, excluding mountainous areas, is suited to growing soybeans, but because of more ideal climatic conditions, most of the soybeans actually cultivated are concentrated in the southwestern area. Even in this region, growing soybeans depends heavily on correct temperatures and rainfall which must occur during the sowing, maturity and pre-harvest periods (Magenthies, p. 22). Furthermore, another considerable drawback to the development of this product is the fact that soybean seeds need to be inoculated with bacteria of soya rhizobium japonicum because it is lacking in French soils.

Yield results obtained from a sample of 114 farms located in the southwestern part of France indicate average yields of 2.03 tons/hectare on non-irrigated land and 2.33 tons/hectare on irrigated land (Magenthies, p. 28).

Although soybeans, as any other legume, are beneficial in a crop rotation because they fix nitrogen in the soil, farmers are reluctant to cultivate such a plant, due to its lack of profitability relative to other crops, particularly corn which is the main cash crop in the southwestern region. Surveys reveal that 75 percent of farmers mentioned the low level of profitability as the major hindrance to growing soybeans (Magenthies, p. 79).

Prices received by farmers for soybeans are determined by a variable subsidy equal to the difference between the target price and the world price with a target yield fixed around 1.9 tons/hectare,



Area where soybean production is possible but risky

Area where soybeans are presently grown

Figure 2.5: Potential Soybean Producing Areas in France

Source: Magenthies, p. 75

since 1975. Such a system has been criticized on the grounds that it discriminates against the most efficient farmers. Subsequently, the C.A.P. for soybeans will be changed so that payments are based on quantity produced, on a contract basis, beginning 1980/81 (Agra Europe, Nov. 1979, p. N1). While this change in the C.A.P. scheme will have a positive impact on the production of soybeans, so will the opening of a new crushing plant in Bordeaux in 1979 which will offer a secure market for French soybean producers. Despite these favourable factors, soybeans will likely remain a secondary crop for farmers, and even if domestic production increased significantly, it would meet only a very small amount of the French demand for soymeal.

2.4.5 Feed Peas and Beans (Peas, Horse Beans)

In addition to oilseeds, a group of plants called proteaginous vegetables are grown in France. Prior to 1973, horse beans were the only plant of this type cultivated on a significant scale with an acreage of about 15,000 ha in the early seventies (Vachel, IV, p. 9). At that time, production was declining and not very attractive to farmers. Yields were low, about 2.1 tons per hectare and production was 29,800 tons.

Following the introduction of guaranteed prices in 1973-74 and later the establishment of an EEC subsidy scheme, production of beans and peas was stimulated. Table 2.12 shows that bean and pea production have increased remarkably between 1976 and 1979.

The protein content of proteaginous vegetables ranges from

TABLE 2.12. Evaluation of field bean and pea production in France between 1976 and 1979

	Acreage (thousand hectares)			Production (thousand tons)		
	1977	1978	1979	1977	1978	1979
Beans	4,700	6,300	9,800	NA	18,700	32,000
Peas	4,100	5,800	33,900	4,900	14,600	135,000
TOTAL	8,800	12,100	43,700		33,300	167,000

Source: Green Europe (Jan. 1980, p. 25).

23 percent to 30 percent and may constitute an adequate substitute for imported soymeal. Peas and horse beans can be incorporated into the feed rations of monogastric animals in proportions up to 10 to 15 percent without causing a significant degradation in weight gain performance.

While there is no real problem in finding outlets for these agricultural products, the development of their production is possible only if improvements in yields are obtained by the introduction and diffusion of hybrid varieties. With hybrids, there is no difficulty in producing 3 tons/ha of horse beans and 4 tons/ha of peas (Vachel IV, pp. 16-17). The other factor which should contribute to the expansion of proteaginous legumes is the EEC policy regulations for these products. According to the French protein feed crop association, these favourable conditions should boost the production by a further 50 percent in 1980 (Green Europe, Jan. 1980, p. 25).

2.4.6 Dehydrated Fodders

Fodders such as clover or alfalfa can be fed directly to cattle in the form of fresh fodder, silage or hay, or fed to animals as a high protein source after a dehydration process. It is in this latter form that these products might be substituted for soymeal. However, because alfalfa contains large quantities of cellulose and is low in energy, its use for monogastrics is limited.[16]

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[16] Dehydrated alfalfa may be incorporated in a feeding ration for broilers and laying hens in a proportion of 2 percent to 3 percent, and 3 percent to 5 percent, respectively.

Despite these shortcomings, the production of dehydrated fodders in France has trended upwards (Table 2.13). So far, it is the most important protein rich crop grown in France and the European Community. France is the largest producer of dehydrated fodder and its production accounts for more than one-half of the total Community production. The existence of French and EEC regulations for this product provide incentives to farmers for developing production.

The total quantity of oilseeds and protein rich crops produced domestically provides a minor part of the total high-protein needs required by French livestock producers. The expansion of this production depends heavily on the common agricultural policies for these products which must guarantee "fair" returns through subsidy programs. Because domestic oilseeds are mainly oil-bearing plants, an additional requirement in developing domestic oilseed production is the need for sufficient outlets for the oil by-products. In that perspective, expanding exports should be encouraged.

2.5 European Agricultural "Protein" and Related Policies

There is not, at the European level, a consistent agricultural "protein" policy but rather a set of various policy regulations which aim directly or indirectly at changing the degree of self-sufficiency in high protein products within the EEC. Two major reasons explain this limited contribution of the Community as a whole in developing an overall "protein" policy. First, the adoption of any major protein policy probably requires the application of protective measures, which

TABLE 2.13. French and EEC production of dehydrated fodders in thousand metric tons from 1965 to 1977

	France	EEC9
1965	100	576
1966	230	709
1967	320	885
1968	450	1072
1969	425	962
1970	505	1120
1971	600	1303
1972	628	1428
1973	675	1513
1974	725.6	1568.8
1975	766.4	1541.3
1976	585	1226.4
1977	851	1585.9

Source: Eurostat.

the EEC may not undertake due to its commitment within GATT for a zero duty on imported high protein feeds. Second, the application of protective measures would signify higher costs of animal feeding and lower incomes for livestock producers. As a result, the only EEC policy scheme dealing with protein independence is a subsidy payment system regulating the production of domestic oilseeds and extended recently to other protein rich crops.

Considering the numerous relationships linking high protein feed ingredients and other agricultural products, it is of primary importance to investigate the EEC cereal policy in the light of its likely impact on the reduction or increase of high protein imports by the EEC. Finally, an examination of some temporary measures taken recently by the Community Council is also included in this section.

2.5.1 EEC Policy for Oilseeds

At the outset, the primary purpose of the C.A.P. for oilseeds was to integrate the different EEC members' oilseed sectors and, according to the Rome Treaty, reduce imports of fats and oils (Parris and Ritson, pp. 23-25). In so doing, the main task consisted of adjusting protected or supported markets, represented by France, West Germany and, to a lesser extent, Italy, with the freer market economies of small EEC member countries through the use of adequate policy measures. The policy tools utilized to reach these goals were subsidy programs for domestic oilseeds and special favourable agreements with trade partners, primarily made up of Third World countries, for the import of oilseeds. In addition, in order to make the EEC crushing industry competitive, ad valorem tariffs on the imports of vegetable oils were maintained.

In the seventies, with the overwhelming role played by oilmeals in the EEC oilseed economy, and the growing deficit of the EEC in high proteins, more attention was given to these problems. Thus, deficiency payment schemes were extended to the domestic production of not only soybeans, but also to other protein rich crop products.

2.5.1.1 Rapeseed and Sunflower

The pricing system for rapeseed and sunflower has operated since 1966. It consists of two reference prices set annually, the target price and intervention price. The target price is fixed at a level which is "fair" to producers, account being taken of the need to keep community production at as high a level as possible. The intervention price is fixed for Genoa (Italy), the region where oilseeds are in shortest local supply, with intervention prices established for other parts of the EEC in such a way that prices are lowest in major oilseed producing areas. When the world market price is below the target price, a subsidy or deficiency payment equal to the difference between the two is paid to the producers. The "world market price" used by the Community Administration is an artificial reference price determined weekly in Brussels, which is adjusted with respect to CIF import prices in Rotterdam. Price setting for rapeseed and sunflower seed takes into account the world prices of other oilseeds, notably soybeans, and the profit obtained from crushing these competing oilseeds in the Community. The subsidy is generally paid to crushers and not to producers. So far, except for the period of high prices in 1973-74, world market prices have been below the target prices.

2.5.1.2 Soybeans and Linseed

The establishment of a deficiency payment scheme has been the sine qua non condition to develop soybean production in France and in Italy. A norm price for soybeans produced in the Community is fixed every crop year. When this price is higher than the world market price, a subsidy equal to the difference between the two prices is granted to producers, calculated by applying a target yield to the area harvested. This target yield has been 1.9 t/ha and 1.95 t/ha for crop years 1974 and 1975-1977, respectively, and is now 2 t/ha (Agra Europe). For reasons given in Section 2.4.4, certain arrangements concerning the aid given to soybean producers were introduced in order to stimulate the production of soybeans. The most important changes were made with regard to the determination of target yields which should take into consideration the results obtained by the producer. In that perspective, the payment system is to be changed to payments by quantity produced, on a contract basis, for 1980/81. The agricultural policy regulating linseed (Agra Europe, Nov.1979, p. N1) production is very similar to that of soybeans and has only been effective recently. Prior to that, the subsidy payment given to producers for flax fiber and seed was a fixed subsidy per hectare. Such a pricing system was very advantageous to producers who expanded production significantly in the mid-seventies (see Section 2.3.4). Aware of a possible oversupply in the future, the Community set up a new formulation of the subsidy payment. In 1977, however, following the fall of linseed acreage in southern France, the amount of aid given to producers was calculated on the basis of the yields recorded in various production areas.

2.5.1.3 New Policy Regulations for Rapeseed

As an outcome of the fall in rapeseed oil consumption, producers have switched from rapeseed varieties with a high content in erucic acid (HEAR), to rapeseed varieties with low content in erucic acic (LEAR). Because the latter varieties contain less oil and have lower yields per hectare, modifications to the subsidy based on HEAR were necessary. During the marketing year 1977, the standard quality upon which the aid was calculated was adjusted to LEAR varieties. In 1978, the EEC council adopted new regulations which will be applicable in July 1979. Now, edible rapeseed must not contain more than 5 percent erucic acid. The calculation of the aid also rests upon on upper limit in erucic acid fixed at 10 percent, crushers receiving the subsidy if and only if the rapeseed crushed contains less than 10 percent erucic acid. For HEAR rapeseed oil, which is destined for industrial use and consumed in the EEC on a very small scale, a contract system between processors and producers has been set up. The impact of these new policy arrangements on the demand for rapeseed meal is of minor importance.

2.5.2 EEC Agricultural Policy for Protein Rich Crops

The guarantee of "fair" prices for field beans and peas was introduced in 1974 by the French Government. Financial aid was granted to collecting and storage agencies who have signed contracts with producers and must pay them a minimum guaranteed price. The subsidy was fixed in such a way that it was equal to the difference between the minimum guaranteed price and a variable market price established by formula (CNTA, 1978, p. 74). In 1978, this system was generalized to all the EEC (CNTA, 1978, p. 75). Because these products are in direct competition with oilcakes from non-member countries at zero duty, the aid is given to feed manufacturers using peas, broad and field beans when the price of soymeal is lower than the activating price for aid. This subsidy is equal to 45 percent of the difference between these two prices and varies directly with soymeal prices. Discrepancies between EEC and French regulations are very minor and the adjustments have been made without great difficulty.

With respect to dehydrated fodders, the EEC council adopted, in 1974, a set of policy measures to promote domestic production. The approved system provides subsidies to producers and includes a protective clause so that the Community market can be defended. These measures were effective until 1977-78 when they were modified to include the setting of a guide price for dehydrated fodder which enables dehydrated fodder processers to pay an acceptable price to farmers for their green fodders, irrespective of the level of import prices of dehydrated fodders. The calculation of the aid is made in a similar fashion to that existing for other products already covered by a common organization of the market.

There is no doubt that the adoption of subsidy payment measures for oilseeds and protein-rich crops have had beneficial impacts on the production of these agricultural commodities. In terms of overall costs, the total amount of money spent by the European Agricultural Orientation and Guidance Fund for these policies amounted to less than 2 percent of the total expenditures devoted to the support of agricultural products in the EEC (Commission of the European Communities, 1979, pp. 46-53).

2.5.3 The EEC Cereal Policy

The Common Agricultural Policy for cereals is made up of a guaranteed price system. Three prices are the key to this pricing system. A target price is established at the beginning of each crop year. This price serves as a price indicator for farmers to form expectations with respect to the allocation of future acreages. To incorporate transport costs between EEC regions, the target price is equivalent to the delivered price in Duisburg which is the center of the area in shortest supply. The intervention price is the minimum price guaranteed to farmers. Whereas intervention prices are determined for each producing area according to cost differences between regions, the minimum intervention price for the EEC is established for the main cereal producing regions located in France. Intervention prices are between 5 and 10 percent below the target price. They are utilized by intervention agencies to provide a denaturation premium in order that the grain can be processed for animal feed rather than for human use; and to pay export refunds (or subsidies to non-member countries) (Ames - Ten Haaf - p. 7).[17]

The third price, the threshold price, is used to protect the EEC market from fluctuations in world market price levels. The threshold price is equal to the Duisburg target price minus transport costs from a fixed port of entry to the center of largest deficit. Imports of cereals entering the EEC are subject to a variable levy equal to the difference between the world price and the target price.

While fulfilling the role of guaranteeing a fair income to cereal growers, the EEC cereal price system had, in its conception, a basic shortcoming in the sense that it does not reflect effectively the feeding values of each cereal. Different intervention prices were set up for each cereal without any reference to the nutritional quality of each crop. The system works against the consumption of wheat as an animal feed, and due to the development of high yielding wheat varieties, new corrective policy measures were necessary in order to value wheat more in line with the feedgrain market.

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[17] This denaturation premium was especially used for wheat in order to reduce surpluses of milling wheat and make more competitive wheat for animal feed relative to corn. This denaturation premium, which has been effective since 1968, was suspended in 1974.

These changes were made gradually between 1976 and 1979 and have led to a common organization of the market, including wheat, corn and barley with a common pricing system called silo. This new pricing system has the following features:

i) there is a unique intervention price for feed cereals with this price being set for the main surplus area;

ii) feedgrains are priced according to their nutritional value. Thus, the following ordering of market prices for feedgrains is expected: barley, feed wheat and corn will, respectively, be equal to 102, 106 and 110 percent of the common intervention prices;[18]

iii) a reference price for bread-making wheat is introduced. This price is set at a level 15 percent higher than the common intervention price for feedgrains; and

iv) as a result of the creation of a reference price for bread-making wheat, there are now two types of target prices among cereals: one for wheat and one for barley and corn.

Figure 2.6 depicts the transitional period during which the system has progressively come into force. By the crop year 1978-79, the system will be completely operational. With these new regulations, the difference in prices between feed and bread-making wheat is 10 to 15 percent.

It is clear that these readjustments in the EEC feedgrain

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[18] It is noticeable that these above rates accord with the nutritional index attributed to feedgrains by some West European compound feed producers (Knipscher, 1980, p. 12). This index was 106 for soft wheat, 102 for barley and 110 for corn.

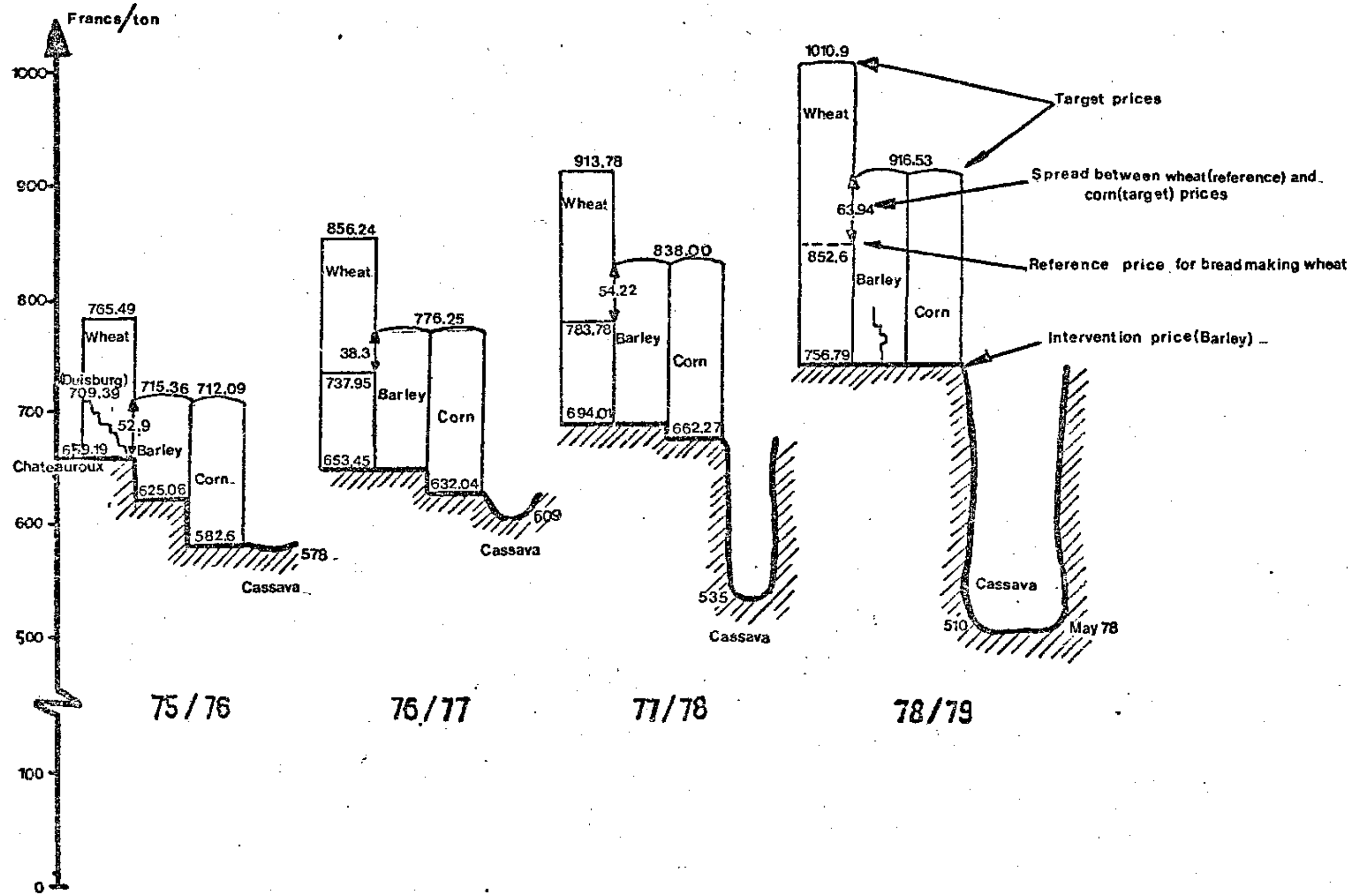

Figure 2.6: Evolution of Cereals Prices in France Setting of the "Silo" System

Source: Gatel

market have had an effect on the demand for soymeal. Considering that prices between feedgrains reflect the nutritional differences between each grain, the competitiveness between these crops should be facilitated and a greater use of feed wheat should be expected, thereby inducing a decrease in corn and soymeal consumption. Although solutions have been found to solve this particular problem, the fundamental question of EEC price differentials between feedgrains, soymeal and cereal substitutes still remains.

2.5.4 Other EEC Policy Regulations to Reduce Protein Imports

To reduce imports of high protein meals, the EEC council has a number of policy instruments it could use. The most likely to be used are *ad valorem* tariffs, voluntary export limitations and the requirement that feed manufacturers incorporate domestic protein sources in their commercial feeds in a given proportion. Illustrative of the type of policies pursued are the forced use of skimmed milk powder in 1976 and the agreement reached by the Community and Thailand on the limitation of cassava exports.

With a 35 percent protein content, skim milk powder can be used in poultry and pig diets with no major difficulty. The European Community is a large producer and consumer of this product.[19] Because

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[19] In 1973, the EEC consumed almost fifty percent of total world consumption (Longmire, p. 314).

of high intervention prices, the European Community is also a large stockholder. In order to stimulate domestic consumption of skim milk powder, a subsidy on the feeding of skim milk powder has operated since 1968. Despite these financial incentives, skim milk has remained uncompetitive with soybean and other high protein meals; its use in animal feeding being limited to weaner pigs and veal. In 1975-76, as a result of an increase in production and a fall in consumption, skim milk powder stocks expanded greatly, reaching 1.1 million tons in August 1975, more than two-thirds of current consumption levels. If no policy changes had occurred in 1976, the Community council estimated that stocks would reach 2 million tons by the end of 1976 (Green Europe, Apr. 1976, p. 37). Because of the growing financial costs associated with stockholding operations, the EEC commission sought ways of reducing the surplus of skimmed milk powder.

Of the four policy proposals envisaged by the EEC commission,[20] the one based on a protein deposit scheme was accepted. Preference for this scheme rested upon the fact that the system was self-financing and, apart from administration costs, did not require any additional costs to the Community. The system which came into effect in March 1976 for a period of nine months functioned as follows: "Any high protein meal imported or produced domestically and purchased by feed manufacturers was taxed on the basis of 30 to 35 units of account

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[20] The three other proposals were: i) to create a system of purchase by tender; ii) to increase the subsidy on inclusion of skim milk powder in animal feed; and iii) to make the inclusion of skim milk powder compulsory in all concentrate feed at a minimum level of two percent.

per metric ton, adjusted according to the protein content of the oil cake. At the same time, skim milk powder was sold at a subsidized price of 522 ua. per metric ton which was 380 ua. below the basic skim milk powder support price" (Parris-Ritson, p. 51). This system permitted the distribution of 400,000 tons of skim milk powder in 1976. Nonetheless, the impact of the protein deposit scheme on imports of soybeans and soymeal was minimal. Following U.S. pressure, the scheme which was initially designed to process 600,000 metric tons was reduced to 400,000 tons. In addition, in order to avoid sudden changes in soybean imports and to permit a continual inflow of imported protein sources, a subsidy on storage was included in the scheme (Parris-Ritson, p. 52).[21] Manufactured feed prices increased by 1.5 to 3 percent during the period of application of the protein deposit scheme.

The other temporary measures taken by the EEC council which have an effect on the consumption of high protein feeds have to do with cereal substitutes and, more particularly, cassava. From 1968 to 1978, imports of cassava by the European Community have risen sevenfold, equalling 5.84 million tons (Agra Europe, April 1979, p. E1). At present, the principal importers of cassava in the European Community are West Germany and the Netherlands. As discussed earlier, cassava imports by France only became significant in 1977-78. It has also been shown that this upsurge in the demand for cereal substitutes is

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[21] The U.S. with the support of other feed exporters (Argentina, Australia, Brazil) succeeded in getting a GATT investigation of the skim milk powder scheme (Parris-Ritson, p. 52).

essentially due to a huge price differential between internal Community cereal prices and the price of cassava and other cereal substitutes. Figure 2.6 depicts the situation for France during the period 1975-1979. So far, imports of cereal substitutes by the EEC are subject to a 6 percent ad valorem tariff applicable to any shipment originating from GATT member countries. However, Thailand, the principal exporter of cassava to the European Community, is not a member of GATT and benefits from the tariff under a 'most favoured nation' agreement (Green Europe, July 1979, p. 20). Although it is recognized that the utilization of cassava reduces the cost of feeding livestock, the expansion of cassava imports may have detrimental effects on French agriculture. According to a study released by the French Ministry of Agriculture in 1979 on the "true cost of manioc to France", the following negative impacts were noted. First, with structural differences between EEC member agricultural sectors, it is feared that distortions in competitiveness between EEC livestock industries will be aggravated. The French livestock industry which is less efficient than that of Belgium or the Netherlands would likely suffer the most. Second, the increase in cassava imports would have negative effects on other sectors of French agriculture. The most immediate one results in a decline in the demand for cereals and an expansion of cereal stocks, thereby inducing a higher contribution by France to the EEC budget. Lastly, a larger amount of imported cassava, combined with higher imports of soymeal, would deteriorate the French balance of payments and jeopardize the efforts of the French Government to reduce high protein imports.

For these reasons and with the support of the French government, the EEC commission proposed renegotiating the current 6 percent tariff on cassava and replacing it with a quota (Agra Europe, May 1979, p. E2). With respect to Thailand, an agreement was reached between the EEC Commission and the Thai Government to limit its exports of cassava to the European Community to the previous year's level in return for Community aid for its agriculture. Thus, for 1980, the target figure is fixed at 5.9 million tons (Green Europe, Nov. 1979, p. 22). Because of opposition by the Netherlands and West Germany, the proposal submitted by the EEC Commission to the Council was rejected on the grounds that the small place taken by cassava imports in the EEC does not require any modification of the import tariff on this product.[22]

It can be noted that an adequate agricultural policy to curb cassava imports by the EEC is very difficult to adopt owing to the numerous social, economic and political implications.[23] This is also valid for any policy which aims at reducing high protein imports through protective measures. It has not been possible to evaluate, at this

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[22] Other considerations are part of this decision. These two countries argued that such policy regulations would hamper Third World agricultural sectors. But they also act according to their own interests which are important in the cassava business (Green Europe, July 1979, p. 20). In addition, in such a policy process, it also should be given consideration of the likely resistance of high protein feed suppliers.

[23] It is the reason why the numerous intentions of introducing tariff barriers in the oilseeds sectors have so far failed. (see Ritson and Parris).

early date, the impact of the agreement reached by the EEC and the Thai government on the demand for soymeal in France and other EEC member countries.

2.6 The French Protein Policy

The foregoing sections have outlined the main policies that can be used by the Community to reduce high protein feed imports. Although France, as any other EEC member, must comply with the Community policy regulations, a more ambitious and consistent agricultural policy has been set up by the French Government to achieve the above-mentioned goal. To have a clear understanding of this question, it is imperative to examine at an early stage the structure of the French animal feed market. Due to the lack of available information, the analysis is conducted at an aggregate level through the investigation of the average feed supply balance available to French livestock for the period 1971-1974. Relevant statistical data are contained in Appendix II.

2.6.1 Structure of the French Animal Feed Market

The most striking characteristics of the French animal feed sector are the importance of grazing and conserved forage feeds in the total feed resource. More than two-thirds of digestible protein and energy feeds fed to livestock are derived from this group of feeds, grass making up the bulk of the category. Totally fed to cattle, roughages are the main obstacle to the penetration of the market by formula feeds. However, as roughages are low in protein and energy, they need to be supplemented by concentrates.

To show the degree of dependence of France on imports of soybeans and other high protein raw materials, it is necessary to analyze the French animal feed market at a narrower level, namely the concentrated feed economy (see Appendix I). Within this market, the cereal group supplies 66.9 percent of total energy feed units. Despite its low content in protein, cereals play a significant role in providing digestible protein to French livestock, contributing 39.2 percent of the total amount of digestible protein derived from feed concentrates. The distribution between feed cereals is relatively well balanced with a slight dominance of corn and barley in terms of energy feed units and soft wheat in terms of digestible protein units.

Another important feature inherent to the feed cereal group is the strong role played by on-farm consumption of feed wheat and feedgrains. During the period under investigation, about 60 percent of cereal crops stayed on the farm, whereas 31 percent of the total were purchased by the manufacturing feed industry, the remainder being purchased directly by farmers. The end use structure of feedgrains differs from one feedgrain to another. Thus, more wheat and barley are consumed at the farm level, whereas corn is the most important high energy feed ingredient utilized by the mixed feed industry. The role of feed wheat in the quantity of cereals purchased by feed manufacturers is enhanced due to the existence of the denaturation premium for wheat.

The other important group of feeds making up the concentrate characterize the French policy to reduce imports of soybeans and other high protein commodities. In so doing, policy regulations have come into effect in two phases. First, in 1975, the Government adopted a program of priority actions with a budget of 97 billion francs for the duration of the VIIth five year plan for the accomplishment of certain actions covering (BIMA, Dec. 1977):

i) developing varieties of protein rich plants particularly adapted for French climatic conditions (peas, beans, soya) and to suitable use by producers;

ii) economic support for the production of protein plants; and

iii) increased storage capacities for imported protein substances.

In 1977, this first set of measures appeared to be insufficient to cope with the growing imports of soybeans. As a result, a new package of propositions was approved by the French Government with an additional budget of 110 billion francs. These new propositions conform with the general above-mentioned orientations pursued by the French Government and are classified into three groups:

i) Re-emphasis on domestic production of oilseeds and rich protein crops. This will be performed through the following actions: Funding of research programs with the objective of improving yields and varieties of legumes, application of financial support schemes in conjunction with the Common Agricultural Policy, and the development of outlets in animal feeding for protein by-products.

ii) Saving of imports. As it has been pointed out in the analysis of the French animal feed market, a better use of domestic feed resources would lead to economics of consumption in imported proteins. With respect to ruminants, it is recommended to develop the production and use of grass silage in feeding dairy cows. The shortage of protein in the ruminants rations might be partly supplied by a greater employment of urea. To do so, training and extension programs are supported by the French Government. Finally, saving protein in feeding ruminants would be possible through the use of better meal quality suited to ruminants.

Economies of consumption in imported proteins for feeding monogastrics are realizable by utilizing alternative high-protein sources produced domestically, such as synthesized products (lysine and methionine),[26] dairy by-products (lactoserum and skim milk powder) and the recycling of slaughterhouse by-products.

Finally, an expansion of the production of feed cereals with higher content in protein would also be another appropriate way to save protein imports.

iii) Support actions. Under this heading are embodied all the actions dealing with improvement and innovations in the livestock production process. The main focus is on cross-breeding, improvement in sanitary

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[26] France is a leader in the production of these products. Thus, France has, respectively, 80 percent and 25 percent of world capacity in producing synthesized methionine and lysine which are, respectively, 100,000 tons and 30,000 tons (Picard and Brette, p. 6).

conditions of hogs and poultry husbandry and control of the quality of raw materials.

When combined together, these measures should imply a reduction in protein dependence from 80 percent to 76 percent in 1982, if 1977 economic conditions prevail. Table 2.14 presents the computations related to these projections.

After two years of this policy program, the targets are far from being reached. As noted recently in Agra Europe (November 1979, p. N1), "Faced with lower world feeding stuff prices and political inertia, the French Government's plan for reducing France's dependence on imported protein feeds appears to be achieving only very modest progress".

The low level of soymeal prices and cassava have made the alternative remedial solutions proposed by the French Government uncompetitive and too expensive. Despite this fact, the French policy program has been maintained and has yielded some positive results, which are reflected by an expansion of domestic production of oilseeds and protein rich crops (Section 2.4). A good indication of the failure of the French protein plan is the fact that a large part of the by-products derived from the subsidized oilseeds and protein rich crop production have been exported to other EEC member countries[27] (Charles Robert, 1978; Green Europe,

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[27] This situation illustrated the effect of complementary agricultural activities located in different areas and the inducing transport costs which are an additional burden for feed compounders. Thus, in the case of domestic rapeseed meal produced essentially in Dieppe (Fig. 2.8), it is cheaper for feed compounders located in Brittany to import soymeal from the U.S. or Brazil than to buy domestic rapeseed meal which will be exported at lower costs to Holland or Belgium (Charles Robert, 1978, p. 38).

TABLE 2.14. Evaluation of the imported proteins saved in 1982 compared to 1977 by applying the French policy measures

Expressed in 1000 MT, Soymeal Equivalent

	1977	1982
Estimated consumption based on present evaluation	3200	3800
Reduction in consumption obtained by "saving actions"		530
Expected consumption after saving	3200	3270
National production	640	785
Dependence rate	80%	76%

Source: BIMA (Dec. 1977).

Jan. 1980, p. 25).

The other major reason for the failure of the French protein plan is due to the structural change which has occurred in French soymeal imports since 1975, characterized by a diversification of import sources. This latter target is less costly and, in that respect, it is worth mentioning that the opening of the crushing plant in Bordeaux with public funding and the financial participation of Brazilian co-operatives proved to be more successful in providing a secure source of supply.

2.7 The Compound Feed Industry in France

As discussed earlier, the modernization and rationalization of hog and poultry production over two previous decades in France has led to a rapid expansion of the demand for formula feeds and a change in the demand pattern for feed inputs. Such evolution is well illustrated by Figure 2.7, and data reported in Appendix II, concerning the use of feed ingredients by feed manufacturers. Almost non-existent in the fifties, the formula feed industry has experienced a tremendous growth in the sixties and seventies. At the outset, production of manufactured feeds was mainly destined for hogs and poultry. Of 3.4 million tons of compound feeds produced in France in 1963, more than 70 percent were fed to those two categories of animals. Today, the demand for formula feed is more diversified with the market share of hog and poultry feeds declining and consumption of commercial mixed feeds by cattle and other animals increasing.

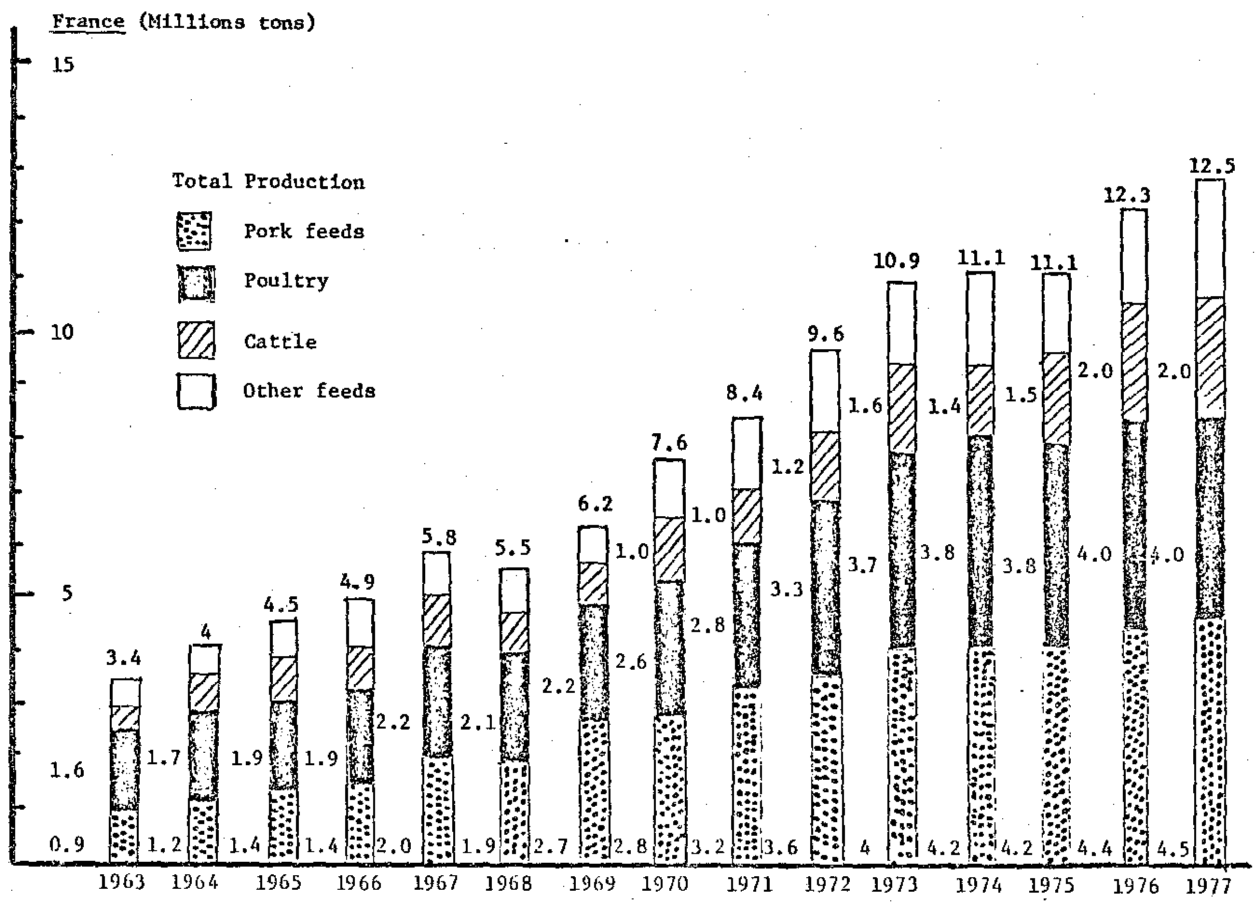

Figure 2.7: Evolution of French Compound Feed Production between 1963 and 1977

Source: SNIA (1978)

Feed manufacturers produce and distribute three broad categories of commercial feeds whose content varies according to the class of livestock (L. Martin, 1974, pp. 1-2).

i) <u>Complete feeds</u> provide all of the nutritional requirements necessary for maintenance of normal health or for promoting production. When fed to livestock, these complete feeds do not need to be supplemented by other feed sources.

ii) <u>Supplements</u> are a mixture of ingredients that supply nutrients and medicating ingredients in sufficient concentration that, when mixed with grain or grain and other carbohydrate materials in accordance with the directions for use, will produce a complete or balanced feed.

iii) <u>Premixes</u> provide vital elements such as vitamins and trace minerals which must be supplied in small amounts to livestock and are often missing in feed ingredients. These missing nutritional elements are provided by premixes and added to a feed ration. Because of the complex production process and the costs involved, these premixes are produced separately in a preliminary stage by specialized firms and supplied to feed manufacturers. For this reason, production of premixes in France are not counted in the available statistical data on compound feed production.

In France, these three groups of commercial feeds are defined by legal regulations and must fulfill certain conditions with respect to content and label which are developed at length in Appendix I.

2.7.1 Structure of the French Compound Feed Industry

An important characteristic of the French manufactured feed industry is its low concentration. Despite the fact that the size of compound feed firms range from those producing a few thousand to more than a hundred thousand tons, the average size is rather small, averaging 13,800 tons in 1977. From data compiled in Table 2.14, it is possible to distinguish three different groups of firms. First, firms which produce less than 5,000 tons have a local market, are generally family-owned and have few employees. The size of this group has declined during the last two decades. In 1962, this category was the most important among French feed compounders and supplied 28.1 percent of the total production of formula feeds. In 1977, although still accounting for a large fraction of the total number of firms, they produced only 5.4 percent of the total quantity of commercial feeds. Second, firms ranging from 5,000 to 30,000 tons, with a regional market, accounted for 32 percent of the total firm population and provided 31.2 percent of the total production of formula feed in 1977. The final size group is represented by large concerns that have a production capacity of more than 30,000 tons.

The main reason for the relatively small size of feed companies is the cost structure associated with the feed compound production process. On one hand, the establishment of bigger plants allows a reduction in the cost of producing formula feeds. Thus, in 1971, the average cost of poultry formula feed produced by a plant with less than 5,000 tons capacity was 6.9 francs, whereas this cost fell to 3.67 for

Table 2.15: Distribution of Firms in the Compound Feed Industry By Class of Production

Output in Tons	1962 # of Firms	1962 %	1962 Prod. 000 tons	1962 %	1969 # of Firms	1969 %	1969 Prod. 000 tons	1969 %	1974 # of Firms	1974 %	1974 Prod. 000	1974 %	1977 # of Firms	1977 %	1977 Prod.	1977 %
< 1000	803	81.2	1003	28.1	241	30.5	91	1.5	304	38.8	103.3	1.3	244	27.5	81	0.7
1 to 5,000					269	34	657	10.5	222	28.3	549.3	6.8	234	26.4	586.2	4.7
5 to 15,000	144	14.6	1123	31.5	183	23.2	1492	23.9	147	18.7	1314.9	16.8	179	20.2	1605.7	13
15 to 20,000	29	3	521	19.6	36	4.6	634	10.2	28	3.6	480.4	6	46	5.2	793.6	6.4
20 to 30,000					30	3.8	735	11.7	35	4.5	844.9	10.5	59	6.6	1467.7	11.8
30 to 50,000	5	0.5	161	4.5	11	1.4	400	6.4	23	2.9	889.9	11	61	6.9	2342.6	18.9
50 to 100,000	5	0.5	329	9.3	11	1.4	672	10.8	15	1.9	1071.5	13.3	44	5	3002.8	24.2
> 100,000	2	2	430	12	9	1.1	1562	25	10	1.3	2801.2	34.8	20	2.2	2509.3	20.3
Total	988	100	3568	100	790	100	6243	100	784	100	8055.4		887	100	12389.	
Average Size of Firms	3.6				17.9				10.3				13.8			

Source: Foucault (Annexe), SNIA.

firms with a size greater than 50,000 tons (Diry, p. 684). But minimum average production costs are often offset by transport and service costs which increase in relation to the size of the distribution area. It is well known that the distribution area of a feed plant is no larger than 50 to 100 km because beyond such a limit, transport costs are prohibitive.

Given this cost constraint, the compound feed industry is located in the neighbourhood of livestock producing areas. Accordingly, Brittany and Loire Valley regions are the two most important producers of formula feeds, accounting, respectively, for 32.3 percent and 10.5 percent of the total (SNIA, 1977). Two other areas, Northern and Rhone-Alpes regions,[28] also contribute significantly to the total production of commercial feeds. Within these regions, feed plants are located close to livestock production centers and are linked to ports by a good transport network (Diry, pp. 699-701).[29]

The organization of the French compound feed industry is unique in Western Europe (Foucault, p. 191). With the creation and expansion of this sector in the late fifties and early sixties, milling companies which specialized in producing commercial feeds performed essentially primary production operations, i.e., purchasing and mixing of feed ingredients and their distribution to customers. All the secondary

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[28] For the localization of these areas, see Figure 1.1.

[29] In Brittany and Loire Valley regions, rail and truck transport is utilized, whereas in Northern France, canals related to Antwerpen and Rotterdam are employed.

operations such as determination of least cost rations, research and development and the production of premixes requiring massive investments are performed by firms called service firms (Foucault, pp. 192-193). Other services are also provided by these companies. For example, they may control the quality of feed ingredients available on the market and give technical and commercial assistance to livestock producers.

Such differentiation in the organization of compound feed production has led to the existence of three types of feed firms in France. First are independent small and average-size producers which only undertake the above-mentioned primary production operations. A second category is made up of feed firms linked to service firms through a concession or contracting system. Third, if firms are big enough, they can do both primary and secondary production operations, in which case they are called integrated firms. These firms generally control several plants scattered throughout the country with some being direct subsidiaries of Multinationals[30] (Foucault, p. 292).

This above production structure is relevant for both the co-operative and private sector. The role of co-operatives in the manufacturing feed industry began to be important in the early sixties during which time they controlled about 10 percent of the market for mixed feeds (Foucault, p. 201). Today, their share is about 30 percent

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[30] In order to diversify their activities, multinational firms such as Unilever and Ralston Purina are involved in the French manufacturing feed industry and, more specifically, as feed service firms (Diry,pp. 685-687).

whereas the remaining 70 percent is controlled by private industry.[31] Co-operatives, because of their specific objectives and larger financial resources, tend to be more concentrated than private feed companies.

After having experienced rapid growth in the sixties, the compound feed industry expanded at a slower rate. This trend which was emerging in the seventies is likely to persist through the 1980's. Three basic problems explain this slowing in the growth of compound feed production.

The first problem concerns the cost of feed ingredients and its impact on price, which at the present time makes up 80 to 85 percent of the total production cost (Diry, p. 674). Until the early seventies, the stable world market conditions existing in the high protein feed and cereal economies allowed feed companies to employ strategies that enabled them to pass on all of the increases in the cost of feed ingredients. They did this by employing different strategies such as obtaining long term contracts or buying large quantities of feed inputs with a significant discount (Foucault, p. 85). In addition, feed companies had to abide by the directives on price variation given by the French Ministry of Finance (CNCA, 1977, p. 51). After successive negotiations aimed at increasing the price of compound feeds, in order to offset the sharp increases of soymeal and other feedstuffs price in

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[31] In fitting the statistical data relative to the market share of co-operatives in the total production of mixed feeds with a logistic trend, Foucault (p. 205) found that the upper limit co-operative's market share was 50 percent.

1974-75, price controls were dropped in 1978-79.[32] Given this change, prices of mixed feed will be more variable, thereby implying more competition between compound feed firms. Although the evolution of livestock production is the key variable for the determination of mixed feed production, the almost complete saturation of the feed market for some categories of animals is also a limiting factor in the future expansion of the compound feed industry. It is the reason why diversification towards other animals such as rabbits and pets is being successfully attempted. Finally, as observed in other West European countries, feed manufacturers are facing stronger competition from home mixed feeds. In this case, prices of home mixed feeds and commercial feeds are the key decision variable.

2.7.2 The Feed Compound Industry and the Integration of Livestock Production

The rapid development of the manufactured feed industry in France has been accomplished by modifications in the relationships between livestock producers and other economic agents in the livestock production system. Primarily, this has involved more vertical integration between livestock operations and the food industry.

Although some feed suppliers do not want to be involved in livestock production, the large majority of mixed feed companies feel

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[32] This liberalization of prices is part of the general economic policy undertaken by the Barre Government to boost the French economy. Through a liberalization of prices, the main purpose of this policy was to provide incentives for French firms to increase investments (LeMonde, May 1980, pp. 17-18).

the need to be involved in the livestock market in order to optimize the use of their resources. Farmers are also interested in contracting systems because it allows them to have guaranteed outlets for their products, fair income and access to more services. In so doing, they attempt to reduce the risk inherent in some livestock operations.

Being more involved in the livestock production system has also been pursued by co-operatives who feel integration of livestock production is a key variable in explaining their internal growth (Foucault, p. 131). For privately owned companies, contracting is also an important factor, but in the sense that it permits a diversification of activities and services (Foucault, pp. 161-163). In order to obtain secure supplies, some slaughter houses have also vertically integrated with livestock operations.

This involvement of food companies in the organization of livestock production has led to the creation of numerous contracting systems that range from complete integration, in which livestock and poultry producers receive feed and a guaranteed revenue through guaranteed prices, to share risk contracts whereby the output price paid to farmers is the market price. Due to the lack of information and the reluctance of food firms to communicate data on the type of payments, it is very hard, if not impossible, to provide a complete overview of the kinds of payments offered to farmers. Payment systems seem to be numerous and vary according to the producing region and the class of animal. In livestock operations, the degree of risk involved plays an important role in the determination of the price system.[33] In poultry operations, Shaller and Saunier (p. 277) note that the most prevalent payment systems in Britany are market prices, guaranteed prices, and providing a margin per bird.

The degree of integration and the type of contracting differ from one class of animal to another. Although the degree of integration is 85 to 90 percent in the broiler sector (Shaller and Saunier), such a rate is not found for other types of animals. Thus, McBullen and Pickard provide the following estimates of the proportion of livestock under contract:

Cattle	
Steers (Jeunes bovins)	80%
Cows and Beef	10-12%
Veal Calves	80%
Pigs	over 50%

It has been recognized by several observers that the existence of a significant contracting system has benefitted hog producers and feed firms. It has been encouraged by the French Government and has permitted the rationalization of the industry and led to an increase in pork production in order to reduce a growing deficit in this product (McBullen and Pickard, p. 36). With the exception of raising veal, there is very low vertical integration in the dairy and beef industries.

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[33] A. McBullen and D. Pickard give a list of contracts existing in livestock production (pp. 147-148).

More information is available on vertical integration for poultry operations. Shaller and Saunier synthesized the results of a survey of 5,000 producers undertaken in Brittany in 1973-74. The form of relationships farmers might have with feed companies, slaughter houses and other food firms range from total independence to linkages resting on a written contract which require producers not to change partners over the life of the contract. In addition, Shaller and Saunier found:

> i) 28 percent of farmers had no relationship with any other economic unit involved in the poultry production process;
>
> ii) 72 percent of farmers are tied to another unit typically either a feed firm or slaughter house, typically through a written contract; and
>
> iii) 63 percent of producers have a dependence relationship with feed firms, whereas 43.7 percent have linkages with both feed firms and slaughter houses or other feed firms.

It is obvious from the above statistics that complete integration does not exist in France in any livestock sector. The tripartite contract in which feed firms, farmers or producer groups, and slaughter houses or distribution companies are involved is not the predominant market arrangement in France. Indeed, the most common type of linkage seems to be a contracting system between farmers with one part of the livestock industry.

2.8 The French Oilseeds Processing Industry

Prior to 1960, the French crushing industry was supplied by peanuts originating from overseas French colonies, and more particularly, Senegal. Owned by family companies, large crushing plants were concentrated in the river and coastal port towns of France, namely Bordeaux on the Atlantic Ocean, Marseille on the Mediterranean Sea, Le Havre and Dieppe on the Channel and Dunkerque on the Northern Sea (Fig. 2.8). By contrast, processing of domestic oilseeds was handled by small and medium-sized concerns located in the neighbourhood of oilseed producing areas. During this period, highly protectionist regulations and strict government control hindered any outside competition and favoured, among other things, the development of a sizeable industry which operated at less than full capacity (Spillsbury, p. 47).

This overall structure of the French crushing industry was modified in the sixties by two major factors; namely, the creation of the European Community, and the subsequent Common Agricultural Policy and the switch from oil-bearing to meal-bearing oilseeds. Structural changes reflected by the increasing concentration of firms and the closing of less efficient plants were imperative for survival. Furthermore, the development of domestic crushing industries in developing countries accelerated this trend (Stepporth and Hoagan, pp. 5-15).

The creation of the common market and the inception of the Common Agricultural Policy implied that French oilseed crushers must compete with foreign oilseed processing industries, and more parti-

▲ Plant capacity less than 200,000 tons

■ Plant capacity higher than 200,000 tons

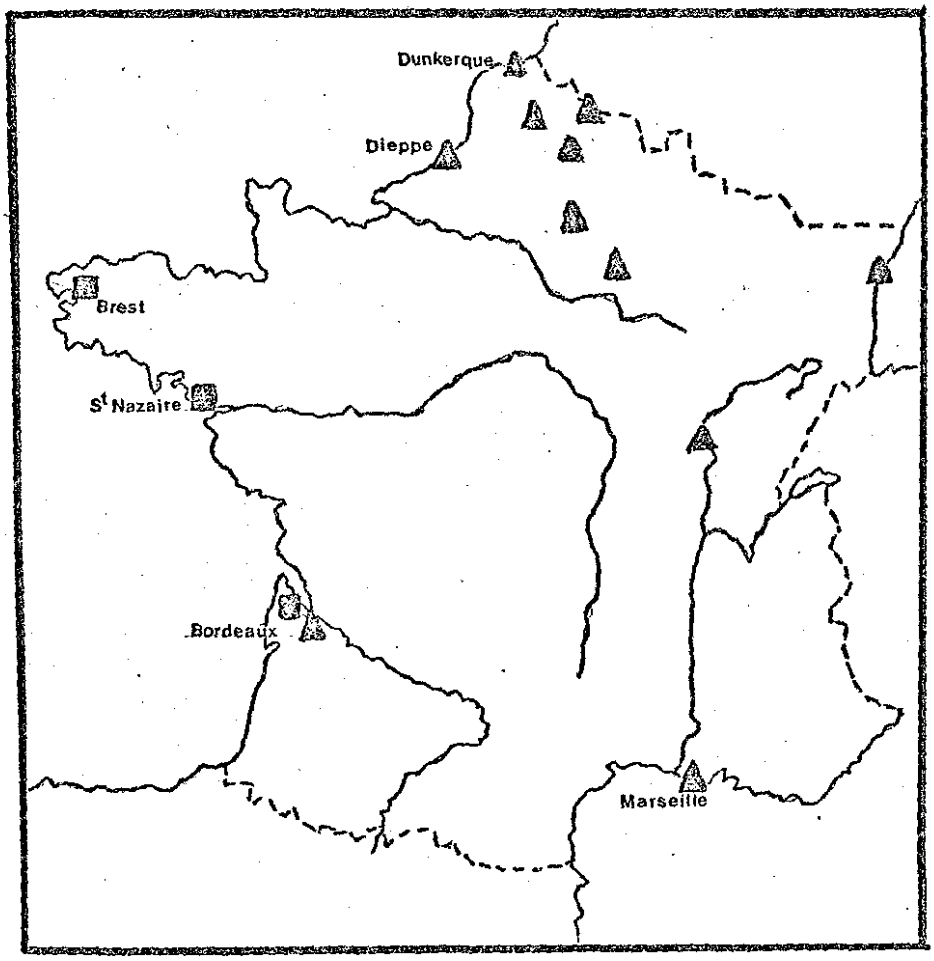

Figure 2.8: The French Crushing Industry in 1978-79

Source: CNTA, Soybean Blue Book

NOTE: The listing of crushing facilities has been done by checking various reference sources. It is believed that it provides a fair representation of the actual location of most plants.

cularly, those located in Northern Europe. The transition has, however, been smoothed by the maintenance of some tariffs on fats and oil imports and the signing of preferential agreements with old suppliers under the Yaoundé Convention. To maintain a competitive oilseed crushing industry in the EEC, capable of operating under world market price conditions, deficiency payment schemes were established for the production of domestic oilseeds (see Section 2.4.1).

The switch from oil-bearing to meal-bearing oilseeds has been difficult for the French oilseed processing industry. In 1963, Spillsbury (pp. 35-37) reported that in spite of the existence of large and well-equipped crushing plants, French crushing companies were not prepared to crush enough soybeans to meet the demand for soymeal in France. Higher processing costs, the difficulty of marketing soybean oil and the existence of technical equipment more suited to handling oilseeds with a higher content in oil were the main obstacles to the development of a domestic soybean crushing industry.

The total crushing capacity in France consists of fifteen crushing plants spread all over the territory (Fig. 2.8). Two kinds of processing units are operated and differ from each other according to their size. A group, comprising three large plants with a capacity of at least 300,000 tons /year, crush exclusively soybeans. These processing units have been constructed recently along the Atlantic Ocean close to livestock producing areas. The oldest of these three plants, located in St. Nazaire, was operational in 1969-1970. This was followed by the opening of Brest and Bordeaux plants in 1975 and

1979, respectively. The newest plant is able to process soybeans, sunflower and rapeseed. These three plants constitute the major part of the solvent crushing capacity available to process soybeans. A group of medium-sized crushing plants crush primarily peanuts, rapeseed and sunflower.

A striking feature of the oilseeds processing industry in France is that the total volume of oilseeds crushed has been remarkably stable for the last four decades. Thus, in 1938, 1,200.000 tons of oilseeds were crushed, of which 750,000 tons were peanuts. In 1976, a similar amount, 1,390,000 tons, were processed, although peanuts no longer dominate, having been replaced by soybeans and rapeseed. What are the factors that explain this stagnation of the French crushing industry as opposed to the expansion of crushing facilities in Northern Europe? The elements to explanation lie in the permanent lack of a comparative advantage for French crushers. The less efficient port infrastructures existing in France do not allow the acceptance of large freighters (French Ministry of Agriculture, 1979, p. 4), thus increasing costs, while the EEC agri-monetary system favours countries with strong currencies such as Belgium and the Netherlands. As noted by other researchers (Paarlberg, 1977, p. 52; Knipscher and Hill, 1980, pp. 41-42), storage facilities are also limited in France. This is illustrated by the small variation in soymeal stocks from one year to the next. Consequently, French crushing capacity is still under-utilized, ranging between 60 percent and 70 percent (Appendix A3).[34]

The concentration of the French crushing industry has increased since 1960 with the opening of several large crushing plants in the 1970's. In 1977, the French oilseed processing industry, combined with the refinery vegetable oil and fats industry, consisted of 15 crushing plants, 10 medium-sized refinery oil plants and 50 small companies (CNTA, 1977, p. 38). Three or four firms control the sector with multinationals such as Bunge, Central Soya and Unilever involved either directly or through partnership.

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[34] This figure is much lower than in the U.S. where the percentage of capacity utilized is 80 percent.

CHAPTER III

A THEORETICAL MODEL OF THE FRENCH FEED-LIVESTOCK INDUSTRY

3.1 Introduction

The objectives of this chapter are two-fold. First, to present a theoretical model of the French feed-livestock sector in which the soymeal market is but one component. Second, in response to the rapid growth of the French compound feed industry during the past two decades, special attention is given to this industry, the ways to include it in the French feed-livestock model and how to assess its impact on the demand for feed inputs and on livestock production.

Most econometric work on the demand for animal feed rests upon the static microeconomic theory of derived input demand (Henderson and Quandt, pp. 69-70). In a study of the U.S. demand for feedgrains, Womack developed the theoretical aspects of the demand for animal feed. Using a Cobb-Douglas production function, Womack shows that the aggregate demand for feedgrain fed to livestock is a function of livestock population (or inventories), price of feedgrains, prices of substitutes, and other exogenous factors. This specification of the demand relationship, conceived in a static and annual framework, stems from a feedgrain livestock sector in which farmers maximize their profits under conditions of perfect competition.

With the incorporation of the compound feed industry in the

French feed-livestock model, the specification of the demand for soymeal and feedgrains needs to be differentiated according to its final use by either feed compounders or directly on farms. For the sake of convenience, these two demand components are designated as either commercial demand or non-commercial (on farm) demand.

This breakdown of the total demand for feed inputs into two components involves estimating more functional relationships and having a more in-depth look at the linkages between the feed-compound and livestock industries which differ for every class of livestock. Accordingly, a large set of endogenous variables is explained by this submodel. Table 3.1 shows the endogenous and exogenous variables which are part of the French feed-livestock model. The domestic price of soymeal, now considered as an exogenous variable, is endogenized later when the model is connected to the other functional relationships describing the French soymeal market.

3.2 Modeling the French Feed-Livestock Sector

3.2.1 Feed-Livestock Processes

The production process underlying the French feed-livestock industry might be viewed as the interface of two interdependent production processes which can be represented by appropriate production functions given a level of technology.

The production process of the mixed feed industry was summarized by Vachel (p. 74):

TABLE 3.1. Structure of the French feed-livestock submodel

Endogenous Variables	Exogenous Variables
Mixed Feed Sector	
Demand for hog mixed feed	Production of pork
Demand for broiler mixed feed	Production of eggs
Demand for laying mixed feed	Production of chicken
Demand for beef and dairy cattle mixed feed	Milk production
Price of mixed hog feed	Beef production
Price of mixed broiler feed	Price of pork
Price of mixed laying feed	Aggregate price of beef and milk
Price of mixed dairy and beef feed	Price of eggs
	Price of chicken
	Dummy variables for climatic changes (1973-76-77)
	Time trend to capture technological change
Soymeal Market	
Commercial demand for soymeal	Price of feedgrains
On-farm demand for soymeal	Quantity of other high-protein commodities
	Production of pork
	Production of beef
	Domestic price of soymeal*
Feedgrain Market	
Commercial demand for feedgrains	Price of feedgrains
Non-commercial demand for feedgrains	Production of pork
	Production of beef

* This variable will be endogenized when this submodel is added to the soymeal block.

> "Receiving rough agricultural products from the farm sector, by-products from industries and nitrogenous products from chemical industries, the compound feed industry blends these inputs at the least cost and provides feed mixes whose contents vary with their destination (calves, cattle, hogs, broilers and laying hens) and with their final use as either supplements or complete feeds."

Such a process is complex but with the aid of linear programming feed compounders produce a wide range of formula feeds using ingredients which can be classified into two large groups: i) energy feeds, mainly cereals; and ii) high protein feeds, of which soymeal is the most important. For the rest of the analysis, the terms soymeal and feedgrains will be used in referring to the two types of feed.

In meeting the nutrient requirements of livestock, a technical complementary relationship exists between the two feed ingredients, with a combination of corn and soymeal being a common feed ration in the EEC. But, as discussed earlier, the application of the Common Agricultural Policy has resulted in the emergence of a substitution relationship between soymeal and cereals. This is due to the internal EEC prices of feedgrains which are artificially high, and the mixed feed industry has tended to use more high-protein meals while replacing cereals with cheaper substitues such as cassava. This situation has become more pronounced in France in the last two years.

An aggregate production function for a feed compounder might be described by a Cobb-Douglas function:

$$QCOMP = A\ SOY^{\alpha}\ CFG^{\beta} \tag{3.1}$$

where QCOMP = the production of compound feed;
SOY = the quantity of soymeal;
CFG = the quantity of feedgrains.

As the basic purpose of the mixed feed industry is to prepare efficient and balanced formula feed, inputs such as labour and capital are considered fixed in the short run and represented by the constant A in equation (3.1). The use of two feed ingredients in the compound feed production process implies that the input demand for soymeal and feedgrains are determined simultaneously. The output of the mixed feed industry provides the inputs for a second production process, i.e. the livestock production process where home produced feeds must be considered.

Depending on the class of livestock, the underlying production function may or may not incorporate different feeding stuffs. This implies that one production function should be specified for each type of animal. The quantity of compound feeds produced by the mixed feed industry constitutes one feed input for livestock which may be consumed as supplements, complete feeds or premixes. A significant portion of feedgrains produced in France are consumed directly on farms and as a result, not only compound feed demand but also on-farm demand for feedgrain functions are specified and included in the French feed-livestock model.

Given the characteristics of the French livestock industry, three kinds of models may be used to identify and embody most of the interdependencies which occur. The three models proposed differ primarily in terms of the degree of co-ordination between the compound feed sector and the livestock sector. In Model I, the two production processes are operated as a single firm and home produced feeds are unimportant. Conversely, Models II and III represent situations where the mixed feed industry has little, if no, control of the livestock process and where home-grown feeds and the direct purchase of feeds by farmers are important. A fuller description of the three models follows:

Model I: This model depicted in Figure 3.1 represents the production process when the feed compounder and livestock producer are completely integrated by contract or through direct ownership. This model is appropriate for describing the demand for compound poultry feed and, to a lesser extent, formula hog feed in France. In this model, home-produced feeds are ignored.

Model II: This model, shown in Figure 3.2, provides an overview of a livestock production process where home-grown feeds and complete formula feed are likely to substitute for each other, although the farmer may purchase a supplement or premix. In this model, there is little or no co-ordination between the feed manufacturer and livestock producer. This model is appropriate for describing the beef industry.

Model III: In Model III (Fig. 3.3), the farmer is assumed to choose between mixing his own balanced ration or buying it from a feed manufacturer.

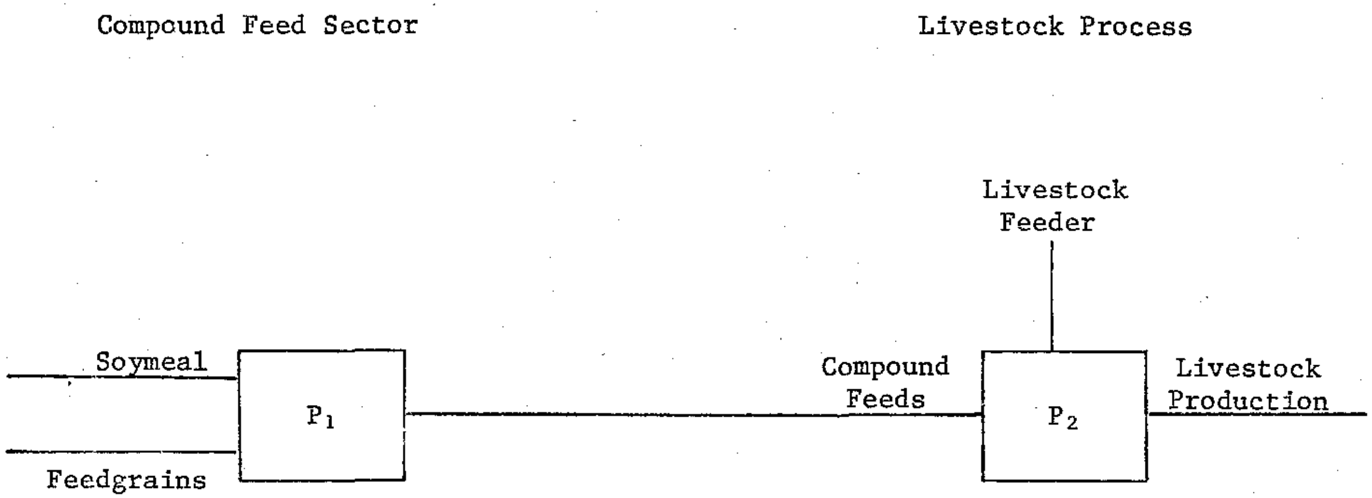

FIGURE 3.1. Feed compound livestock processes without home-grown feeds.

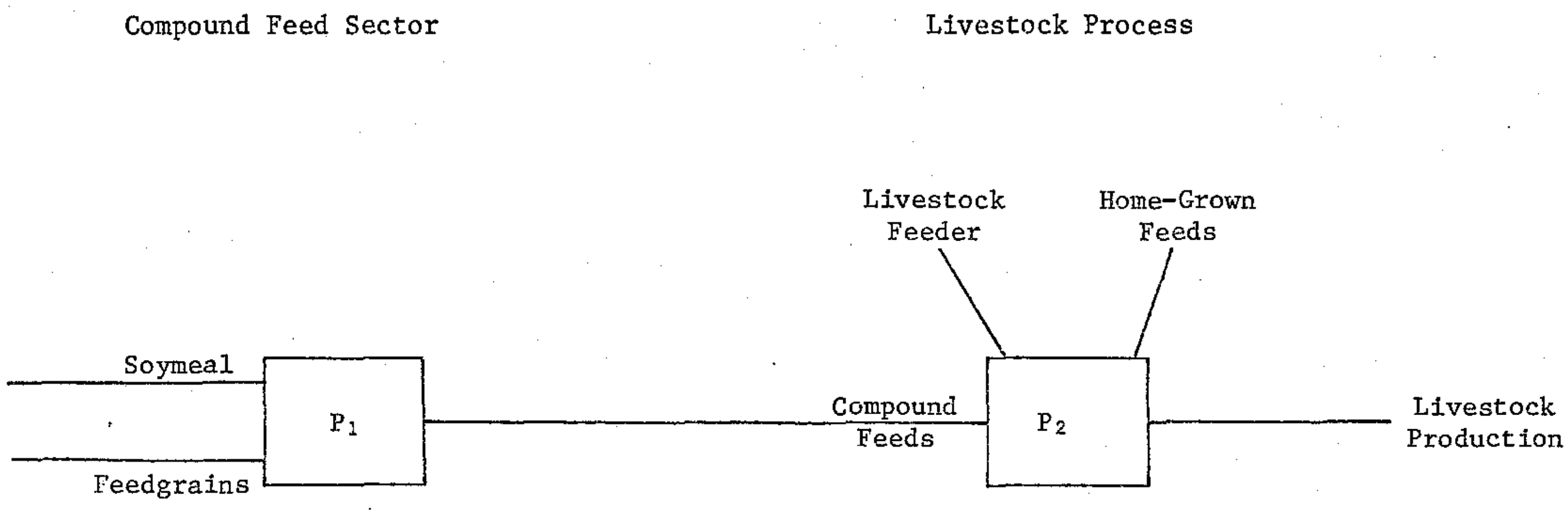

FIGURE 3.2. Feed compound-livestock processes with home-grown feeds.

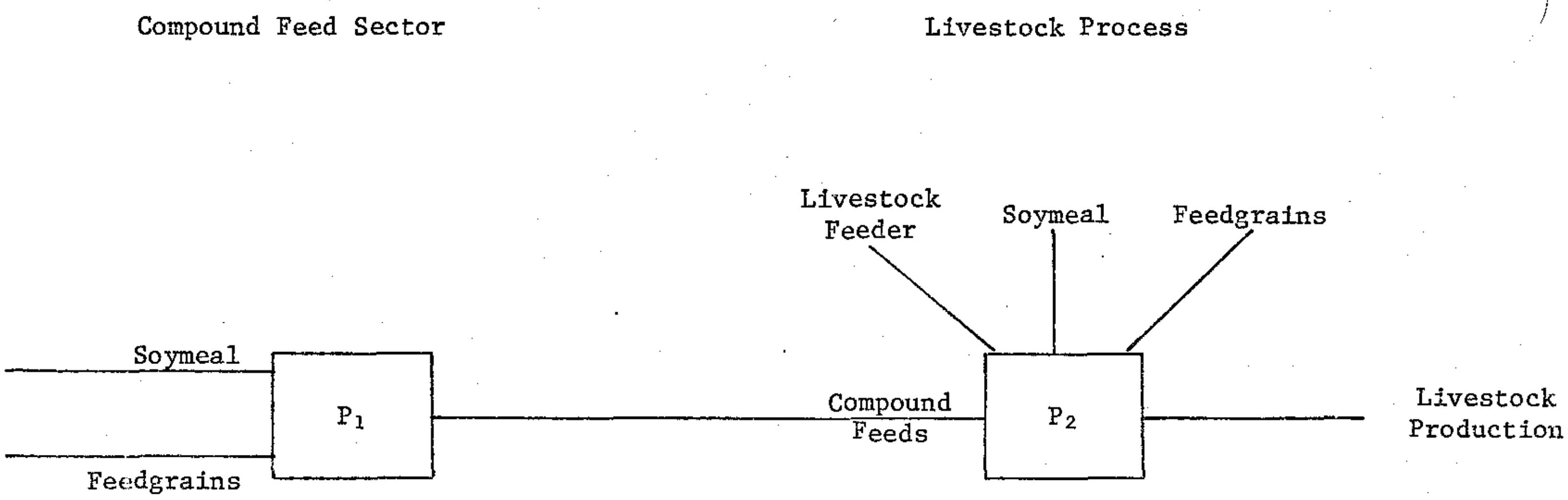

FIGURE 3.3. Feed compound-livestock processes when farmers decide whether or not to prepare efficient feed rations.

This model is used to determine the factors important in specifying the demand, by farmers, for soymeal.

It should be kept in mind that these three models are very general and are not meant to describe completely the biological and economic nature of French livestock systems, but they should help in conceptualizing the variables that are important in each situation.[1]

3.2.2 Commercial Demand for Feedgrains and Soymeal

The specification of the commercial demand for feedgrains and soymeal rests on the modeling of the compound feed decision process corresponding to P_1 in Figures 3.1, 3.2 and 3.3. The problem is to minimize costs for a given level of output. The optimization and solution of this problem leads to specification of the commercial demand for soymeal and feedgrains. Described by expressions (3.2) and (3.3), it consists of producing formula feed at the least cost after meeting the nutritional needs of livestock.

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[1] In fact, to answer these questions, a microeconomic approach is more appropriate. In this approach, a thorough description of the livestock process, a multi equation model is set up to specify all the internal relationships. In his book, The Analysis of Response in Crop and Livestock Production, Dillon gives some examples of broiler and sheep grazing (pp. 83-93), which could be adapted to French livestock systems. As a proponent of this procedure, Dillon argues that "multi equation systems are particularly pertinent in livestock processes because the animal exercises choice over time as to the quantity and type of feed they consumed" (p. 162).

$$\text{Min } Z = (P_{soy}SOY + P_{cfg}CFG), \text{ subject to} \tag{3.2}$$

$$QCOMP_o = A \; SOY^{\alpha} \; CFG^{\beta} \tag{3.3}$$

where P_{soy} and P_{cfg} = respectively, the prices of soymeal and feedgrains; and

$QCOMP_o$ = a given level of compound feed to be produced.

The optimal solution can be derived from a Lagrangian function given by:

$$\text{Min } L = P_{soy}SOY + P_{cfg}CFG + \lambda(QCOMP_o - A \; SOY^{\alpha} \; CFG^{\beta}) \tag{3.4}$$

The solution of the first order conditions yields the optimal combination of soymeal and feedgrains associated with the given level of compound feed to be produced.

$$\frac{\partial L}{\partial SOY} = P_{soy} - \alpha \; \lambda A SOY^{\alpha-1} \; CFG^{\beta} = 0 \tag{3.5}$$

$$\frac{\partial L}{\partial CFG} = P_{cfg} - \beta \; \lambda A SOY^{\alpha} \; CFG^{\beta-1} = 0 \tag{3.6}$$

$$\frac{\partial L}{\partial \lambda} = QCOMP_o - A \; SOY^{\alpha} \; CFG^{\beta} = 0 \tag{3.7}$$

In doing so, compounders produce on the expansion path where the marginal rate of technical substitution equals the ratio of factor prices. This is depicted by the following equation:

$$\frac{P_{soy}}{P_{cfg}} = \frac{\alpha}{\beta} \frac{CFG}{SOY} \tag{3.8}$$

Substituting for CFG and SOY in (3.8) from (3.5), (3.6) and (3.7) gives the quantities of feed ingredients SOY^* and CFG^* required to produce $QCOMP_o$ units of compound feed at the cost minimizing input ratio.[2]

$$CFG^* = \left[A^{-1}\ QCOMP_o\ \alpha^{-\alpha}\ \beta^{\alpha} \left(\frac{P_{cfg}}{P_{soy}}\right)^{-\alpha} \right]^{\frac{1}{\alpha + \beta}} \tag{3.9}$$

$$SOY^* = \left[A^{-1}\ QCOMP_o\ \beta^{-\beta}\ \alpha^{\beta} \left(\frac{P_{soy}}{P_{cfg}}\right)^{-\beta} \right]^{\frac{1}{\alpha + \beta}} \tag{3.10}$$

CFG^* and SOY^* are conditional factor demand functions (Varian, p. 18) which are increasing functions of the quantity produced (QCOMP), when QCOMP is not constant, and decreasing functions of the factor price ratio (3.11 and 3.12),

$$\frac{\partial SOY^*}{\partial QCOMP} \text{ and } \frac{\partial CFG^*}{\partial QCOMP} > 0, \text{ and} \tag{3.11}$$

$$\frac{\partial SOY^*}{\partial \left(\frac{P_{soy}}{P_{cfg}}\right)} \text{ and } \frac{\partial CFG^*}{\partial \left(\frac{P_{cfg}}{P_{soy}}\right)} < 0 \tag{3.12}$$

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[2] The second-order conditions are assumed to be met.

It is worth noting that these demand functions are homogenous of degree zero with respect to factor prices, thereby implying that feed manufacturers are not subject to money illusion.

If all the compound feed firms are represented by identical production processes, and perfect competition prevails in the factor and product markets, then the firm's input demand functions can be extended to the whole market. The result is the specification of commercial demand relationships for soymeal and feedgrains with a similar set of explanatory variables.

In general, equation (3.8) implies that each formula feed is produced in such a way that the following relationships hold:

$$\frac{P_{soy}}{P_{cfg}} = \frac{f'_{soy}(\text{Hogs})}{f'_{cfg}(\text{Hogs})} = \frac{f'_{soy}(\text{Broilers})}{f'_{cfg}(\text{Broilers})} =$$

$$\frac{f'_{soy}(\text{Laying Hens})}{f'_{cfg}(\text{Laying Hens})} = \frac{f'_{soy}(\text{Cattle})}{f'_{cfg}(\text{Cattle})} \qquad (3.13)$$

This equation states that the ratio of feed input prices equals the ratio of marginal productivities for each class of mixed feeds produced (King, p. 79). This price ratio, when incorporated in the demand equation for each feed type, is expected to have a negative effect. The demand for soymeal by compounders also depends on the consumption of other high-protein feeds used by feed manufacturers. As an outcome of the compound feed decision-making process, this factor should be incorporated in the demand function by including the price of other high-protein feeds relative to the price of soymeal. But because other protein meals are of secondary importance and because EEC policy actions have required feed manufacturers to include skim milk powder in rations, a "quantity" variable, including skim milk powder as well as other oilcakes and animal meals measured in soybean meal equivalents, is incorporated in the group of variables explaining the demand for soymeal by compounders. It is expected to have a negative impact on the quantity of soymeal consumed.

Using the above-mentioned factors and the theoretical framework, the demand equation for feedgrains and soymeal by compounders is specified as follows:

$$DSMC = f(\frac{PSM}{PCFG}, TOTQCOMP, OMSOYA), \text{ and} \tag{3.14}$$

$$DCFGC = f(\frac{PCFG}{PSM}, TOTQCOMP), \tag{3.15}$$

where DSMC = the quantity of soymeal consumed by compounders;

DCFGC = the quantity of feedgrains consumed by the mixed feed industry;

TOTQCOMP = the total production of compound feeds;

PSM = the price of soymeal;

PCFG = the aggregate price of feedgrains;

OMSOYA = the consumption of high-protein feed ingredients other than soymeal, in soymeal 46 percent equivalents.

3.2.3 Demand for Compound Feeds

Following earlier discussions on the inclusion of the mixed feed industry in a feed-livestock model, the demand for feed compounds is disaggregated into four large categories,[3] with the demand for each explained by an appropriate functional relationship. The breakdown is as follows:

1) dairy and beef cattle;
2) hogs;
3) broilers and other fowls; and
4) laying hens.

Despite the fact that there are differences between each livestock production process, the development and a thorough examination of Model I highlights the specification of the different demand functions for compound feeds. Depicted in Figure 3.1, this scheme displays a close complementarity between compound feeds and the livestock processes which is strengthened by the role played by contracting and vertical integration between feed companies, co-operatives and livestock producers. The livestock production process P_2 may be represented by the following production function:

$$Q_m = B \ LOA^{\gamma} \ QCOMP^{\theta} \ e^{\delta t} \qquad (3.16)$$

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[3] The aggregate sum of hogs, poultry and cattle compound feed production account for 90.7 percent of the total production of compound feeds during the 1972-1977 period.

where Q_m = the livestock production;

LOA = the livestock feeder population; and

t = a time trend.

Interpretation of the constant B is similar to the constant A incorporated in the compound feed production function (Equation 3.1), while the exponential trend captures the changes in feeding practices that have taken place in France during the last two decades. Assuming that the trend is an increasing function of time at a diminishing rate, the impact of changes in feeding practices on livestock production is expected to be more pronounced at the beginning of the time period than at the end. It implies that $0 < \delta < 1$.[4]

The overall optimization problem underlying Model I is a combination of two vertical decision-making processes P_1 and P_2 similar to those of a production plant model (Dano, pp. 149-150). The representative integrated firm co-ordinates these processes in the following manner: 1) it determines the quantity of livestock it wishes to produce based on the size of the breeding herd, expected livestock prices and expected feed prices; and 2) given this level of livestock pro-

[4] Incorporating the effect of technological change in equation (3.16) in such a manner means that changes in feeding practices are neutral with respect to labour and capital used in the livestock process. This is not true in the long-run where the capital/labour ratio in the French farm sector has changed since 1945. In fact, with the expansion of the demand for compound feeds, more capital and less labour are required to produce livestock products. As a result, the effects of technological progress should be specified in terms of labour savings. This approach has not been used for ease of convenience and studying it goes far beyond the purpose of this research.

duction, it calculates the quantity of compound feeds necessary to feed the animals and this quantity enters the feed manufacturers demand function for soymeal and feedgrains. In other words, decision process P_2 is initiated first, then P_1 follows.

Translated into mathematical terms, this problem consists of maximizing a profit function π given by

$$\text{Max } \pi = P_m Q_m - P_{qcomp} \text{QCOMP} - P_{loa} \text{LOA}, \tag{3.17}$$

Subject to

$$Q_M = B \text{ QCOMP}^{\theta} \text{ LOA}^{\gamma} e^{\delta t}, \text{ and}$$

$$\text{QCOMP} = A \text{ SOY}^{\alpha} \text{ CFG}^{\beta},$$

where P_m = the price of livestock output;

P_{loa} = the price of feeders.

Because the purpose of this model is aimed only at analyzing feed-livestock relationships and does not encompass all the different stages of the livestock industry, it is assumed that the livestock feeder population (LOA) is a fixed input. Optimum livestock production is attained when the first order conditions relative to (3.17) are solved, i.e., when the marginal value product of compound feed equals the price of compound feed:

$$\frac{\partial \pi}{\partial \text{QCOMP}} = \theta \text{ B QCOMP}^{\theta-1} \text{ LOA}^{\gamma} e^{\delta t} P_m = P_{qcomp} \tag{3.18}$$

With LOA held constant, the quantity of compound feeds required to produce Q_M units of livestock product is obtained by an inversion of equation (3.18):

$$QCOMP^* = \left(\frac{P_m}{P_{qcomp}}\right)^{\frac{1}{1-\theta}} (\theta\ B)^{\frac{1}{1-\theta}}\ LOA^{\frac{\gamma}{1-\theta}}\ e^{\frac{\delta t}{1-\theta}} \tag{3.19}$$

$QCOMP^*$ is the level of compound feed produced by the mixed feed industry. Then, through expressions (3.9) and (3.10), the commercial demand for soymeal and feedgrains are automatically determined. Several properties can be attributed to the demand function for compound feeds represented by equation (3.19). First, the demand for compound feed varies in the same direction as the price of livestock and the livestock feeder population

$$\frac{\partial QCOMP}{\partial P_m} > 0 \qquad \frac{\partial QCOMP}{\partial LOA} > 0 \tag{3.20}$$

Second, QCOMP is a decreasing function of the price of formula feed,

$$\frac{\partial QCOMP}{\partial P_{qcomp}} < 0 \tag{3.21}$$

Third, the effect of technological change on the demand for compound feeds is positive,

$$\frac{\partial QCOMP_t}{\partial t} > 0 \tag{3.22}$$

These conditions are fulfilled if and only if $0 < \theta < 1$. It should also be observed that incorporation of LOA as a fixed factor implies that the price of feeder livestock vanishes in the final specification of the demand for compound feed.

The four variables entering the right-hand side of expression (3.19) constitute the group of explanatory variables taken into consideration in specifying the demand for compound feeds in France. The variable "livestock feeder population", which is exogenous, is replaced by a proxy, the corresponding livestock production. This approach is adopted owing to the difficult task of collecting homogenous and reliable data on French livestock populations. Prices are incorporated in these demand relationships as price ratios and the effect of time on the demand for mixed feeds is analyzed using information accumulated on the diffusion process of formula feeds in the French feedstuffs market. The final section of this chapter is devoted to its evolution.

Given the above considerations, the demand for compound feed by broilers, laying hens and hogs are specified as follows:

$$\text{QCOMPLH} = f\left(\frac{\text{PLH}}{\text{PQLH}}, \text{ EGGS}, \text{ TIME}\right) \tag{3.23}$$

$$\text{QCOMPBR} = f\left(\frac{\text{PBR}}{\text{PQBR}}, \text{ QPLCW}, \text{ TIME}\right), \text{ and} \tag{3.24}$$

$$\text{QCOMPPK} = f\left(\frac{\text{PH}}{\text{PQPPK}}, \text{ QPKCW}, \text{ TIME}\right) \tag{3.25}$$

where QCOMPLH = the demand for compound feed for laying hens;

QCOMPBR = the demand for compound feed for broilers;

QCOMPPK = the demand for compound feed for hogs;

PLH = the price of eggs;

PBR = the price of poultry;

PH = the price of pork;

PQPPK = the price of compound feed for hogs;

PQBR = the price of compound feed for broilers;

PQLH = the price of compound feed for laying hens;

EGGS = the production of eggs;

QPLCW = the production of poultry;

QPKCW = the production of pork;

TIME = a linear time trend.

3.2.4 Demand for Compound Feed for Beef and Dairy Cattle

The demand for compound feed for beef and dairy cattle needs special treatment because its specification stems from Model II. Substitution between home-grown and compound feed must be considered when dealing with this class of livestock. In addition, the role played by forages and grazing in cattle feeding limits the development of the demand for compound feed for cattle. If a forage variable was included in the specification of the demand for cattle feed, we would expect a negative relationship between these two feedstuffs. This is well illustrated by the severe drought during the spring and summer of 1976 which caused a fall in the quantity of forage available and stimulated an increase in the consumption of feed concentrates for cattle. Because data on forages are unreliable, this influence is captured with a dummy variable which takes the value of 1 for any year characterized by significant climatic change and zero otherwise. In addition, livestock production is measured in cereal equivalents.

The demand for compound feed for beef and dairy cattle is

$$QCOMPBF = f(\frac{FPBF}{PQBF}, \; PRMLG, \; DUM, \; TIME) \qquad (3.26)$$

where QCOMPBF = the demand for compound feed for beef and dairy cattle;

PQBF = the price of compound feed for beef and dairy cattle;

PRMLG = aggregate dairy and beef production in cereal units;

FPBF = the aggregate price of milk and beef;

DUM = a dummy variable representing poor forage conditions.

3.2.5 Price of Compound Feeds

So far, the price of the intermediate product, compound feed, has not been included in the analysis of the optimum integrated firm's behaviour. In order to make the optima of processes P_1 and P_2 consistent with the overall optimum, a certain value should be given to the price of compound feed, P_{qcomp}. If the mixed feed industry produces at the most efficient point on the expansion path, the amount of compound feed to be produced is set where the price of compound feed is equal to the marginal cost of producing the compound feed. Thus, P_{qcomp} must equal the Lagrange multiplier λ which is the marginal cost in the cost minimization problem relative to process P_1. This condition can also be derived more formally by stating the overall conditions for maximizing the profit function π given by equation (3.17) with respect to soymeal and feedgrains. In doing this, the overall optima conditions satisfy the conditions for minimum cost in process P_1 and do not involve the need for an intermediate stage to estimate the demand for feedgrains and soymeal by compounders. Instead, both input demands are related directly to the price of livestock and livestock feeder population. In fact, this is the traditional approach employed in specifying the derived demand for feed ingredients.

To represent equilibrium in the compound feed sector, an additional mark-up equation is needed to relate the price of formula feeds to the price of the main factors of production in the mixed feed industry, namely, soymeal (P_{soy}), feedgrains (P_{cfg}), and wages (W) which represent fixed inputs. This relationship is given by

$$P_{qcomp} = a + b\,P_{soy} + c\,P_{cfg} + d\,W \qquad (3.27)$$

where $a, b, c, d > 0$.

The inclusion of this price equation is not at variance with the price behaviour of feed compounders. Foucault for France (pp. 83-84) and Longmire for England (p. 51) argue that feed compounders work on relatively low profit margins. In addition, the fact that until recently, feed manufacturers had to apply the directives for any rise in compound feed prices given by the French Ministry of Finance (see Section 2.6) also explains why prices will be closely related to costs.

The above discussion on the pricing of compound feed leads to the formulation of a similar equation for each of the four different types of feed:

$$PQPPK = f(PSM, PCFG, W), \tag{3.28}$$

$$PQBR = f(PSM, PCFG, W), \tag{3.29}$$

$$PQPLH = f(PSM, PCFG, W), \text{ and} \tag{3.30}$$

$$PQBF = f(PSM, PCFG, W). \tag{3.31}$$

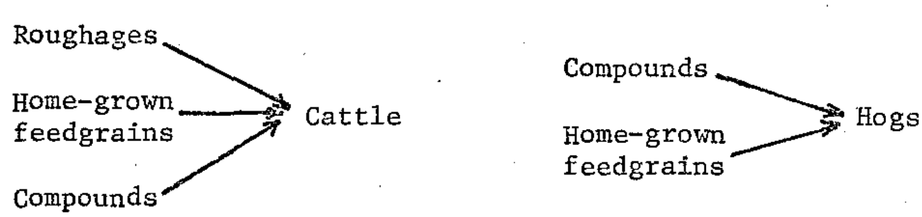
3.2.6 <u>On-Farm Demand for Feedgrains</u>

The on-farm demand for feedgrains is still important in France, occurring primarily in mixed farm operations which are described by Model II (Fig. 3.2). In addition to the general compulsory technical complementarity relationship inherent to the feed-livestock sector which is characterized by interchangeability, the fulfillment of the energy-protein requirement in feed rations takes place between feed compounds and home-grown feeds. Representative of Model II are two types of livestock operations.

First, dairy and beef cattle are raised using rations made up of roughages, home-grown feeds and straights which are purchased by farmers. In this latter category are included linseed, peanut and rapeseed meals and milling by-products which are very suitable to cattle (Foucault, p. 79). A strong seasonal pattern characterizes the cattle production process with feed compounds used more heavily in the fall and winter when the supply of roughages is short.

Second, a significant but declining fraction of the French pig population is still fed by home-grown feeds. These are generally small farms where rational production methods are not used and the typical feed ration employed comprises barley, milk by-products, potatoes and roots (Petit, 1968, p. 32). Farmers may also improve the efficiency of these rations by buying some commercial feed supplements.

In order to limit the number of substitution relationships, the following feed ingredients are assumed to enter feed rations for cattle and hogs:



The modeling of the on-farm consumption of feedgrains is done by merging the pork and cattle production processes. The underlying specification is based on the optimization of feed compound and livestock processes represented by Model II. The corresponding decision-making process is now more complex and cannot be analyzed in the same fashion as that of Model I. Even if the compound feed process P_1 remains identical, this is not the case for the livestock production process P_2 which is now described by a production function with more than one feed input. The most noticeable change is the modification in the degree of co-ordination between both processes. Although a very tenuous linkage might exist between P_1 and P_2 through some contracting, the livestock process is now independent of the compound feed process. Therefore, the task of solving the underlying optimization problem is facilitated by assuming the compound feed production function is homogenous of degree one which enables the determination of sub-optima in process P_1 and then in P_2, regardless of overall optimum conditions (Dano, p. 152).

The functional relationship proposed to explain the on-farm demand for feedgrains is presented below according to the revised optimization decision-making process defined above,

$$\text{DCFGF} = f\left(\frac{\text{PLIVG}}{\text{PCFG}},\ \text{QCOMPB},\ \text{TOTLIVWA}\right) \tag{3.32}$$

where DCFGF = the on-farm consumption of feedgrains;

PLIVG = the aggregate price of pork and beef;

TOTLIVWA = QPKCW + QBFCW and

QCOMPB = QCOMPPK + QCOMPBF.

As a result of aggregating the hog and cattle productions, TOTLIVWA is a "proxy" variable representing both herds and the impact of this variable is expected to be positive.[5]

The interrelationships between compound feed production and on-farm consumption of feedgrains should be assessed by an appropriate price variable in order to conform with the underlying optimization framework. This approach has not been adopted, because it was found that this interrelationship is better captured by a quantity variable consisting of the production of compound feeds for hogs and cattle. This could be interpreted as one of the effects of the continuous diffusion process of the feed compound sector on hog and beef producers. A negative impact on the on-farm consumption of feedgrains is expected.

The price ratio of meat products over the price of feedgrains is a profitability index which reflects the maximizing profit behaviour of farmers. If the price of feedgrains increases, farmers will tend to sell more grains and reduce their on-farm consumption. If the price of livestock products rises more rapidly than the price of grains, producers will keep their feedgrains for feeding livestock and will obtain better returns by selling livestock. Accordingly, the on-farm consumption of feedgrains and the price ratio $\frac{PLIVG}{PCFG}$ vary in the same

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[5] The effect of the dairy cattle herd on the on-farm consumption of feedgrains is partly taken into consideration by the aggregate variable TOTLIVWA. This is done by incorporating the production of meat obtained from dairy cows.

direction.

The on-farm and commercial demand for feedgrains are two components of the total demand for feedgrains fed to livestock. They have been incorporated in the French feed livestock model and specified indirectly as an outgrowth of the role of the compound feed sector. In so doing, supply conditions and stock flows were not considered, and this might constitute a shortcoming of the model. Nonetheless, in order to keep the model of reasonable size, consideration of the feedgrain sector is limited to the demand equations specified above.

3.2.7 The On-Farm Demand for Soymeal

There is little data concerning on-farm use of soymeal by animal class in France.[6] Some information, though, is scattered in various French references, suggesting the need to consider farm demand for soymeal. Some relevant facts are:

i) According to the French Compound Feed Association, the on-farm consumption of soymeal which was constant for many years, increased rapidly in the last two years (see Section 2.2.1.4).

ii) One hint on the direct consumption of soymeal by farmers is provided by Foucault (pp. 166-167) who notes that in Britany, the main French livestock area, 15 percent of livestock producers in 1971 prepared their own feed ration. The livestock production concerned is mainly pork.

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[6] Problems encountered in the collection of these data are presented in Appendix III.

Although this information is limited, it indicates the existence of livestock producers who do not purchase their feed from the mixed feed industry.

iii) The impact of the drought occurring in 1976-1977 has induced a higher consumption of soymeal by cattle. This has been effective for 1976-1977 and, as a result of a habit effect and cheap prices, we might find that these farmers continue to buy soymeal in 1977-1978.

Given this information, we can postulate a theoretical decision model of the French animal feed livestock industry characterized by two production processes, compound feed and livestock, in which farmers have two alternate choices: i) to prepare home mixes at a least cost and on a technically efficient basis, or ii) to buy compound feeds directly. Depicted in Figure 3.3, Model III can be presented in a mathematical form similar to, but more complicated, than Model I's formulation. In fact, these mathematical relationships have to encompass the perfect substitutability which can occur between formula feed provided by feed companies and balanced feed rations prepared by farmers. For this latter "feed product", soymeal and feedgrains are the main suppliers of protein and energy which can be directly produced on the farm or purchased by farmers. In this third model, it is assumed that the livestock producer's decision process can be approximated by a hog producer who is willing to produce an efficient balanced feed ration for his livestock herd at the least cost. This behaviour is, to a certain extent, similar to the strategy adopted by feed manufacturers and described in Section 2.3.2. This type of farmer must be located at the most efficient point on the expansion point.

The following functional relationship is proposed to explain the demand for soymeal used directly by farmers,

$$DSMF = f(\frac{PSM}{PQPPK}, \frac{PCFG}{PQPPK}, TOTLIVWA, PLIVG) \tag{3.33}$$

where DSMF = the demand for soymeal directly used by the farmers;

PSM = the price of soymeal;

PQPPK = the price of compound feed for hogs;

PCFG = the price of feedgrains;

TOTLIVWA = QPKCW + QBFCW; and

PLIVG = the aggregate price of beef and pork.

As a result of the formulation of the decision process underlying Model III, the decision variable farmers use is a price ratio of the feed ration price when prepared by farmers over the price of compound feed for hogs. The former is a composite price of feed ingredients which must equal the shadow price attached to the home mix constraint. As indications on the composition of farm feed rations are non-existent in France, two proxy variables, $\frac{PSM}{PQPPK}$ and $\frac{PCFG}{PQPPK}$, are included to represent this composite price ratio. To meet nutritional requirements in feed mixes prepared by farmers, a compulsory technical complementarity must take place between soymeal and feedgrains. Accordingly, the two proxy variables, when incorporated in equation (3.25) will move in the opposite direction of the dependent variable.

To complete the analytical description of the optimization process, a profitability index approximated by the aggregate price of beef and pork is included in the demand specification. The higher the price of livestock products, the more soymeal consumed by farmers. As the production of beef and pork increases, there is a greater need for feed inputs.

As stated earlier, the consumption of soymeal has increased tremendously during the last two years. While it is almost, if not, impossible to explain precisely the origin of this increase, this phenomenon has caused a "structural change" in the consumption pattern of soymeal in France. Subsequently, the soymeal conversion ratio has changed and reached a new level represented by A_1 in Figure 3.4. This new value is still not definitive and may be subject to variation in the future. In expression (3.33), the soymeal conversion ratio is proxied by the coefficient attached to the variable (TOTLIVWA). To handle the structural shift, this parameter has been allowed to vary over the 1975-1978 period. The procedure employed to handle this problem is taken from a study dealing with structural shift with an inter-structural transition function. In analyzing the Canadian imports of U.S.-produced automobiles, Wilton examined the structural shift which characterized this economic variable. In doing so, he uses several Almon polynomials both with and without ending point constraints applied to some coefficients of the specified functional relationship. The procedure employed in estimating equation (3.33) is developed at length

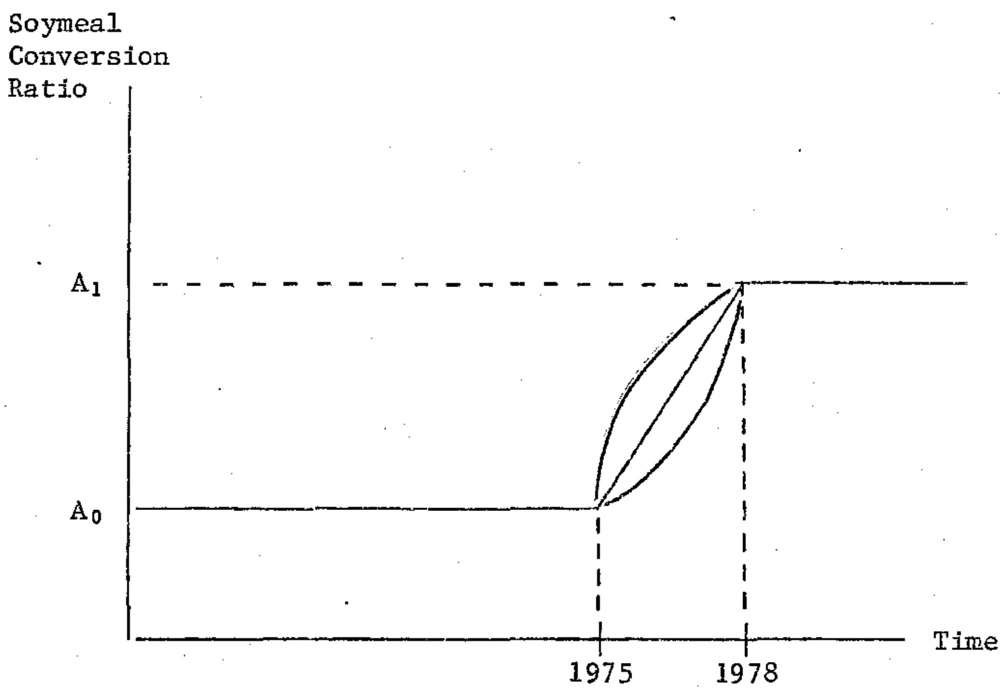

FIGURE 3.4. Evolution of the soymeal conversion ratio at the farm level

in Chapter V.

3.3 Technological Change and the Demand for Compound Feeds

This section explains a quantitative procedure suitable for measuring the diffusion of formula feeds in France and the effect of technological change on the production and demand for compound feeds. For this purpose, a short review of earlier work dealing with these problems precedes the quantitative approach which is proposed for incorporation in the econometric analysis of the demand for soymeal in France.

3.3.1 Review of Literature

Despite a long expansion period, the development of the compound feed market in France can be regarded as studying the marketing of a new product and its chances of success or failure.

Viewed as either an adoption or diffusion process, the marketing of a new product is usually analyzed by adoption or diffusion models. These were defined by Raj et al. (1978, p. 1) as follows:

> "Diffusion models involve postulation of a few macroparameters to locate a growth curve of sales to adopters of a new product through time. These macroparameters may or may not have a behavioural content.
>
> Adoption models, on the other hand, are rich in behavioural content and involve the mental process through which the individual moves towards the trial and use of a new product."

It is the diffusion model which is used in the explanation of the growth process of the French compound feed industry. Among diffusion models, the most appealing and popular one is the S-shaped curve model which is very often approximated by a logistic function.[7] Empirical studies based on the use of this latter method may be grouped as follows.

First, a category which emphasizes the description of the growth process to be studied and the ways to approximate it by statistical tools. By using an S-shaped curve, one can detect several phases in the growth process. The typical study of this type is the one undertaken by Kuznetz on long and medium economic cycles and their interaction. Of specific interest for this study is research dealing with the effect of technological change on the consumption of new products, thereby inducing substitution between commodities. A typical example is the replacement of certain products by synthetics (Polasek *et al*; Behrman).

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[7] The above-mentioned authors surveyed the different procedures underlying the diffusion model and classified them into four categories. In addition to the S-shaped curve model, they note:

i) the concave models which suggest that new products follow an exponential growth to some asymptote;

ii) the epidemiological model which is modelled after biological diffusion processes such as the spread of epidemics;

iii) the reliability engineering model which postulates that every potential buyer of the new product receives various stimuli whose arrival time is given by an identical Gamma distribution.

A second category, although descriptive, seeks to discover factors explaining the innovation process. Mansfield carried out several studies where he explained the rate of diffusion of new techniques in terms of profitability potentialities (Mansfield, 1968, pp. 99-103; 1977, pp. 108-125). With the aid of cross-section data, Griliches (1957, pp. 28-37) analyzed the effects of innovation on the development of hybrid corn in the U.S. by testing economic variables as explanatory factors of this process. Moreover, in an application of a "learning by doing" theory proposed by Arrow in the early sixties, Kislev developed a theory of innovations in which experience, skills and knowledge of farmers were the forces that accelerate the diffusion process of new techniques in the agricultural sector.

It is acknowledged that both economic and sociological variables are closely interrelated in the adoption of innovations in agriculture (Petit, 1973, p. 295). In a direct application of the S-shaped model, rural sociologists found that in the course of adopting innovations, farmers might be sorted into five groups ranging from innovators to laggards. Assuming a normal distribution of the diffusion process, Figure 3.5 describes the ranking of these five groups over time. Studies conducted by rural sociologists also indicate that there are important differences among these five categories with regard to attitudes, values, social status, group membership and farm business considerations (Mansfield, 1968, p. 127).

The diffusion process of the French compound feed industry is subject to these above considerations. In-depth studies of the French

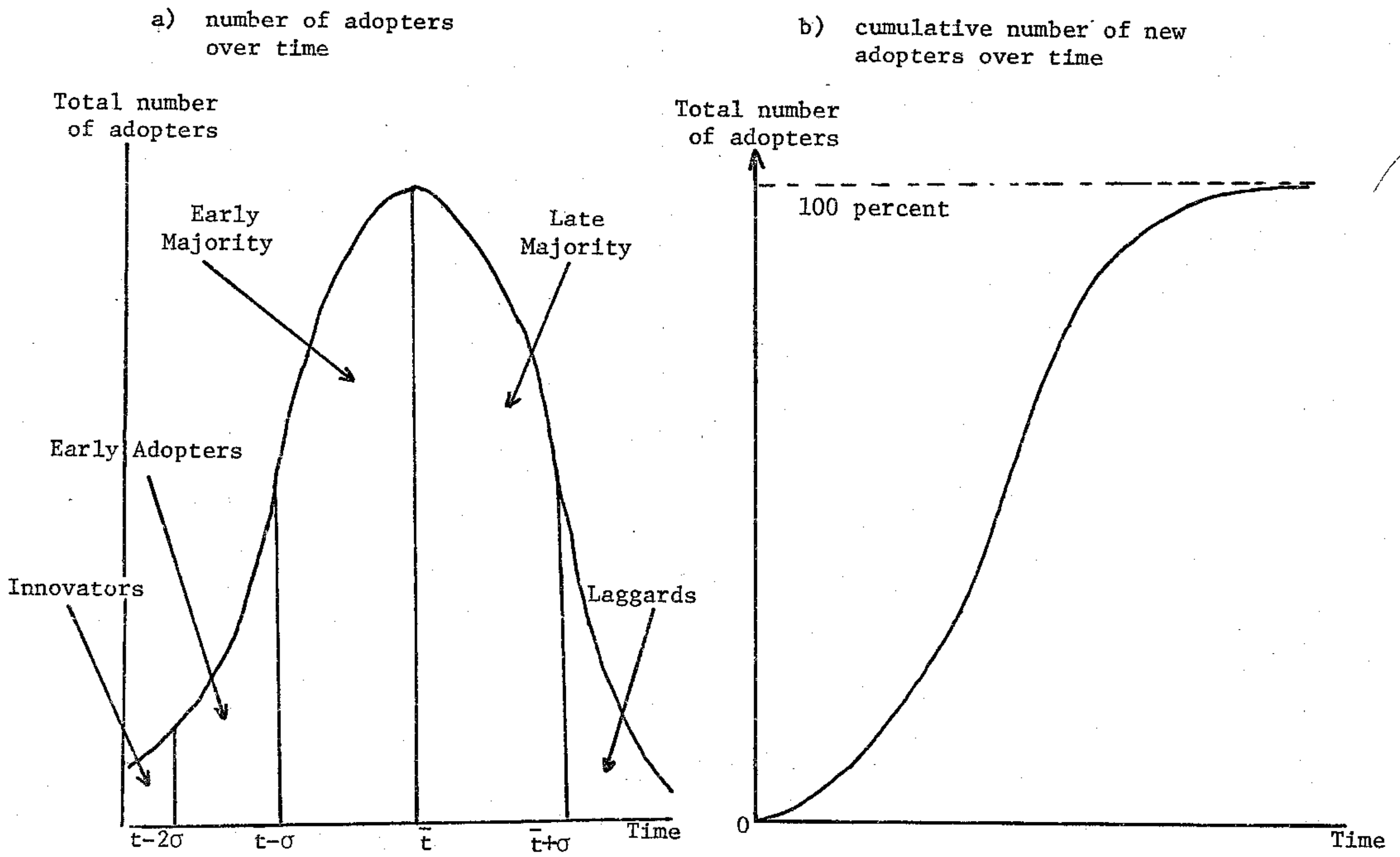

Figure 3.5: Normal distribution model of the diffusion process.

Source: Raj _et al_. (1978).

hog and poultry sectors resting upon a microeconomic approach or an adaptive behaviour model similar to the one applied by Petit on a sample of farmers display the factors which might explain the so-called industrialization of the livestock and poultry sectors. It should be borne in mind that family situation and long-term objectives of the French farmer, combined with management experience, might constitute the main elements which favour the adoption of compound feeds by French livestock producers.[8] Further research in this area goes beyond the purposes of this paper.

3.3.2 Measurement of the Penetration of the Compound Feed Sector in the French Animal Feed Market

The S-shaped curve and its approximation by a logistic function are appropriate tools to explain the rapid growth of the French feed manufacturing industry. The evolution of the production of different compound feeds, or rather the penetration rates of the French animal feed market by feed compounds, can be represented by the following mathematical expression,

$$QCOMP_t = \frac{QCOMP^*_t}{1 + e^{-(a + bt)}} \qquad (3.34)$$

where $QCOMP_t$ = the production (or penetration rate) of the compound feed in year t; and

t = a linear time trend.

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[8] These factors which are of long-term nature have been found by Petit (1973, pp. 311-312).

According to Griliches (1957, p. 504), the three parameters ($QCOMP^*_t$, b and a) are interpreted, respectively, as the ceiling or equilibrium rate, the rate of growth coefficient or acceptance rate, and the constant of integration which positions the curve on the time scale.

If a logistic trend representing technological change is included in one of the functional demand relationships for compound feeds (equations 3.23, 3.24, 3.25 and 3.26), no room is left for the "economic variables" to explain any variation in the demand for compound feeds. This is partly due to the fact that the data representing the quantity of compound feeds demanded includes a strong trend resulting in high multicollinearity between the time trend and livestock production.

In addition to these econometric and statistical problems, the inclusion of a logistic trend as a straight explanatory variable in the demand equation for formula feed is not theoretically satisfactory. In the initial specification given by expression (3.19), the increasing use of formula feeds by farmers is captured by shifting the derived demand curve by a given amount each year. But, in reality, the adoption of new technology likely affects the demand equation for formula feeds in three ways: (1) as more and more farmers use formula feed, the quantity of formula feed used per kilo of animal production will approach the average feed conversion ratio, i.e., if each demand equation for formula feed has a linear form, the parameter attached to the live-stock production variable will vary depending on the degree of market penetration; (2) the price of formula feed may fall relative to livestock prices resulting in more demand for formula feed; and (3) the introduction of formula feeds may change the associated livestock production function (expression 3.16) which will be reflected by changes in livestock production.

The specification of the demand for formula feeds should incorporate all three of these influences. It is clear that the introduction of formula feed has had no great impact on the input/output price ratio, while changes in the livestock production function are reflected by changes in livestock output. Hence, the major issue is how to accommodate the varying impact of livestock production changes on the demand for formula feed.

To solve this question, it is of primary importance to know what pattern the "efficiency response" coefficient associated with the variable livestock production (coefficient B_t in equation 3.35) follows during the transition period from where very few farmers use formula feed to a situation where nearly all farmers are using formula feed. Let us assume the adoption of formula feed follows a normal diffusion process as depicted in Figure 3.5. It can be seen that the penetration ratio follows an S-shaped curve and coincides with the curve drawn in Figure 3.5b. This is, in turn, reflected by a varying feed compound conversion ratio which evolves according to an S-shaped curve represented in Figure 3.6. At the beginning of the transition period, the number of farmers having adopted the new feed input is small and its use related to livestock production is similarly small at B_0. After complete adoption of formula feeds, the relationship between feed

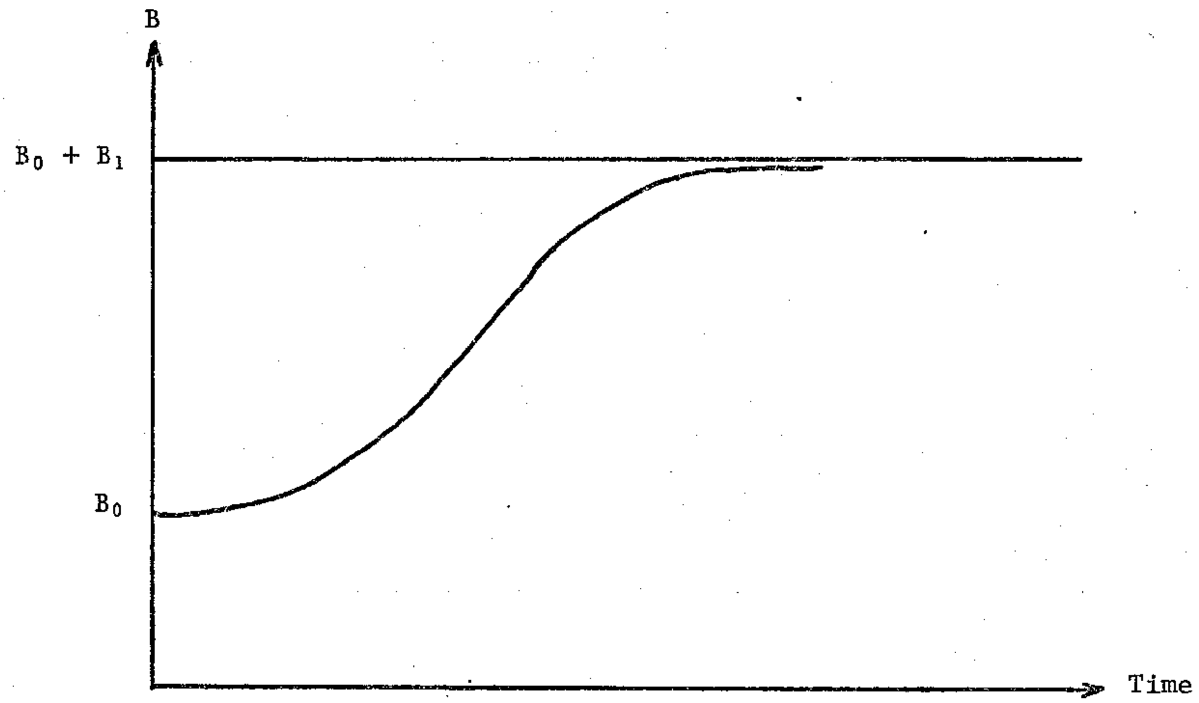

FIGURE 3.6. Expected evolution of the feed compound conversion ratio

inputs and livestock output is much higher at $B_0 + B_1$ and this number should reflect the average feed conversion ratio if market penetration has been complete.

If the demand for compound feed equations have a linear form, then the transition growth process of the compound feed industry during the last two or three decades is depicted by the two expressions below:

$$QCOMP_t = A + B_t Q_{mt} + C \frac{P_{mt}}{P_{qcomp_t}} \tag{3.35}$$

$$B_t = B_0 + \frac{B_1}{1 + e^{-(B_2 + B_3 \, TIME)}} \tag{3.36}$$

where $QCOMP_t$, P_{mt} and P_{qcomp_t} = have the same nomenclature as in expression (3.19);

Q_m = denotes the corresponding livestock production;

TIME = a linear time trend;

B_0 , B_1 , B_2 , B_3 = parameters to be estimated and expected to be positive.

Expression (3.36) shows that the varying efficiency response coefficient B_t captures the expected evolution of the compound feed conversion ratio described by Figure 3.6. The logistic part of this equation gives the approximate S-shape curve depicted in Figure 3.6. The parameter B_t also has upper and lower bounds; when the time variable tends to zero, $B_t \rightarrow B_0$; and when TIME $\rightarrow \infty$, B_t moves toward an asymptote $B_0 + B_1$.[9]

Several interesting interpretations of the parameters defining the logistic pattern can be drawn:

i) when the TIME variable tends to $+\infty$, the asymptote $(B_0 + B_1)$ which is the "ceiling" in Griliches' terms, is roughly equivalent to the quantity of formula feed needed to produce another unit of livestock product;

ii) parameters B_2 and B_3 have the same interpretation as a and b in equation (3.34);

iii) the penetration effect in year t is given by the ratio

$$X_t = \frac{1}{1 + e^{-(B_2 + B_3 \ \mathrm{TIME})}} \tag{3.37}$$

which approaches 1.0 as time $\to +\infty$, and which shows that the penetration ratio is linked to B_t according to equation (3.39).

$$B_t = B_0 + B_1 \ X_t \tag{3.38}$$

It should be noted that due to the existence of on-farm feed resources, the penetration rate expressed by equation (3.37) may reach, for some classes of livestock, an upper limit lower than one.

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[9] Because equations (3.35) and (3.36) are a particular case of a time varying parameter model, the reader must be aware that coefficients, B_0 and B_1 when they are estimated, will be mean values and differ from the values contained in Figure 3.6. For the sake of exposition, the above specification is used throughout this chapter.

iv) In relation to the logistic growth process, the stages of growth occurring during the expansion of the compound French feed sector mentioned earlier can be identified and assessed. This valuable information is provided by the parameter B_3. In fact, considering the mathematical properties of the logistic curve, the slope of rate of change of the penetration ratio X_t at any point of time is given by the relation

$$\frac{dX_t}{dt} = B_3 \ X_t \ (1 - X_t) \tag{3.39}$$

Thus, the slope is proportional to the distance of the point concerned from the lower and upper asymptotes (Ashton, p. 17). If X_t is plotted against $\frac{dX_t}{dt}$, the result is a parabola which represents the rate of change of the penetration ratio to the penetration ratio itself (Fig. 3.7).

It can be seen that the area under the curve is given by

$$\int_0^1 B_3 \ X_t \ (1 - X_t) \ dX_t = \frac{B_3}{6} \tag{3.40}$$

Since X_t ranges from 0 to 1, this quantity represents the <u>average growth rate of the penetration ratio</u>. The reciprocal of this quantity, $\frac{6}{B_3}$, is a rough indicator of the time required for the major part of the growth process to be completed. Hence, given the symmetry of the logistic curve, it is possible to define and evaluate the

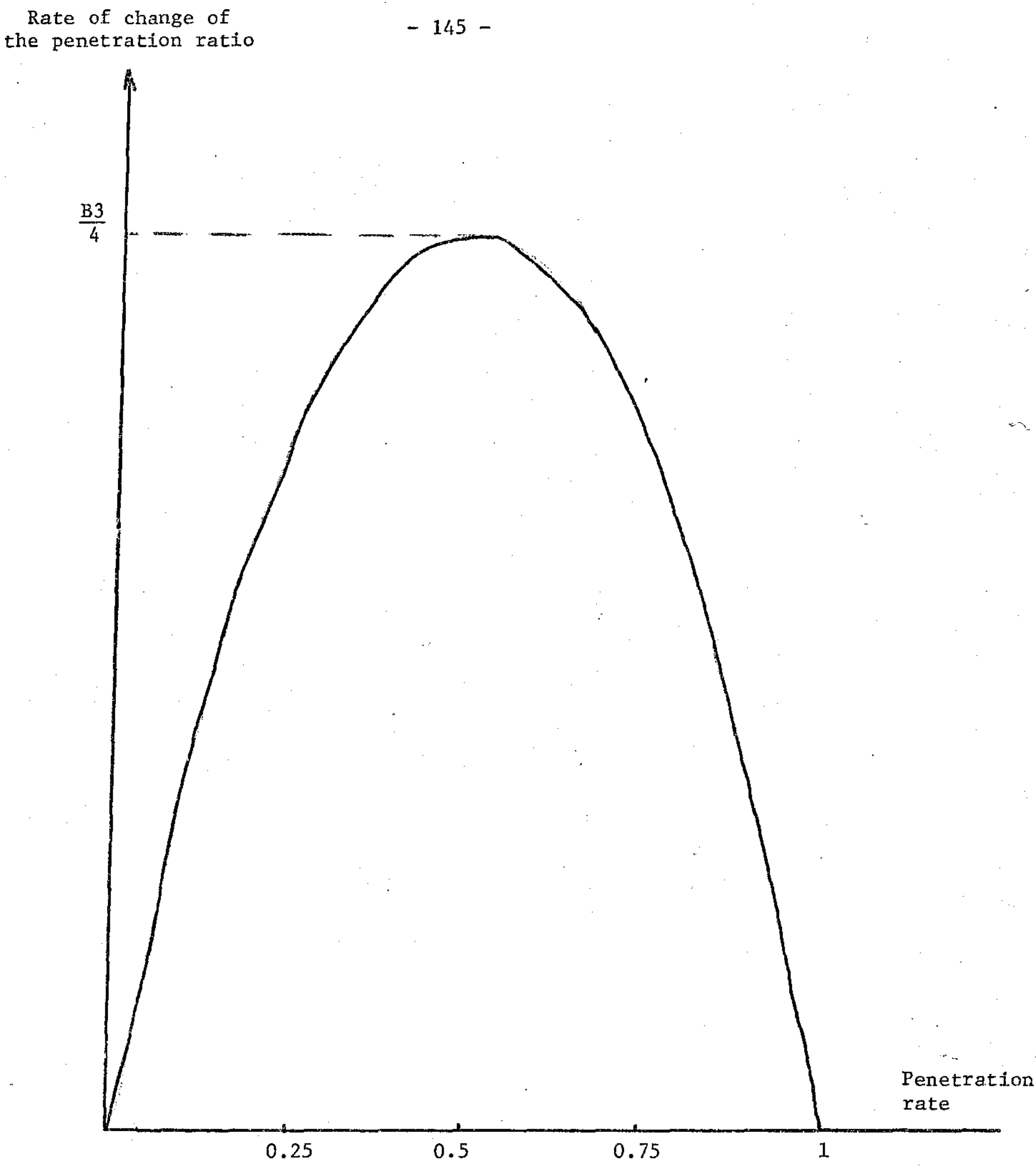

Figure 3.7: Relation between the rate of change of the penetration rate and the penetration rate itself.

Source: Adapted from Ashton (p. 18).

different periods of growth experienced by the French compound feed sector in the last three decades according to a normal diffusion process described by Figure 3.5.

v) The elasticity of compound feed produced with respect to livestock production is given by

$$E_{gy} = B_t \frac{Q_{mt}}{QCOMP_t} \tag{3.41}$$

which should tend to one as the time variable $\rightarrow \infty$. Underlying this is the idea that as long as the penetration effect is not total, the rate of growth of demand for compound feeds will be higher than the rate of growth of livestock production. It provides a quantitative evaluation of changes in feeding which evolve over time.

vi) It is worth noting that the ceiling $(B_0 + B_1)$ may also vary over time in relation to the improvement of feeding rations, a better selection of breeding animals and the degree of response of French farmers to technical innovations. In fact, $(B_0 + B_1)$ may be a decreasing function of time, thereby reflecting higher technical efficiency of livestock producers. If a linear decreasing trend is assumed for most classes of animals as suggested by Foucault (pp. 87-89), the coefficient B_t will undergo some modifications which are described by Figure 3.8 and expression (3.42)

$$B_t = B_0 + \frac{B_{10} - B_{11}\ TIME}{1 + e^{-(B_2 + B_3\ TIME)}} \tag{3.42}$$

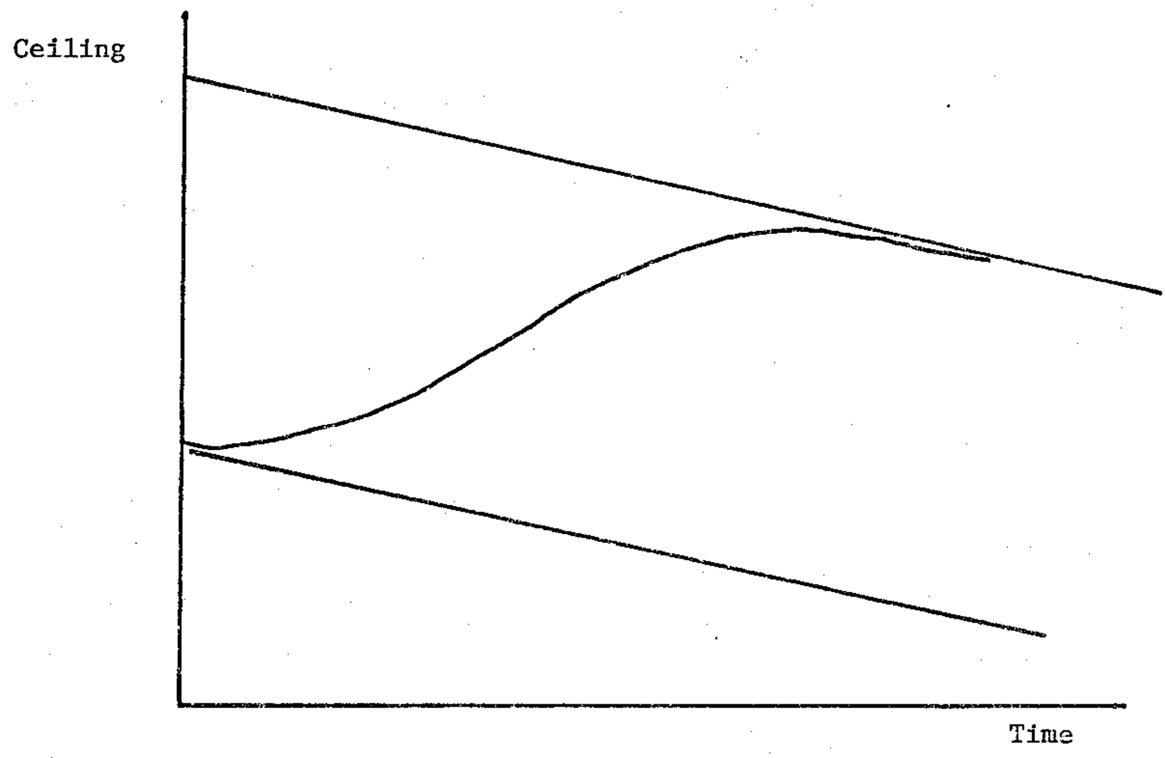

Figure 3.8: Expected evolution of the compound feed conversion ratio with a moving ceiling

Consequently, the elasticity of the demand for compound feed with respect to livestock production must be revised and evaluated with this new formulation of B_t.

The incorporation of a logistic time trend in explaining the evolution of the demand for compound feed yields a final specification of the demand for compound feed which is non-linear with respect to the livestock production and time variables. The following functional relationship is tested for broilers, laying hens, hogs and beef.

$$QCOMP_t = A + B_0 Q_{mt} + \frac{B_1 Q_{mt}}{1 + e^{-(B_2 + B_3 \text{ TIME})}} + C \frac{P_{mt}}{P_{qcomp_t}} \tag{3.43}$$

The alternative form represented by expression (3.42) is also tested for some feed types.

3.4 Summary

In order to assess the interrelationships existing between the French soymeal market and the other segments of the French feed-livestock sector, an aggregate theoretical model of the industry has been presented in this chapter. This framework differs from the standard feed-livestock models generally used in that an intermediate industry, the mixed feed industry, has been included and modeled. Consequently, linkages between the compound feed, the livestock and the feed ingredients market have been represented by appropriate functional relationships derived from a two-stage process model of livestock production. This model has also been designed to embody all the various livestock systems existing in France. In the factor market, the total feed input demand has been divided into two components: the demand by compounders and the on-farm demand.

Finally, an approach has been developed to deal with the problem of the penetration of compound feeds in the animal feed market and to incorporate this factor in the demand equations for compound feeds.

CHAPTER IV

A THEORETICAL FRAMEWORK FOR THE FRENCH SOYBEAN COMPLEX

4.1 Introduction

As noted earlier, the econometric model which is proposed to represent the French soybean complex is based on the framework developed by Houck and applied by Paarlberg to West Germany. Appropriate relationships representing the underlying market forces in the French soybean sector are specified for each market, namely beans, soyoil and soymeal. To specify these equations, each market is considered in turn. To make the understanding of this chapter more convenient for readers, the variables which make up the model are summarized in Table 4.1.

It should be kept in mind that the components of the soymeal market that are analyzed here are the supply side and the soymeal price determination process; the different soymeal demand schedules having been fully studied previously in connection with the modeling of the French feed-livestock industry.

4.2 General Representation of the French Soybean Market

The French soybean economy is dominated by the soymeal sector. Figure 4.1 provides a visual picture of the unbalanced French soybean complex where the figures in brackets represent the 1977 commodity

TABLE 4.1. Structure of the French soybean model

Endogenous Variables	Exogenous Variables
Crush Sector	
Crush demand	Peanut and rapeseed margins
Soybean margin	French solvent crushing capacity
	Price of soybeans
	Price of soybean oil
Soybean Oil Sector	
Production of soybean oil	Real price of soybean oil
Domestic demand for soybean oil	Real price of peanut oil
Domestic demand for peanut oil	Real price of rapeseed oil
Domestic demand for rapeseed oil	Real price of sunflower oil
Domestic demand for sunflower oil	Real disposable income
	Dummy variables
Foreign trade balance for soy oil	Domestic demand for peanut oil lagged one year
Soymeal	
Supply of soymeal	World price of other high-protein meals
Export supply of soymeal by the Rest of the World to France	World crushing capacity excluding France
Domestic demand for soymeal by compounders	World harvest of soybeans in the past period
Domestic demand for soymeal by farmers	Effective livestock numbers in the world except France
Domestic demand for soymeal	Price of feedgrains
World price of soymeal	Quantity of high protein commodities other than soymeal consumed in France
	Production of pork
	Production of beef
	Total compound feed demand*
	Price of compound feed for pork*
	Compound feed demand for dairy and beef cattle*
	Compound feed demand for hogs

* The variables with a star superscript are explanatory variables which are endogenized when the soymeal block is connected to the French feed-livestock model described in the previous chapter.

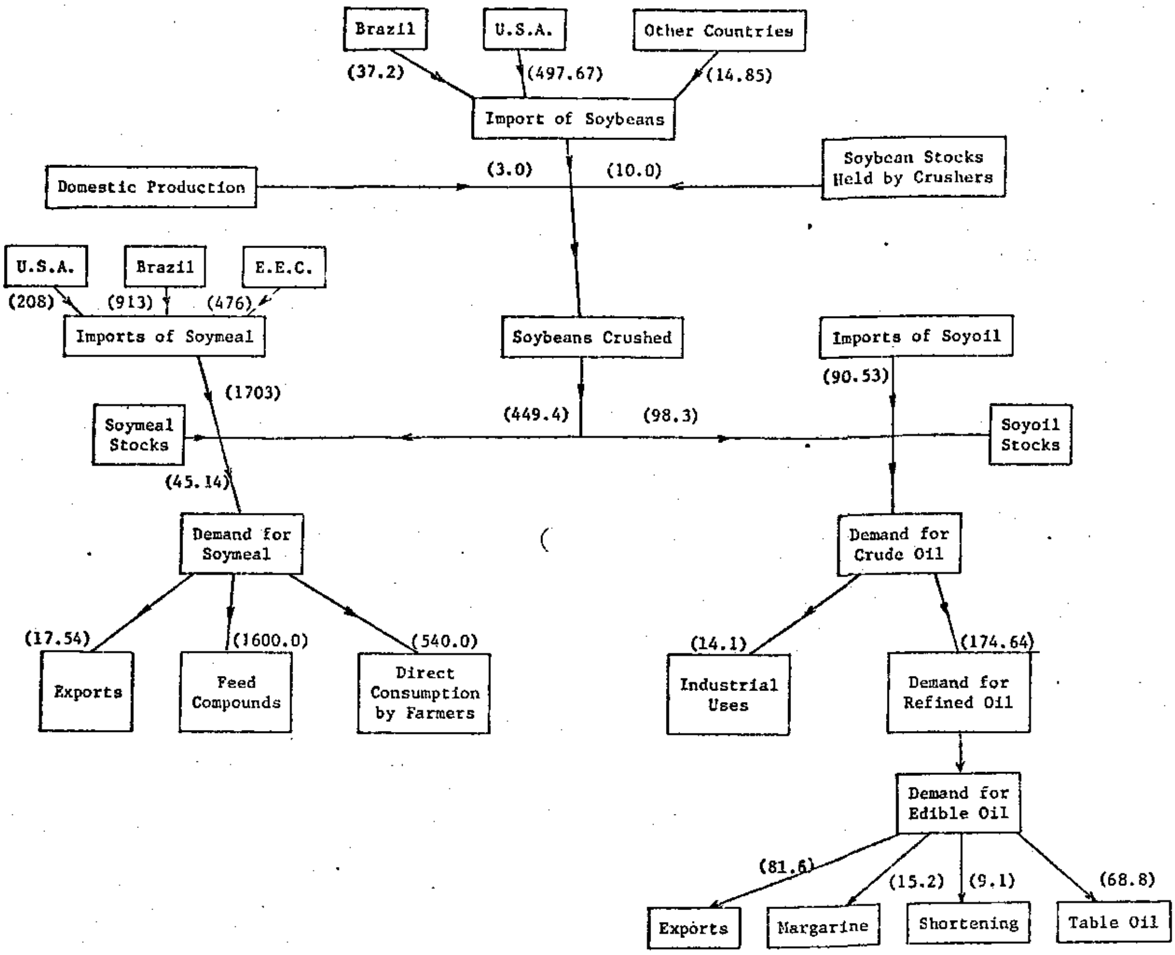

FIGURE 4.1. The structure of the French soybean complex with 1977 commodity flows.

Note: The statistics within brackets correspond to the various supply, demand and stock data collected in 1977 by several French public and professional organizations. The statistical figures referring to stock quantities are stock variation flows. Soybean stocks held by crushers have been obtained by deduction of (imports of soybean + soybean production) minus soybeans crushed.

Source: Charles Roberts, Tourteaux et autres matières riches en protéines (1977), yearly issues, Paris.

SCEES.

Syndicat general des fabricants des huiles et tourteaux de France.

flows (demand, supply, stocks) of soybeans and soybean products. Although expanding steadily in recent years, the market for soy protein for human food is still small and is ignored in the theoretical framework.

The identification and specification of each market within the soybean sector is straightforward. The three related markets, crush oil and meal, are identified and tied by a joint-product relationship based on fixed technical coefficients between beans, meal and oil. Despite the possible occurrence of variation in this functional expression, it is assumed that the average oil and meal yields applicable to France are not subject to large year to year changes.[1]

The linkages between the French and world soybean economies are depicted in Figure 4.2. It should be noted that for the sake of convenience, transportation costs and exchange rates are excluded in these diagrams. France is a net importer of soybeans and soybean products on the world market. No Community policy regulations, except an ad valorem tariff on soybean oil, hampers free trade which seems to prevail in the world soybean economy.[2] French imports of soybeans for crush and soyoil are very small compared to the world volume traded. Consequently, France is considered a "small country" for these

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[1] Numerous factors influence the variation of oil and meal yields (see data appendix). Due to averaging and aggregation, yearly data do not display this variability. The only way to solve this problem is to study the seasonal patterns of soybean crushing as Heady and Griffin did for the United States.

[2] Despite elements which suggest the possibility of imperfect market conditions, McCalla noted that "the 'country' concentration in trade appears to be negated by the participation of relatively large numbers of private traders" (p. 29) and hence concludes that a competitive price formulation is more likely to occur.

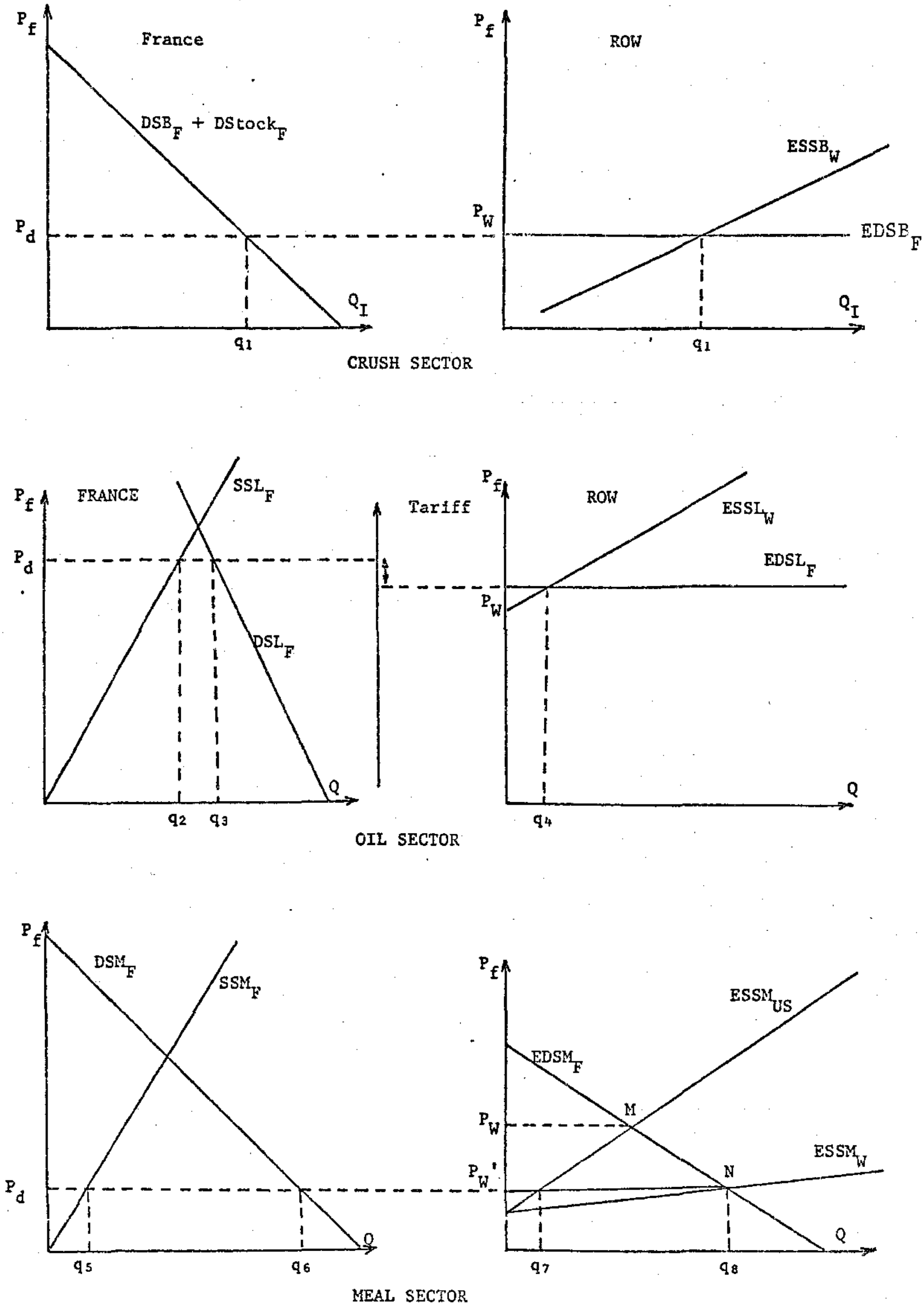

FIGURE 4.2. Graphical representation of the French soybean sector

commodities and is thus a price taker. On the other hand, despite the existence of a significant domestic supply, imports of soymeal to France are quite large and represent an important portion of world soymeal imports and the small country assumption is likely invalid. Hence, French domestic and world soymeal prices are simultaneously determined in the model. As a result, the price determining mechanism underlying Figure 4.2 is explained for each market as follows:

<u>Crush Sector</u>: The French demand for soybeans (DSB_F) is the aggregate quantity of beans used by each French crusher and the variation in stocks (Δ $stock_F$). Because the domestic supply of soybeans is very small, DSB_F is also an import demand function ($EDSB_F$) which is perfectly elastic with respect to the world market, assuming that France is a price taker. The intersection of $EDSB_F$ with the excess supply curve ($ESSB_W$) by the rest of the world to France, obtained after having deducted all the domestic demand schedules of soybean exporters and excess demand schedules of all other importers, determines the quantity of soybeans (q_1) imported by France and thus, the French demand for crushing.

<u>Soybean Oil Sector</u>: The same price determining mechanism as used in the bean sector is applied to the soyoil market. Due to the existence of a domestic supply of soyoil, derived from the crushing of soybeans, the import demand ($EDSL_F$) by France is a reduced form, equal to the difference between French domestic demand and supply for soybean oil. A situation close to the domestic equilibrium has been

drawn, reflecting the very small deficit in the French soyoil balance of trade.[3] Finally, it is observed that the domestic price of soyoil is equal to the world price, plus an ad valorem tariff imposed by the EEC.

Soymeal Sector: Since France is one of the largest importers of soymeal, its demand for soymeal is large enough to influence the world market price. The import demand for soymeal, which is obtained after the deduction of the domestic supply from the domestic demand schedule, is a decreasing function of world prices. It meets two excess supply curves $ESSM_{US}$ and $ESSM_W$, the former being the volume of exports provided by the U.S. and the other EEC countries such as Belgium and Holland to France, the latter representing the aggregate sum of $ESSM_{US}$ and the volume of Brazilian exports of soymeal to France. This breakdown in the excess supply curve is necessary in order to show the recent and rapidly growing influence of Brazil in the world soymeal market. Prior to 1976, the French soymeal market was essentially supplied by the U.S. and the world price was determined by the intersection of $ESSM_{US}$ and $EDSM_F$ at point M. Since 1976, through an export policy which favours the shipment of processed soybean products and a better quality of soymeal,[4] Brazil has increased enormously its meal

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[3] From 1967 to 1977, France has always been a net importer of soyoil, except for 1972 and 1973, where the trade balance was positive. From 1974 to 1977, the average trade deficit has been 8948.5 metric tons.

[4] See Section 2.2.

export share in France. Accordingly, a large supply of soymeal has been available and has caused a downward shift of the world excess supply curve. The direct outcome of this change has been the establishment of a new equilibrium at point N and a new lower world and domestic soymeal price (P'_W). The volume of French imports at this point is equal to Oq_8, with the Brazilian share q_7q_8, and the U.S. share Oq_7.

The situation which is described in the diagrams in Figure 4.2 do not necessarily correspond to the actual conditions which prevail in the world soymeal market. After the 1973 price increases, the world soymeal price did not decrease drastically with the emergence of Brazilian soybean production. In fact, a higher world demand for soymeal, illustrated by the steady and continuous consumption of meal in France and other countries has offset the new sources of supply. Fluctuations in exchange rates and uncertainties in the Brazilian soybean crop are additional factors contributing to the variation in the world soybean price. To represent such changes on the meal diagrams, assume that a shift in $EDSM_F$ is caused by increased livestock output. This then results in a new excess demand schedule which meets $ESSM_W$ at point O, which is located above point N. It yields a new world and domestic soymeal price and an increase in imports (Fig. 4.3).

The above discussion of the French soybean economy leads to a special structure for the French soybean model. The "small country" assumption implies that prices are exogenous to the system. The result is that the soybean and oil markets can be analyzed separately from

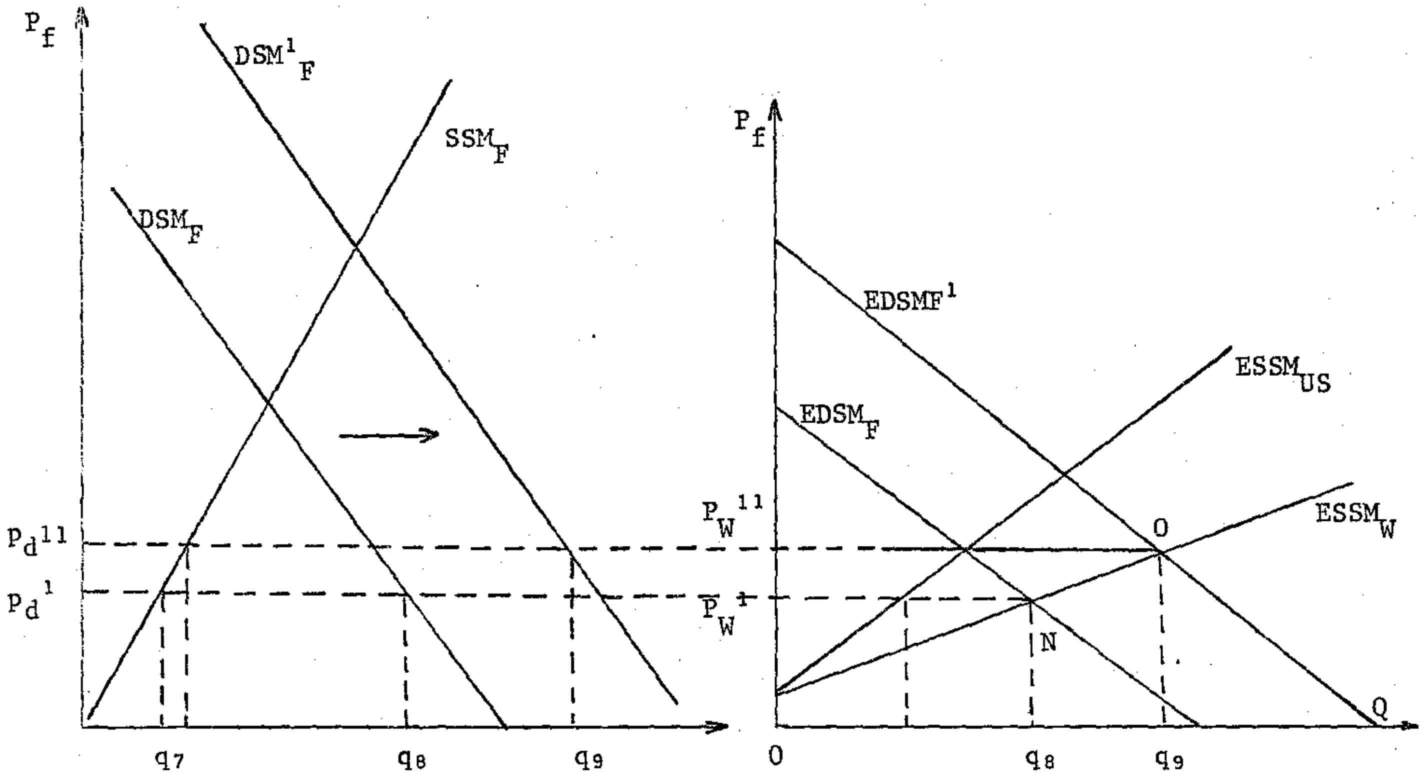

FIGURE 4.3. Actual graphical representation of the French soymeal sector.

the meal sector. Three different blocks within the French soybean model are thus created. However, in relation to the French feed-livestock model developed in Chapter III, it should be noted that the splitting of the demand for soymeal into two components, demand by compounders and a farm demand, implies a complex functional relationship in the French soymeal sector.

4.3 The Crush Sector

Soybean, meal and oil prices, plus crushing capacity, are the usual variables used to explain the demand for soybeans to be crushed. Because France is a "small country" relative to the world soybean market, only one behavioural equation is needed to represent the French soybean crush sector. The specification is

$$CRSOG = f(MSB,\ MORP,\ CRSOCAA), \text{ when} \tag{4.1}$$

$$MSB = PSLG * SLYIELD + 0.8 * PSM - PSOG \tag{4.2}$$

where CRSOG = the quantity of soybeans crushed;

MSB = the soybean crushing margin;

CRSOCAA = the solvent crushing capacity;

MORP = the crushing margin of substitutes;

PSM = the domestic price of soymeal;

PSOG = the domestic price of soybeans; and

SLYIELD and 0.8 = the oil and meal yields, respectively.

It is expected that MSB and CRSOCAA will have a positive effect on the demand for soybeans to be crushed, the latter variable having a greater influence due to the fact that crushing capacity is normally utilized because of significant fixed costs. Capacity utilization, on the other hand, will depend on the profitability of the operation represented by the price of soybeans, oil and meal.

Although substitution effects are less likely to occur in the future due to the specialization of crushing plants, multipurpose crushing units tend to replace soybeans by other oilseeds when corresponding prices are favourable. Plants with hydraulic press equipment are ideally suited for this type of conversion. Presently, France has mainly large crushing units using a solvent process, which does not allow the processing of more than one type of oilseed (Williams, p. 45). Thus, the substitution phenomenon is now less important in France, but was significant in the fifties and sixties. Hence, it is necessary to include in the crush equation the crushing margin of the other main oilseeds processed in France, which are peanuts and rapeseed. It is expected that the impact of this variable on the quantity of soybeans crushed will be negative, but small.

4.4 Soybean Oil Market

The demand for soyoil in France is influenced directly by conditions prevailing in the retail market for table oil. Taking into consideration the principal elements in the market allows one to specify the French demand for soyoil. For that purpose, a simultaneous demand system is proposed as follows:

$$DSLG = f(RPSLG, RPDYG, RPSLSUB, DUM), \quad (4.3)$$

$$DPNLG = f(RPNLG, RPDYG, RPNLSUB, DUM, DPNLG_{-1}), \quad (4.4)$$

$$DRLG = f(RPRLG, RPDYG, RPRLSUB, DUM), \text{ and} \quad (4.5)$$

$$DSNFLG = f(RPSNFLG, RPDYG, RPSNFLSUB, DUM) \quad (4.6)$$

where DSLG = the quantity of soybean oil consumed;

DPNLG = the quantity of peanut oil consumed;

DRLG = the quantity of rapeseed oil consumed;

DSNFLG = the quantity of sunflower oil consumed;

[a]RPSLG = the real domestic price of soyoil;

RPRLG = the real domestic price of rapeseed oil;

RPNLG = the real domestic price of peanut oil;

RPSNFLG = the real domestic price of sunflower oil;

RPSLSUB = the real domestic price of oil substitutes to soybean oil;

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[a] All the prices and disposable incomes have been deflated by the Consumer Price Index.

RPRLSUB	=	the real domestic price of oil substitutes to rapeseed oil;
RPNLSUB	=	the real domestic price of oil substitutes to peanut oil;
RPSNFLSUB	=	the real domestic price of oil substitutes to sunflower oil;
DUM	=	dummy variables;
RPDYG	=	real disposable income; and
$DPNLG_{-1}$	=	the quantity of peanut oil consumed in France lagged one year.

Through a typical consumer demand specification, five aspects of the French table oil market have been identified and synthesized by the above explanatory variables.

First, as for any food product, the demand for edible oils in developed countries is an increasing function of disposable income, but at a diminishing rate (Mohtadi and Moe). Thus, it is expected that the demand for each vegetable oil in France will be inelastic with respect to real income (RPDYG). Population also shifts the demand schedule to the right and the usual way to incorporate this factor is to specify a per capita equation. In high-income countries where the growth rate of population is low, this variable does not play an important role in the short- and medium-run variations of the demand for edible oils. For that reason, population is not included as a separate variable and its influence is captured by the income variable in the econometric model.

Second, the demand for each edible oil will be inversely related to its own real price. Previous research has shown that the price responsiveness for edible oil is inelastic.

Third, because different edible oils can substitute for each other, the demand for all edible oils are interrelated. Many scholars, who have undertaken empirical studies on this problem, have found that substitution effects are more likely to occur between oils which have the same chemical properties or similar final ones. Thus, as previously mentioned in Section 2.2.1, the strongest cross-commodity effects will be among two groups of edible oils that are differentiated by price and quality:[5] a group of low quality and cheaper oils comprised of soybean and rapeseed oils, which are used in salad dressings; and, a second group of higher quality and higher priced oils, mainly peanut and sunflower oils, which are used in cooking oils and salad dressings. The substitution effects are primarily of a short-term nature and may be difficult to estimate in an annual model.

Due to high multicollinearity among the oil prices, the variables representing the influence of substitute oils will not enter the demand equations separately, but instead, as a composite weighted sum of different prices. In doing so, this approach will measure changes in demand for one edible oil relative to the influence of all other

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[5] From a chemist's standpoint, the classification of fats and oils will be operated according to the content of each oil in different acids. The usual way is to distinguish liquid edible vegetable oils, called soft oils, which have a high proportion of unsaturated fatty acids, from other oils, such as rapeseed oils that forms a category by itself, or animal oils.

On the other hand, consumers categorize oils according to criteria such as taste, digestibility, final use, price, health hazards, etc.

vegetable oils considered as a homogenous group. The effects of these variables (RPSLSUB, RPNLSUB, RPRLSUB, RPSNFLSUB) on the demand variables are expected to be positive.

Related to the substitution problem between edible oils is the change in demand for vegetable oils relative to the consumption of butter. There is a general concensus that consumer taste patterns have been altered in favour of vegetable oils and against animal fats, particularly butter because of the supposed health hazards due to a high intake of animal fats. This movement away from butter and lard has not been an important determinant of edible oil consumption in France.

Fourth, although it is not easy to assess them using only price variables, it is believed that long-range substitution relationships are also important in the fats and oils complex. Various factors other than price, such as tastes, consumer habits and quality characteristics contribute to the demand for fats and oils. This is especially illustrated by a succession of events which have taken place in the French vegetable oil economy during the late sixties and early seventies causing substantial and very sudden changes in the consumption patterns for various edible oils. Described in the economic literature as structural changes, these impacts are not easily measured with conventional econometric tools. The only type of variable which can capture some of the effects are dummy variables.

Fully analyzed in a previous chapter, the various changes in the economic environment since 1970 encompass a wide range of factors which could have a positive or negative impact on the consumption of various oils. Despite the difficult task of isolating each of these factors, the dummy variables included in each demand equation are meant to represent:

i) for soybean oil, the repercussions of the opening of a soybean crushing plant in the western part of France;

ii) for sunflower oil, the role played by an advertising campaign launched in 1969-1970 and the continuing positive image perceived by consumers of this oil (Rouffiac, pp. 29-50);

iii) for peanut oil, the supply shortage from West Africa; and

iv) for rapeseed oil, the effect of the erucic acid campaign in 1972-1973.

These events which have occurred since 1970 have a continuing influence on the demand for oil. For the first three edible oils, the dummy variable takes the value of 1 from 1970 to 1977, whereas the effect of the erucic acid campaign was only perceived after 1973. The binary variable will shift upwards the demand schedules for soybean and sunflower oil and downwards for rapeseed and peanut oils.

Fifth, the recognition of habit persistence in France implies the incorporation of this factor in the demand system. It is assumed that the cooking habits of French households are reflected by the large consumption of peanut oil. Accordingly, a lagged dependent variable is one of the explanatory variables for the demand for peanut oil.

The specification proposed here to explain the demand for soybean oil and other edible oils is not unique, but seems to capture the multiple and diverse factors that affect this market. Nonetheless, several shortcomings are apparent. First, the fact that prices are exogenous is not very realistic. It would have been worthwhile to relate them to the world market conditions of different edible oils. Second, no attention has been paid to the influence of spatial or social factors, such as regional differences and urbanization, on the demand for edible oils.

Finally, because the oil price data used in this model are not domestic but CIF Rotterdam prices and hence may not be representative of French market conditions, the aggregate prices of substitutes are replaced by the corresponding quantities. In so doing, we postulate a mixed demand system based on the concept of an indirect utility function.[6] The final model representation of the French table oil market is:

$$DSLG = f(RPSLG, RPDYG, DSLSUB, DUM70) \tag{4.7}$$

$$DPNLG = f(RPNLG, RPDYG, DPNLSUB, DUM70, DPNLG_{-1}) \tag{4.8}$$

$$DRLG = f(RPRLG, RPDYG, DRLSUB, DUM73) \tag{4.9}$$

$$DSNFLG = f(RPSNFLG, RPDYG, DSNFLSUB, DUM70) \tag{4.10}$$

$$DSLSUB = DPNLG + DRLG + DSNFLG \tag{4.11}$$

$$DRLSUB = DSLG + DSNFLG + DPNLG \tag{4.12}$$

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[6] For a theoretical justification of this specification, see Heien.

$$DPNLSUB = DSLG + DRLG + DSNFLG \tag{4.13}$$

$$DNSFLSUB = DSLG + DPNLG + DRLG \tag{4.14}$$

4.5 Soymeal Imports by France

The linkage between the French and world soybean market is analyzed only for soymeal. As the "small country" assumption has been stated for the soybean and soyoil markets, there is no need to specify export supply relationships for these commodities.

The export supply of soymeal by the rest of the world is a reduced form equation obtained after summation of all export supply schedules of meal exporters to France minus the soymeal demand schedules of other importing countries except France. More specifically, export supply of soymeal to France by the rest of the world is made up of Brazilian and U.S. exports as well as the export supply of other countries in which large crushing capacities allow them to import beans and export meal. In this latter group are all EEC member countries that re-export to the rest of the Community.

The specification of the export supply function of soymeal to France enables the determination of a world soymeal equilibrium price and the closing of the French soymeal market. This behavioural equation includes both supply and demand shifters following the procedure used by Paarlberg for the West German soymeal market. The elaboration of this functional relationship takes into consideration the specific factors characterizing French imports of soymeal and several recent changes that have occurred since 1973 in the world soybean economy and that have greatly modified its traditional picture.

The major change has been the emergence of Brazil as an important soybean exporter. This implies that the world reference price for soymeal is not only the U.S. price, but a combination of U.S. and Brazilian prices of soymeal. Thus, the following formulation is adopted for this study:

$$PSMW = \alpha_{US}\, PSM_{US} + \alpha_{BR}\, PSM_{BR} \qquad \text{where} \tag{4.15}$$

$$\alpha_{US} + \alpha_{BR} = 1 \qquad \text{and} \tag{4.16}$$

where PSMW = represents the world soymeal price;

PSM_{US} = represents the U.S. export unit value of soymeal;

PSM_{BR} = represents the Brazilian export unit value of soymeal; and

α_{US} and α_{BR} = are, respectively, the export shares of the U.S. and Brazil in the world market.

The choice of export unit values[7] is deliberate in order to take into account the different qualities of soymeal furnished by the U.S.A. and Brazil. It is acknowledged that the quality of Brazilian soymeal, measured in terms of protein content, is higher than that shipped by U.S. crushers. French and Western European compounders prefer the higher protein content which is attractive in terms of price and nutritive value. This preference is accentuated by the "cheap" prices offered by Brazil under its export policy regulations covering soyoil and meal products and its advantageous seasonal position of exporting soymeal when the U.S. supply is short and U.S. meal prices are at the highest point of the yearly cycle. Most price series published by governmental bodies such as the U.S.D.A. generally refer to a price of soymeal 44 percent equivalent which cannot deal with the quality problem relative to soymeal. Instead, the soymeal export unit values of the two main producers which are computed annually by F.A.O. provide a better measure of the export price of all soymeal regardless of protein level. This composite world price of soymeal is expected to be

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[7] Readers will find it strange to select export unit value as an indicator of world soymeal price when it is known that numerous short-comings are attributed to this kind of price index. The main pitfalls often advanced by economists may be grouped under three headings: 1) coverage of commodities; 2) composition of export unit index and inter-country difference; and 3) assessment of quality. Therefore, these critics are especially expressed for aggregate export unit values (see Kravis and Lipsey; and J.H. Chunlee). In the case of soymeal, these weaknesses vanish. Because we deal with a very disaggregate commodity, the two first points are not applicable. Only remains the quality problem in terms of protein content which is more or less solved by the use of homogenous data originated from the same source.

positively related to the export supply of soymeal. If the export supply of meal equation is linear, the coefficient corresponding to the price variable should be high enough to indicate the elastic supply suggested by economic theory.

The price of substitutes is an aggregate price of other main high-protein meals including peanutmeal, fishmeal and rapeseed meal. As in Paarlberg's specification, we would expect the price of other high-protein meals to vary in an opposite direction to the export supply of soymeal to France. Price variables are not measured in real terms, but in nominal terms.

The world crushing capacity, excluding France, and the world production of soybeans in the past period, which acts as an upper limit for the world meal supply, are the "quantity" supply shifters incorporated in the export supply equation. The expected relationships between these two explanatory variables and the dependent variable is positive.

The demand shifter used by Paarlberg in the specification of the export supply of soymeal to West Germany by the rest of the world is the effective livestock numbers in the main soymeal consuming countries, namely, the United States, Japan and Western Europe, excluding West Germany. In this study, a similar variable is used to explain the export supply of soymeal to France. Contrary to Paarlberg's approach, the scope of this variable is extended to other important consuming countries such as Eastern Europe and the U.S.S.R. that have experienced phenomenal growth in their demand for soybean products

(B. James and Morrison). The main reason for this extension of the demand shifter is that these countries are believed to have an increasing role in the world soybean market. More specifically, when the world soybean market is in such a tight supply situation, the expanding demand of centrally-planned economies may influence the world market in a way similar to what occurred in the world feedgrain market in 1972-1973. As a demand shifter, it is expected that this variable will vary in an opposite direction of the export supply of soymeal.

The combination of these above-mentioned factors allows the specification of the following relationship:

$$ESSMG = f(PSMW, POMW, CHSW, S_{t-1}, LSNOW) \qquad (4.17)$$

where ESSMG = the export supply of soymeal to France by the rest of the world;

POMW = the aggregate world price of other high-protein meals;

CHSW = the world crushing capacity, excluding France;

S_{t-1} = the world harvest of soybeans in the past period;

LSNOW = the effective livestock numbers in the U.S., Japan, Eastern Europe, the U.S.S.R. and Western Europe, except France.

This equation suffers from some shortcomings which may cause specification bias. First, a simultaneous price mechanism should have been set up to determine endogenously the world price of alternative meals (POMW). If such an approach were adopted, the export supply of other meals and the domestic demand of other meals would have to be estimated. In addition, some elements unique to the French oilseed complex would have to be incorporated in these equations. For example, for policy purposes, it would have been worthwhile to take into consideration the French rapeseed economy which may affect imports of soymeal. However, such an analysis has been avoided to keep the size of the model small.

Second, with the recent changes in the international monetary system, characterized by floating exchange rates, it can be argued that monetary factors such as devaluations have caused modifications in world agricultural trade patterns and hence should be incorporated in import demand or export supply equations of agricultural products. This problem is not addressed in this study, partly because of the time period chosen to estimate the equations in the model.[8]

4.6 Price Linkages, Technical Relationships and Identities

As in any simultaneous commodity model, a set of identities and technical relationships are important in closing the model. The quantity of soybeans crushed (CRSOG) results in a fixed proportion of soybean oil (QSLG) and meal (QSMG) given by the following expressions:

$$QSLG = SLYIELD * CRSOG, \tag{4.18}$$

[8] For a critical review of the role of exchange rate in agricultural trade, see Chambers and Just (1979).

$$QSMG = 0.8 * CRSOG \qquad (4.19)$$

where SLYIELD = the oil yield equal to 0.18 from 1955 to 1975 and 0.175 from 1975 to 1977; and

0.8 = the meal yield.

QSMG and QSLG are then fed into the soybean oil and meal market clearing identities which equate supply with the different components of demand.

Because stock data on soyoil are deficient, the market clearing identity for the French soyoil market does not include stock variations. The residual quantity (TRSL) obtained after deduction of the demand for soyoil from the supply, is the French net trade balance relative to this commodity, which may be either positive or negative. It is an endogenous variable equal to

$$TRSL = QSLG - DSLG. \qquad (4.20)$$

Four different components make up the total demand for soymeal. In addition to the different domestic demands, exports of soymeal and stock variation are part of the soymeal equilibrium identity which is

$$ESSMG + QSMG = DSMF + DSMC - DELTASMG + EXSMG, \qquad (4.21)$$

where EXMSG and DELTASMG = exports and stock variation of soymeal, respectively,

which, because they are very small, are assumed exogenous.

It is also desirable to recall a series of identities which create aggregate variables from individual ones to obtain the total production of compound feed and substitute quantity variables for different oil items. These are:

$$\text{TOTQCOMP} = \text{QCOMPPK} + \text{QCOMPBR} + \text{QCOMPLH} + \text{QCOMPBF} \quad (4.22)$$

$$\text{DPNLSUB} = \text{DSLG} + \text{DRLG} + \text{DSNFLG} \quad (4.23)$$

$$\text{DRLSUB} = \text{DSLG} + \text{DPNLG} + \text{DSNFLG} \quad (4.24)$$

$$\text{DSLSUB} = \text{DRLG} + \text{DPNLG} + \text{DSNFLG}, \quad \text{and} \quad (4.25)$$

$$\text{DSNFLSUB} = \text{DRLG} + \text{DPNLG} + \text{DSLG}. \quad (4.26)$$

Finally, a price linkage needs to be established between the world and French prices of soymeal. Generally, if no government intervention obstructs free trade in world commodity markets, model builders set up an identity which equates the domestic price to the world price adjusted by transport costs, exchange rates and tariffs. Two major problems hinder the use of a price identity in the French soymeal market. First, no data base on transfer costs over a long period of time are available. Even if the cost of shipping soymeal in bulk from the U.S. to Western Europe was known, it is not the relevant freight rate from Brazil. Furthermore, the maritime freight market is subject to ample fluctuations resulting from supply-demand conditions. Second, the world price of soymeal is a weighted average price of Brazilian and U.S.

soymeal export prices. Accordingly, the world price changes as the origin of exports changes. This implies the use of at least two price identities which is not compatible with the specification adopted for export supply of soymeal to France.

To overcome these problems, a behavioural relationships is proposed to represent the world-French soymeal price linkage. Basically, a linear functional relationship is expressed as follows

$$PSM = a + b\,(PSMW * EXCH) + T \qquad (4.27)$$

where EXCH = the French exchange rate; and

T = the transport cost in francs/ton.

A theoretical interpretation is attributable to this equation. It is often used to represent the degree of government intervention and its impact on the world markets (Zwart and Meilke).[9] In that context, a and b are called policy parameters and it is assumed they can be manipulated by governments to achieve policy goals. Thus, if $a = 0$ and $b = 1$, the market to be represented is characterized by free trade. On the other hand, values attributed to $a \neq 0$ and $b \neq 1$ correspond to various intervention price policies. In the case of the soymeal market in which there are no import tariffs, the expected values of a and b should be in the neighbourhood of 0 and 1, respectively. To make this

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[9] This above equation is presented in its simplest form. It is very likely that other variables must be incorporated in this equation. Zwart and Meilke point out that the nature of this functional relationship might also be non-linear (p. 439).

price linkage economically reliable, the domestic price of soymeal must be consistent with the world soymeal price. This latter is an aggregate export unit value index purposely selected to take into account the French soymeal import pattern and the underlying quality problem. Hence, the domestic soymeal price must be an import unit value obtained by dividing the total money value of French soymeal imports by imported quantities. In addition, the use of such an index alleviates collecting data on domestic soymeal prices which are very scanty in France. The world price of soymeal is converted to French francs with the aid of the U.S. dollar/franc exchange rate.

4.7 General Overview of the Soybean Model

Nineteen behavioural equations, three technical relationships and seven identities make up the structure of the French soybean model. Within this model, there are three autonomous blocks corresponding to each product market:

i) the crush sector described by one crush demand equation and the soybean margin identity;

ii) the soybean oil block comprised of four simultaneous behavioural equations, in which prices of different oil items are exogenous, and four identities; and

iii) the soymeal block which is the most sophisticated component of the French soybean model. It is formed by several interrelated subsystems that represent the different economic agents acting in this sector and the underlying causal relationships between representative economic variables. Within this block is included the feed-livestock model developed in Chapter IV. The following three interrelated subsystems form the soymeal block: soymeal demand and export supply of meal; the feedgrain demand model and the compound feed process model.

A series of technical relationships and market clearing identities link these different blocks. An overall picture of the relationships embodied in model structure is presented in Table 4.2. The variables with a star superscript are endogenous variables, while signs located above the variables indicated the expected nature of the relationships between dependent and independent variables.

In order to provide a clear understanding of the numerous causal relationships and their functioning, a flowchart representative of the soymeal block is depicted in Figure 4.4. It displays the way in which economic variables are believed to be connected to one another. For ease of recognition, circles are used to represent prices, while boxes are used to represent quantities. Solid lines indicate the causal relationships and arrows give the direction of influence.

In addition to the three production process models proposed in Section 3.2.7, this diagram provides additional understanding of the complex relationships and underlying economic behaviour inherent to the French feed-livestock sector. On one hand, the two-stage model structure allows the simultaneous determination of feed inputs at more than one stage in the animal feed market. On the other, the existence of "horizontal" connections between compound feeds and home-mixed feeds

TABLE 4.2. General overview of the French soybean model

Crush Sector

$CRSOG = f({}^*MSB^+, MORP^-, CRSOCAA^+)$

$MSB = SLYIELD * PSLG + 0.8 * PSM^* - PSOG$

Oil Block

$DSLG = f(RPSLG^-, RPDYG^+, DUM^+, {}^*DSLSUB)$

$DRLG = f(RPRLG^-, RPDYG^+, DUM^-, {}^*DRLSUB^-)$

$DPNLG = f(RPNLG^-, RPDYG^+, DUM^-, {}^*DPNLSUB^-, DPNLG(-1)^+)$

$DSNFLG = f(RPNSLFG^-, RPDYG^+, DUM^+, {}^*DSNFLSUB^-)$

$DSLSUB = {}^*DRLG + {}^*DPNLG + {}^*DSNFLG$

$DRLSUB = {}^*DSLG + {}^*DPNLG + {}^*DSNFLG$

$DPNLSUB = {}^*DRLG + {}^*DSLG + {}^*DSNFLG$

$DSNFLSUB = {}^*DPNLG + {}^*DSLG + {}^*DRLG$

Soymeal Block

$DSMC = f(\frac{{}^*PSM^-}{PCFG}, {}^*TOTQCOMP^+, OMSOYA^-)$

$DSMF = f(\frac{{}^*PSM^-}{{}^*PQPPK}, \frac{PCFG^-}{PQPPK^*}, TOTLIVWA^+, PLIVG^+)$

$DCFGC = f(\frac{PCFG^-}{{}^*PSM}, {}^*TOTQCOMP^+)$

$DCFGF^* = f(\frac{PLIVG^+}{PCFG}, TOTLIVWA^+, {}^*QCOMPB^-)$

$QCOMPLH = f(\frac{PLH^+}{{}^*PQLH}, EGGS^+, TIME^+)$

$QCOMPBR = f(\frac{PBR^+}{{}^*PQBR}, QPLCW^+, TIME^+)$

$QCOMPPK = f(\frac{PH^+}{{}^*PQPPK}, QPKCW^+, TIME^+)$

$QCOMPBF = f(\frac{FPBF^+}{{}^*PQBF}, PRMLG^+, DUM7376^+, TIME^+)$

$PQPPK = f({}^*PSM^+, PCFG^+, W^+)$

$PQBR = f({}^*PSM^+, PCFG^+, W^+)$

TABLE 4.2. Continued

Soymeal Block - Continued

$PQLH = f(^{*}PSM^{+}, PCFG^{+}, W^{+})$

$PQBF = f(^{*}PSM^{+}, PCFG^{+}, W^{+})$

$ESSMG = f(*PSMW^{+}, POMW^{-}, CSHW^{+}, S_{t-1}^{+}, LSNOW_{t}^{-})$

$PSM = a + b * (^{*}PSMW * EXCH) + T$

$TOTQCOMP^{*} = {}^{*}QCOMPPK + {}^{*}QCOMPLH + {}^{*}QCOMPBR + {}^{*}QCOMPBF$

$QCOMPB = {}^{*}QCOMPPK + {}^{*}QCOMPBF$

Technical Relationships

$QSMG = 0.8 * {}^{*}CRSOG$

$QSLG = SLYIELD * {}^{*}CRSOG$

Identities

$TRSL = {}^{*}QSLG - {}^{*}DSLG$

$ESSMG + QSMG = {}^{*}DSMF + {}^{*}DSMC - DELTASMG + EXSMG$

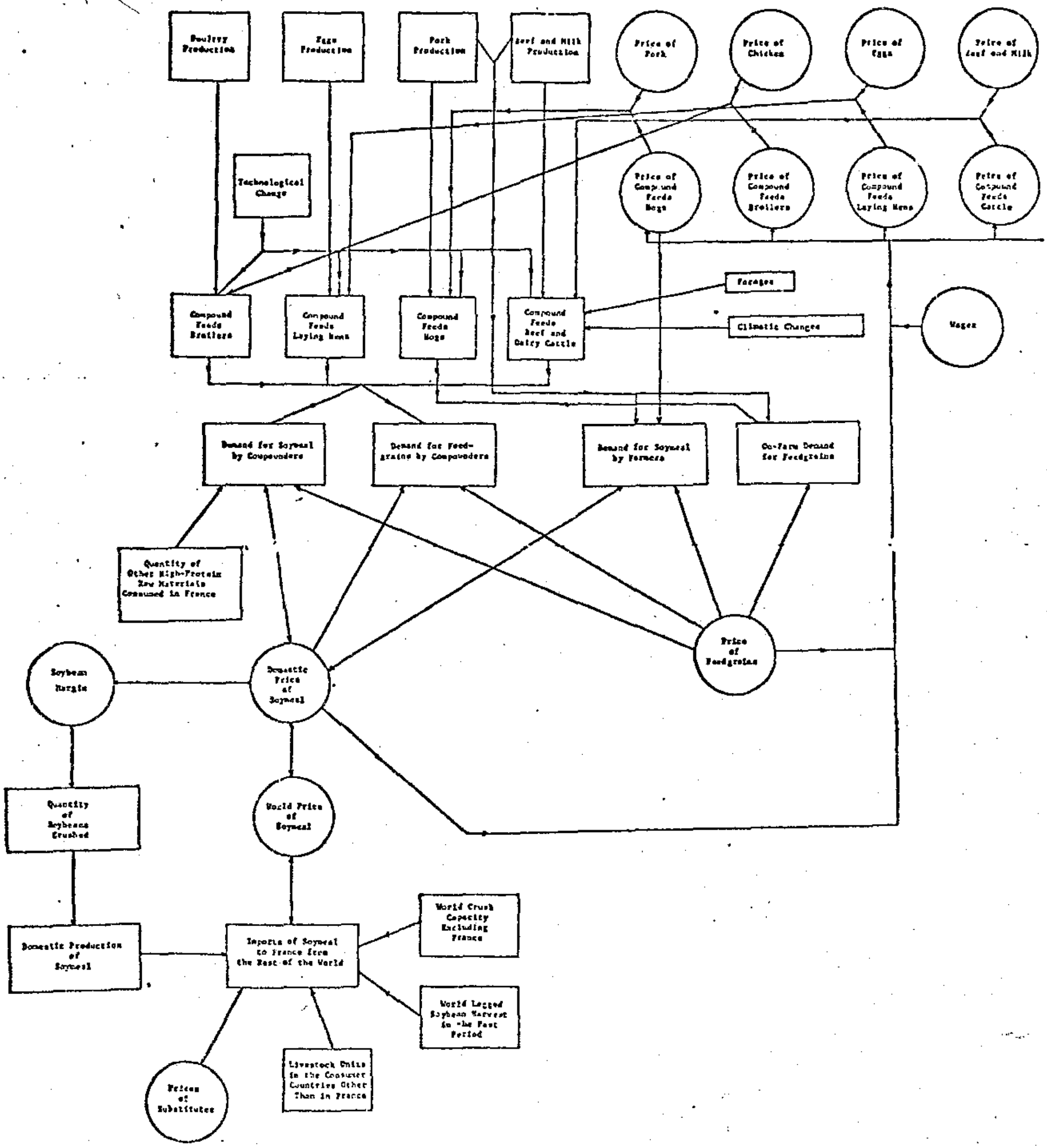

Figure 4.4: Flow chart of the French feed livestock industry

shows how farmers prepare feed rations to meet the nutrient requirements for hogs and cattle.

The economic rationale behind this model is illustrated in part by Longmire's linear programming model of the United Kingdom feed market. Assuming a rise in the price of high-protein, Longmire showed that the simultaneous determination of feed inputs at more than one stage is represented by a sequence of likely events depicted by Figure 5.5 and explained as follows (p. 144):

> "The higher price of high-protein feed induces a decline in high-protein feed inclusion rates in both compounds and home-mixes. However, this adjustment does not prevent some increase in the final price of manufactured feeds since there is no perfect substitute for high-protein feed. A rise in the price of manufactured feed encourages the substitution of forage feed for concentrate feed. So far two substitution effects have occurred: other raw materials for high-proteins, and forages for concentrate feed. However, the higher opportunity cost of additional forage feed, as well as the higher cost of concentrate feed, is likely to reduce livestock output, which is a (negative) expansion effect. This, in turn, leads to a reduction of the total feed input, with its effect on inputs of manufactured feeds and on raw materials. Thus, an increase in high-protein feed prices leads to a decline in high-protein feed consumption, due both to substitution and expansion effects."

A similar sequence may be traced in the French feed-livestock model. It differs from the above only in the sense that peculiar features of the French livestock system and the aggregate nature and scope of the corresponding model must be considered. For instance,

FIGURE 4.5. Sequence of events in response to a rise in the price of soybean meal (or high-protein feed)

Event	Where Events Occur
Increased price of high-protein feed	Raw material markets
Substitution of other feeds for high-protein	Feed manufacturing industry action
Increased price of manufactured feeds	Manufactured feeds market
Substitution of forage feeds for concentrate feeds	Farm action
Higher price of feeds for livestock	Farm feeds market
Reduction of livestock output	Farm action
Reduction of total feed input	Farm feeds market
Reduction of concentrate feed input	Concentrate feeds market
Reduction of raw material feed input	Raw materials market

Source: Longmire, op. cit., p. 144.

the number of events likely to occur is limited in broilers and laying hen operations due to the absence of cross-effects between feed compounds and other feeds. By contrast, the above scheme works fully for hogs and cattle.

As a result of these above discussions on the economic functioning of the French feed-livestock sector, the soymeal block has a peculiar simultaneous structure. First, direct simultaneity operates within the soymeal market through direct confrontation of meal export supply with the different domestic demand schedules which enables the determination of the soymeal price. Second, an indirect simultaneity is represented by a feedback effect from the price of soymeal to the demand for soymeal via equations describing the feed compound sector. Third, the interconnection between crush and meal sectors is represented by a second feedback effect linking successively the domestic price of soymeal with the soybean margin which influences the quantity of soybean crushed. Then, through the technical soybean relationships and the soymeal market clearing identity, the demand for crush yields a fixed amount of domestic production that, in turn, will affect the level of French soymeal imports. Lastly, the demand expressions for feedgrains are recursive. In fact, because the price of feedgrains is exogenous, there is no feedback to the soymeal sector.

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CHAPTER VII

POLICY ANALYSIS

7.1 Introduction

As stated in the introductory chapter, an important aspect of this analysis is the evaluation of the impact of various agricultural policies on France's demand for and trade in soybeans, soybean meal and soybean oil. Of direct interest are the implications of the four following policies on the French soybean economy: i) an increase in crushing capacity; ii) the replacement of soymeal imports by other high-protein feed sources; iii) the imposition of an *ad valorem* tariff on soymeal imports; and iv) the downward adjustment of EEC feedgrain prices to world price levels. Among this set of policy actions, the first two are the most feasible and have been used by France during the past five years. The first two policies are evaluated over the period 1979 to 1985 and compared with the base period solution obtained in Chapter VI. The two latter policies, which should be analyzed in an European context, are evaluated over the historical period 1962-1977 for the tariff policy and 1963-1978 for the feedgrain price policy.

Given the structure of the French soybean market, the abovementioned policy simulations have no impact on the demand for vegetable oils. In fact, since the domestic price of soybean, peanut and rapeseed oils are exogenous, the respective demands for each edible oil do not respond to any change resulting from the application of one of the above policies. The only influence of the policies which improves self-sufficiency in the soybean oil block results from the additional domestic production of soyoil and its impact on the soybean oil trade balance.

7.2 Increase in Crushing Capacity

The first policy consists of expanding by approximately 30 percent the existing French solvent crushing capacity. As indicated earlier, this corresponds to the opening of the 300,000 tons crushing plant in the southwestern part of France in the fall of 1979. This policy might also be viewed as an attempt to reduce protein dependence on the U.S. because soybean supplies increasingly originate from Brazil.

Using a partial equilibrium model of the market for soybeans and soybean meal, the likely theoretical effects of the increase in crushing capacity on the French and world soybean and soymeal economies are shown in Figure 7.1. For the sake of exposition, transfer costs and exchange rates are assumed to equal zero. In the soybean crush sector, an expansion of crushing capacity shifts to the right of the French crush demand for soybeans, from DSB_F to DSB'_F. Considering that domestic production of soybeans is very small, this leads to an increase in soybean imports in the same proportion. The adoption of the small country assumption for the French soybean crush market means that an expansion in the soybean crushing capacity

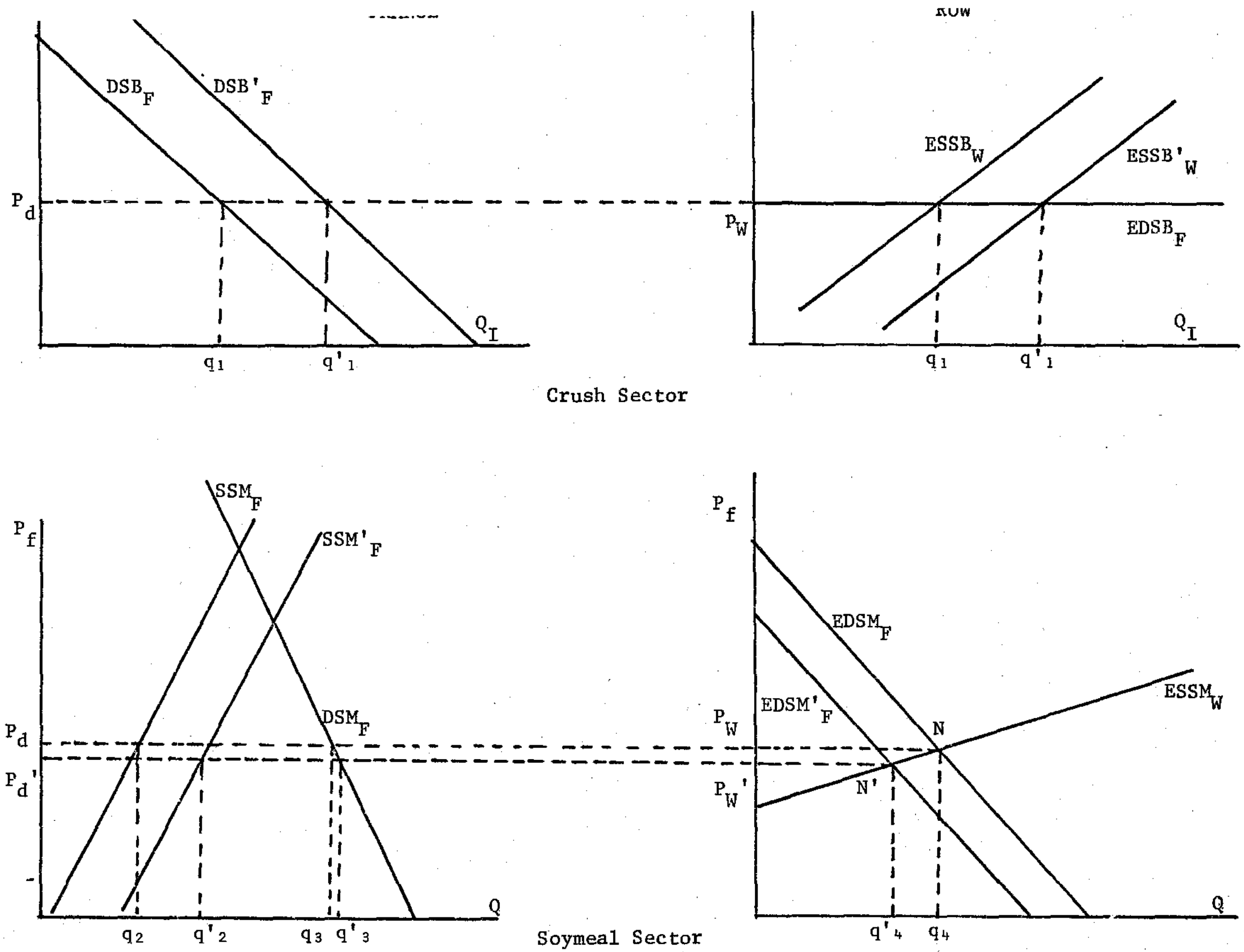

FIGURE 7.1. Impact of an 30 percent increase in crushing capacity on the French soybean and soymeal economy.

has no influence on the world price of soybeans.[1] In the soymeal market, an increase in crushing capacity leads to a rightward shift of the domestic soymeal production function which, in turn, implies a shift to the left of the excess demand for soymeal in France.

These shifts in the supply and demand schedules for the French and world soymeal markets yield new world and domestic soymeal prices which are lower than the initial ones. This decrease in soymeal price causes an increase in the domestic demand for soymeal from q_3 to q'_3, but in total soymeal, imports decline from q_4 to q'_4.

In the model specified and estimated in the previous chapters, additional interesting impacts emerge and these must be taken into account. Thus, the fall of the world soymeal price resulting from an increase in crushing capacity causes a reduction in the price of each compound feed, which, in turn, leads to an expansion of the demand for each compound feed and hence soymeal. Thus, the price effect is converted into a quantity effect through the demand and price equations for each compound feed. For the demand for soymeal by farmers, similar reasoning is valid and the feedback effect through the price of compound feed should be taken into consideration. However, since the price of soymeal is incorporated in the demand specification for soymeal by farmers, this secondary effect may be

[1] However, this condition is relaxed later when policy simulations are made. In fact, for reasons given in Chapter VI, the price of soybeans is endogenized and responds to any variation of the world price of soymeal, although the crushing margin remains constant.

neutralized. A lower world soymeal price would also reduce the soybean margin and subsequently the quantity of soybeans crushed, but this impact is expected to be small relative to the direct one associated with the expansion of the crushing capacity and depends on the value of the coefficient associated with the soybean crush margin in the demand for soybean crush equation. In the feedgrain market, an increase in crushing capacity has only minor effects. On one hand, as a result of the decline in the domestic soymeal price, it is expected the commercial demand for feedgrains will decrease. On the other hand, the fact that the demand for compound feed expands slightly with the expansion of the crushing capacity implies a higher demand for feedgrain which may offset the former effect. The non-commercial demand for feedgrain is linked to the quantity of compound feed fed to hogs and beef and dairy cattle. This latter variable should decrease very slightly with increased crushing capacity.

Average simulated values of the endogenous variables have been generated for the 1979-1985 period and are compiled in Table 7.1. Because a 300,000 ton increase in crushing capacity was incorporated in the base projection simulation in Section 6.4, this first policy simulation consists of comparing the former solution with a simulation based on the assumption that no increase in crushing capacity occurred during the 1979-1985 period.

The simulation results obtained accord with the expected effects. A 30 percent increase in crushing capacity leads to a 20 percent increase in the demand for soybeans and 10 percent and 4.8 percent

TABLE 7.1. Impact of 30 percent increase in crushing capacity on the French soybean economy during the period 1979-1985

	Increase in Crushing Capacity (Base Solution) (Average Values)	No Increase in Crushing Capacity (Average Values)	Average Percentage Change
Soybean crush (CRSOG)	866.75	686.71	-20.51
Soymeal demand by compounders (DSMC)	1999.12	1968.58	- 1.52
Soymeal demand by farmers (DSMF)	985.02	983.26	- 0.17
World price of soymeal (PSMW)	198.36	219.82	10.82
Commercial demand for feedgrains (DCFGC)	7973.7	8027.32	0.6
Non-commercial demand for feedgrains (DCFGF)	7813.88	7828.29	0.18
Total demand for soymeal (DSM)	2984.14	2951.84	- 1.07
Total demand for compound feeds (TOTQCOMP)	13013.9	12989.1	- 0.18
Price of compound feeds for hogs (PQPPK)	1634.79	1667.69	1.98
Price of compound feeds for broilers (PQBR)	1523.36	1537.39	0.9
Price of compound feeds for beef and dairy cattle (PQBF)	1150.42	1171.64	1.82
Price of compound feeds for laying hens (PQLH)	1639.78	1657.23	1.05
Domestic supply of soymeal (QSMG)	693.4	549.36	-20.51
Domestic supply of oil (QSLG)	151.68	120.17	-20.51
Excess supply of soymeal (ESSMG)	2303.09	2414.82	4.83
Domestic price of soymeal (PSM)	982.07	1085.14	10.43
Soybean oil trade balance (TRSL)	51.19	19.69	-60.0

decreases in the world price of soymeal and the quantity of soymeal imported, respectively. The fall in soymeal prices cause a decline in the price of compound feeds by 1 to 2 percent. Since the demand for each compound feed is extremely inelastic, the total consumption of compound feed increases only slightly by 0.18 percent. As expected, the change in the demand for soymeal by farmers is almost nil. Similarly, commercial and non-commercial demand for feedgrains are not very sensitive to the expansion of crushing capacity decreasing by 0.6 and 0.18 percent, respectively.

When the above simulation is compared to the results obtained by Paarlberg for the West German soybean sector, it is clear that the impacts are smaller than those derived from Paarlberg's model. Thus, for a 22 percent increase in the West German crushing capacity, Paarlberg found that price of soymeal declined by 25.11 percent, implying an almost one to one relationship between these two variables. For France, the ratio is much lower in absolute terms at 0.3.

7.3 Increased Use of Other High Protein Feeds

An increase in the consumption of high-protein feeds other than soymeal influences the French soymeal economy in two ways. First, expanding the consumption of domestic and imported tropical meals may be achieved by an increase in the quantity of oilseeds crushed such as peanuts or rapeseed. The implications of such a policy are presented in Figure 7.2.[2] The demand for soybean crush and imports of soybeans

[2] In these diagrams, transport costs and exchange rate are assumed to be equal to zero.

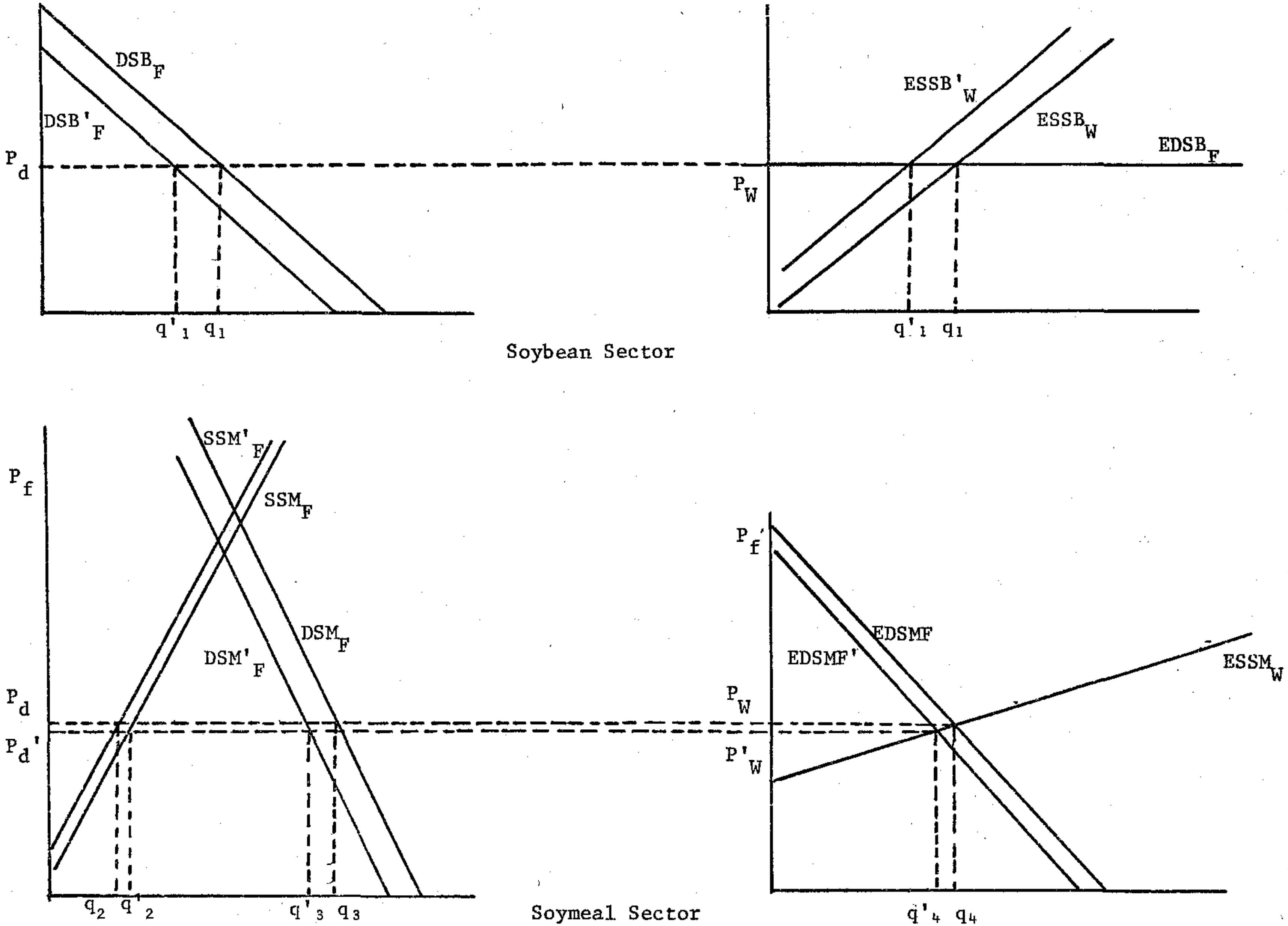

FIGURE 7.2. Impact of an 20 percent increase in the quantity of other proteins consumed other than soymeal on the French crush and soymeal economies.

are reduced as are the domestic production of soymeal and soyoil. The second impact of this policy affects the domestic demand for soymeal, shifting it to the left from DSM_F to DSM'_F. The excess demand for soymeal by France also shifts from $EDSM_F$ to $EDSM'_F$.

The combination of the above impacts leads to the establishment of a new equilibrium with soymeal prices at P'_W. The secondary impacts of this policy through the compound feed sector are likely to be small.

The policy simulation is performed assuming a 20 percent increase in the quantity of high-protein feeds other than soymeal (OMSOYA) consumed. To take into account the influence of this policy on the French demand for soybeans crushed, it has been assumed that given the present structure of the French oilseed sector, a 20 percent increase in OMSOYA entails a 4.09 percent increase in the quantity of rapeseed and peanuts crushed. This variable enters in the demand equation for soybeans crushed and captures the substitutability occurring between soybeans and other oilseeds. Since the French soybean model is highly aggregated, the distinction between expanding the domestic production of oilseeds and increasing the level of "tropical" oilmeal imports is ignored in this policy simulation.

Simulation results are shown in Table 7.2. As most of the policy actions to develop the production and consumption of domestic oilseeds and other high-protein feeds were initiated after 1975, the simulation is for the 1976-1985 period. In addition, the time period has been broken into two sub-periods in order to separate the short-

TABLE 7.2. Impact of a 20 percent increase in the quantity of high-protein feeds other than soymeal on the French crush and soymeal economies

	1976-1978 Period			1979-1985 Period		
	Base Solution Average Values	20% Increase of Other High-Protein Feeds Average Values	Average Percent Change	Base Solution Average Values	20% Increase of Other High-Protein Feeds Average Values	Average Percent Change
Soybean crush (CRSOG)	614.09	612.91	- 0.19	866.75	865.08	- 0.19
Soybean meal demand by compounders (DSMC)	1676.5	1584.36	- 5.49	1999.12	1778.01	-11.0
Soybean meal demand by farmers (DSMF)	593.03	594.79	0.29	985.02	988.65	0.36
Total demand for soymeal (DSM)	2269.54	2179.15	- 3.98	2984.14	2766.67	- 7.24
Excess supply of soymeal (ESSMG)	1794.16	1704.73	- 4.98	2303.09	2086.96	- 9.33
World price of soymeal (PSMW)	184.32	167.15	- 9.31	198.36	156.85	-20.99
Domestic price of soymeal (PSM)	977.56	890.46	- 8.9	982.00	782.87	-20.23
Domestic supply of soymeal (QSMG)	491.27	490.32	- 0.19	693.4	692.06	- 0.19
Domestic supply of soyoil (QSLG)	107.46	107.25	- 0.19	151.68	151.38	- 0.19
Soybean oil trade balance (TRSL)	1.43	1.22	- 1.45	51.19	50.9	- 0.59
Total demand for compound feeds (TOTQCOMP)	10910.9	10936.0	0.23	13013.9	13063.8	0.38

TABLE 7.2. Continued

	1976-1978 Period			1979-1985 Period		
	Base Solution Average Values	20% Increase of Other High-Protein Feeds Average Values	Average Percent Change	Base Solution Average Values	20% Increase of Other High-Protein Feeds Average Values	Average Percent Change
Price of compound feeds:						
Pork (PQPPK)	1311.86	1284.08	- 2.11	1634.79	1571.28	- 3.84
Broilers (PQBR)	1216.75	1204.89	- 0.97	1523.36	1496.25	- 1.75
Laying hens (PQLH)	1279.95	1265.21	- 1.15	1639.78	1606.08	- 2.03
Beef and dairy cattle (PQBF)	950.15	932.23	- 1.88	1150.42	1109.44	- 3.52
Commercial demand for feedgrains (DCFGC)	6977.63	6937.0	- 0.58	7973.7	7815.36	- 1.96
Non-commercial demand for feed-grains (DCFGF)	7065.68	7050.99	- 0.2	7813.88	7784.39	- 0.37

term effects of the policy from the long-term ones.

As expected over the total period, the simulated values and changes in the endogenous variables conform with the theoretical effects described earlier. The lack of response in soybeans crushed to the quantity of rapeseed and peanuts crushed results in a very small change in the quantity of soybeans crushed (CRSOG), the domestic supply of soymeal (QSMG) and soyoil (QSLG) and the soybean oil trade balance (TRSL). For similar reasons, the results indicate that the total demand for compound feeds (TOTQCOMP), the price of each compound feed (PQPPK, PQBR, PQLH and PQBF) and the demands for feedgrains (DCFGG and DCFGF) are unresponsive to this policy action. The increase in consumption of other meals has its major influence on the endogenous variables representing the French and world soymeal markets. With the exception of the demand for soymeal by farmers (DSMF), the other endogenous variables vary substantially with average percentage changes ranging, in absolute terms, from 5 to 20 percent.

The separation of the simulation period into two sub-periods indicates that the impact of an expansion of the demand for other high-protein feeds is much smaller between 1976 and 1978 than for the 1979-1985 period. In most cases average percentage changes almost double between the two periods.

The results imply that a 20 percent increase in the consumption of other high-protein feeds will lead to a 20 percent decline in the price of soymeal between 1979-1985. A decline in the soymeal price of this magnitude is not realistic. It is caused by the fact that the coefficient attached to OMSOYA has been constrained to -1 which means that the present model probably overstates the decline in the consumption of soymeal caused by an increase in OMSOYA and this, in turn, causes a very large drop in the price of soymeal because of the inelastic excess supply curve. Since the two impacts work in opposite directions, it is difficult to know if the policy effects are over- or under-stated.

The policy simulation is conducted for a 20 percent increase in the demand for other high-protein feeds, but simulations at different levels indicate that the endogenous variables respond to this policy change in a linear fashion.

7.4 Reduction of EEC Feedgrain Prices

This policy deals with one of the basic deficiencies in the Common Agricultural Policy, namely the existence of high feedgrain prices relative to world price levels and their impact on the demand for high-protein feeds in the EEC. Because high energy and protein feeds are substitutes in the EEC reducing the domestic price of feedgrains to world price levels should induce a fall in the consumption of soymeal. The likely theoretical effects of such a feedgrain policy on the French and world soymeal markets are depicted in Figure 7.3. Since soymeal is a substitute for feedgrains, a decline in feedgrain prices shifts the demand for soymeal to the left. At the same time, the excess demand for soymeal by France ($EDSM_F$) also shifts to the left from $EDSM_F$ to $EDSM'_F$. This results in a new lower equilibrium

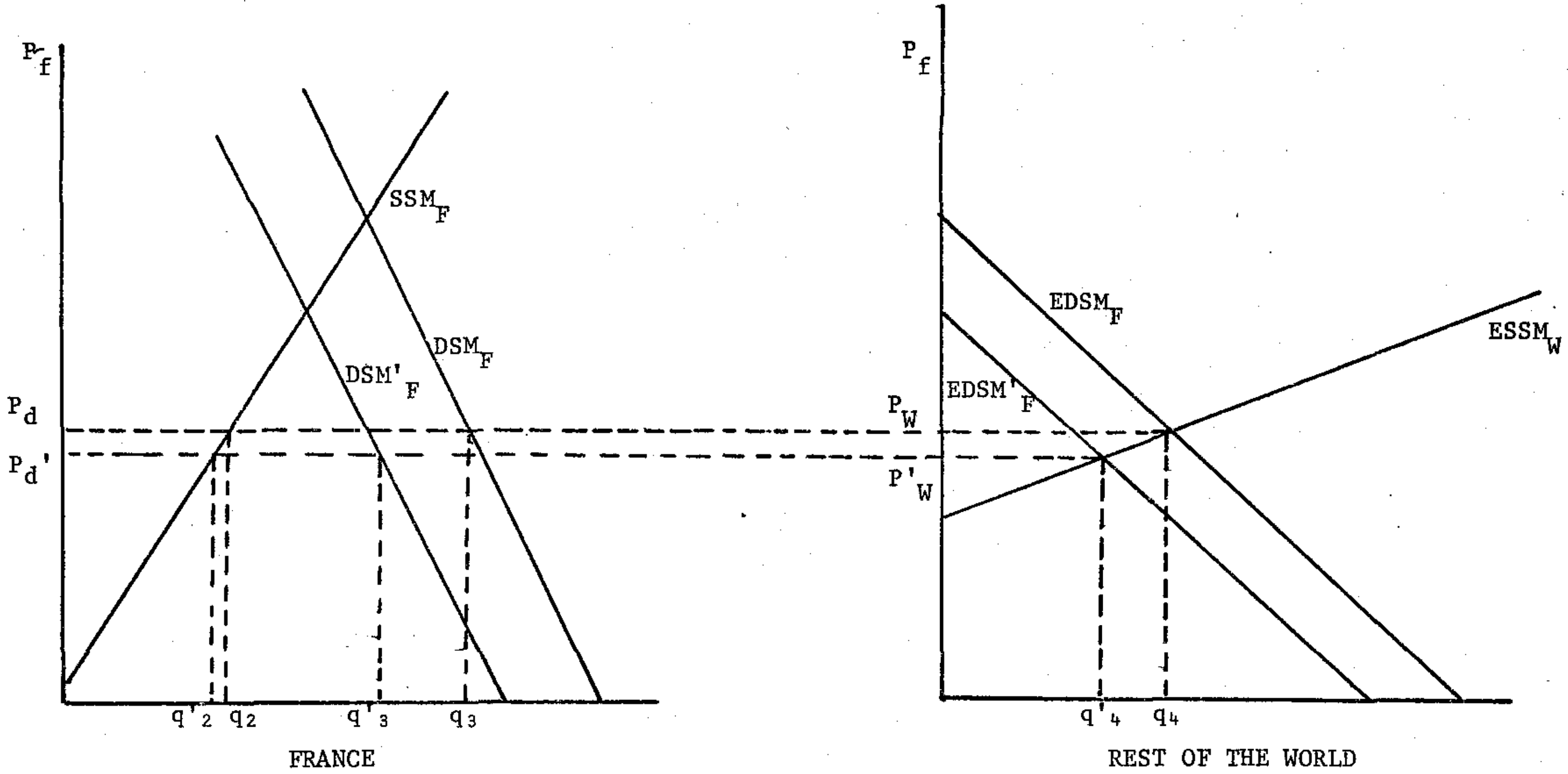

FIGURE 7.3. Impact of a reduction of EEC feedgrain prices on the French soymeal economy.

price for soymeal, P'_W. The decrease in the consumption of soymeal from q_2 to q'_2 is offset by an expansion in the demand for feedgrains.

However, the above conclusions are only valid when assuming a partial equilibrium model and cannot be generalized to the French soybean model estimated in Chapter V. This is the case because, opposite side effects, associated with the reduction in feedgrain prices occur and may overcome the direct impacts pictured in Figure 7.3.

To provide a more complete understanding of the implications of the feedgrain policy on the French feed livestock sector as a whole, the likely direct and indirect effects implied by the model are reported in Table 7.3. The numbers appearing for each impact indicate the ordering of the effects and their occurrence. The first column of this table shows the direct effects on the endogenous variables representing the French and world soymeal markets. Because the demand for soymeal is broken into two components, the demand for soymeal by farmers does not decline as suggested by Figure 7.3, but instead increases. This response is due to the fact that in the corresponding demand specification, feedgrains and soymeal are complements. Nevertheless, since feed manufacturers are the major users of soymeal, it is expected that the total demand for soymeal will be characterized by changes similar to those for commercial soymeal. Thus, the direct impact of the fall in feedgrain prices on the total demand for soymeal is expected to be negative.

The indirect effects occurring through the compound feed demand and price equations are more complex and lead to changes in

TABLE 7.3. Likely direction of impact on the French and world soymeal markets of a reduction in domestic feedgrain prices to world price levels

	Direct Effect	Indirect Effect Through the Compound Feed Sector	Indirect Effect Through the Soybean Crush Market
Demand for soymeal by compounders (DSMC)	↓ 1	↑ 1	↓ 5
Demand for soymeal by farmers (DSMF)	↑ 1	↓ 1	↓ 5
Total demand for soymeal (DSM)	↓ 1	↑ 1	↑ 2
Excess supply of soymeal (ESSMG)	↓ 3	↑ 3	↑ 3
Domestic supply of soymeal (QSM)			↓ 1
World price of soymeal (PSMW)	↓ 4	↑ 4	↑ 4
Domestic price of soymeal (PSM)	↓ 4	↑ 4	↑ 4
Excess demand for soymeal ($EDSM_F$)	↓ 2	↑ 2	↑ 2

endogenous variables, opposite to the direct impacts. The decline in the price of cereals involves a decrease of the price of each compound feed which in turn causes an increase in the demand for each compound feed and hence in the demand for soymeal by compounders. The indirect impact on the demand for soymeal by farmers takes place through the price of compound feed for hogs. In this case the price of commercial feed is so attractive that farmers buy more commercial feed and drop the direct use of soymeal. Assuming that changes in the total demand for soymeal depend primarily on the response of feed compounders, the fall in the price of feedgrains will cause the demand for soymeal to increase. This secondary impact causes the excess demand and the price of soymeal to rise.

The sequence of indirect effects occurring through the soybean margin identity can be analyzed along the same lines and start with a fall in the domestic supply of soymeal resulting from lower prices of soymeal.

When direct and indirect impacts are combined, the overall effects on each endogenous variable are indeterminant. The only way to evaluate them would be to have a complete model representing the French feed livestock sector including the livestock price determination process. Only in this way would the variation in the price of compound feed be transmitted to the price of livestock.

Given these considerations, the corresponding policy simulation has been performed by truncating part of the model. Each demand for compound feed _is assumed to be exogenous_. This is justified

the grounds that if feedgrain prices had been lower so would have
estock prices and the demand for compound feed would have been
hanged. The feedback effect on the demand for soymeal by farmers
ough the price of compound feed for hogs has been maintained. The
ılation period selected is the 1963-1978 period during which the
rage spread between world and EEC feedgrain prices was more than
percent.

Table 7.4 presents the average simulated values and average
centage changes for each endogenous variable. The resulting
ction of change accords with expectations. Variables which are
ect to the most significant variation are the demand for feed
edients by farmers which decline by 21 and 31 percent for soymeal
feedgrains, respectively. The lack of high-protein feed is
ensated for by the purchase of cheaper commercial feeds in the
of supplements.

The fact that feed manufacturers do not respond greatly to a
ease in feedgrain price is explained by two factors. First, the
astic response of the demand for feed inputs used by compounders
respect to their own price keeps these variables from changing
much. Second, as the demand for soymeal and feedgrains by feed
facturers have been specified as homogeneous of degree zero with
ect to prices, the respective declines in the prices of soymeal and
grains are neutralized.

Although the decline in feedgrain price is fully reflected
he variation of the price of each compound feed, the price of

TABLE 7.4. Impact of a reduction of domestic feedgrain prices to world level prices on the French feed livestock and soybean crush sectors

	Base Simulation Average Values	Policy Simulation Average Values	Average Percent Change
Demand for soybean crush (CRSOG)	326.3	306.28	-11.75
Demand for soymeal by compounders (DSMC)	984.93	953.23	- 3.03
Demand for soymeal by farmers (DSMF)	240.38	210.95	-21.15
World price of soymeal (PSMW)	124.47	115.81	- 8.66
Domestic price of soymeal (PSM)	684.31	637.50	- 7.86
Domestic production of soymeal (QSMG)	261.04	246.02	-11.75
Excess supply of soymeal (ESSMG)	977.07	931.94	- 5.86
Total demand for soymeal (DSM)	1225.32	1164.18	- 6.60
Commercial demand for feedgrains (DCFGC)	4902.36	4987.57	1.94
Non-commercial demand for feedgrains (DCFGF)	7333.12	9591.32	31.27
Price of compound feeds:			
Hogs (PQPPK)	831.23	653.90	-22.7
Broilers (PQBR)	821.35	661.14	-19.89
Laying hens (PQLH)	837.55	650.46	-23.0
Beef and dairy cattle (PQBF)	643.25	532.57	-17.79

soymeal falls moderately. Thus, for an average 30 percent decrease in the feedgrain price, domestic and world prices for soymeal decline by 8.7 and 7.9 percent, respectively.

A graphical representation of the policy simulation is presented in Figures 7.4 to 7.12. It can be seen that most endogenous variables react consistently during the simulation period to a change in feedgrain prices. The crucial years 1973-1974, characterized by world cereal prices higher than EEC prices, are well captured by all variables that exhibit a base solution higher than the policy simulated values. At the end of the simulation period during which EEC cereal prices have increased significantly, demand and price variables have experienced a higher change.

The only variable which does not subscribe to this pattern is the demand for soymeal by farmers which is more responsive to the variation in feedgrain prices between 1963 and 1972 than during the last part of the simulation period. Thus, although DSMF decline by an average 32 percent between 1963 and 1973, the percentage change is only 2.7 percent from 1974 to 1978. Such an evolution is attributable to the structural shift occurring for this variable between 1975 and 1978.

7.5 Tariff on Soymeal Imports

The fourth policy analyzed concerns the imposition of an *ad valorem* tariff on soymeal imports. While soybeans are imported duty-free by the EEC according to the 1961 GATT agreement, there are no

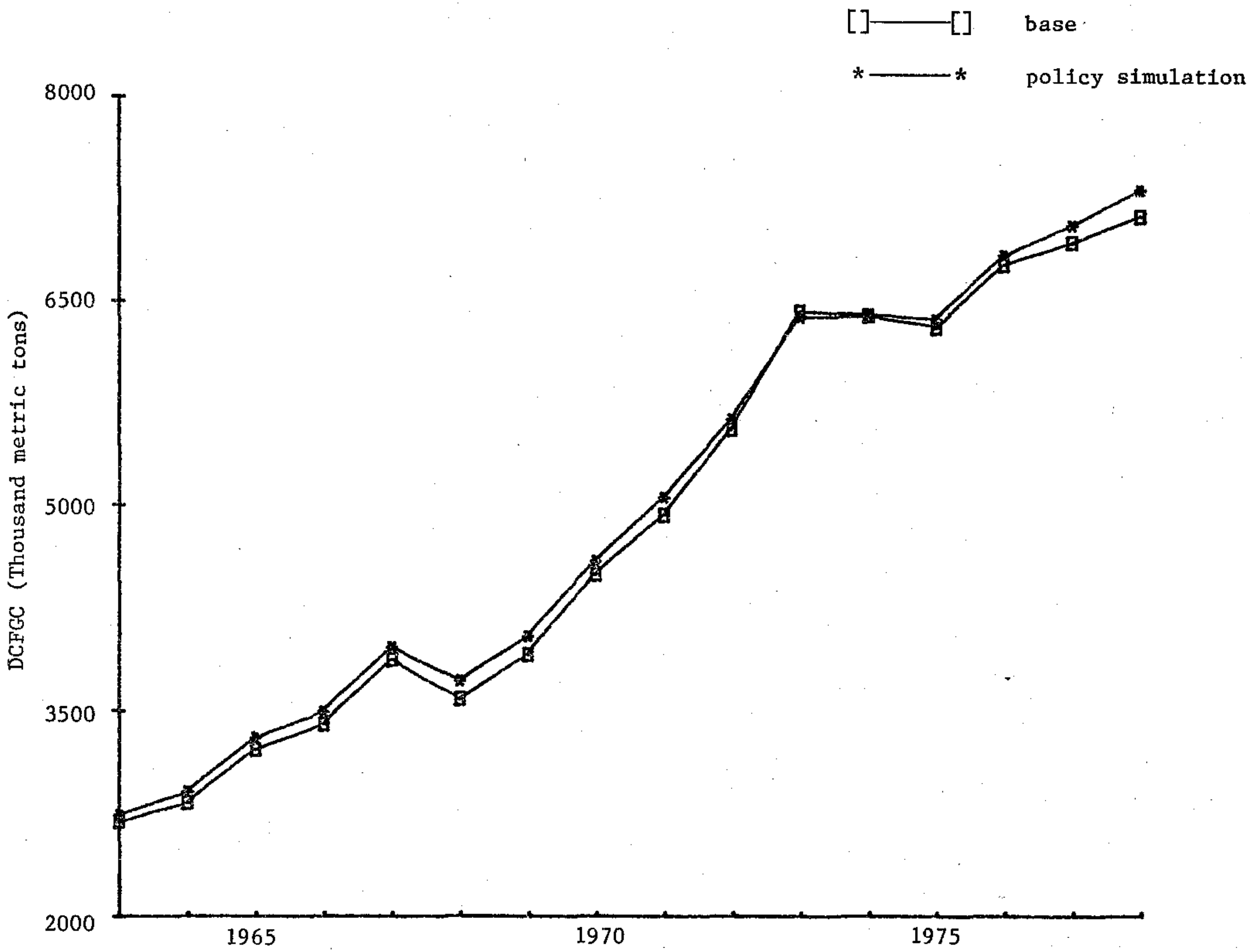

FIGURE 7.4. Impact of a reduction of domestic feedgrain prices to world level prices on the commercial demand for feedgrains.

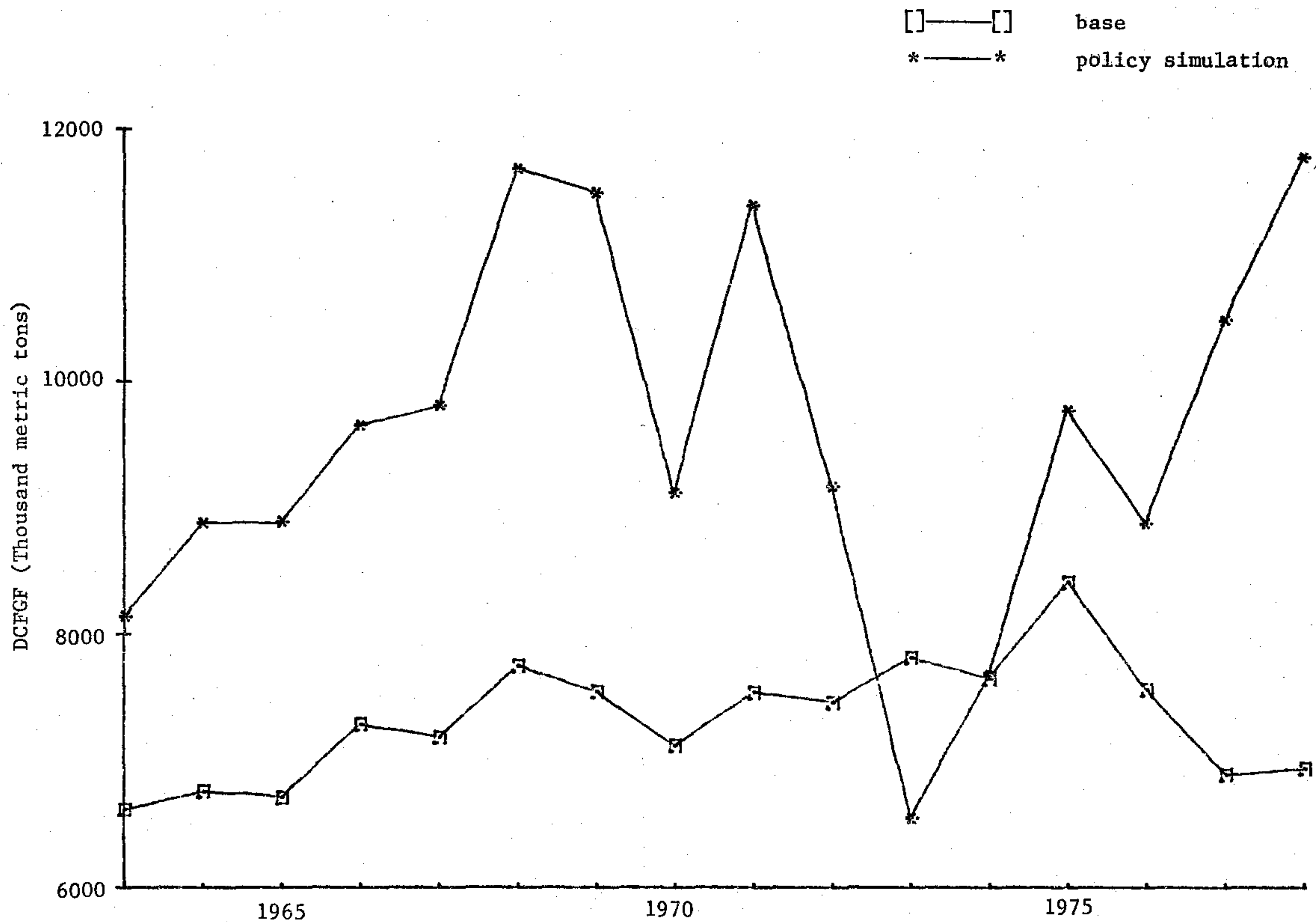

FIGURE 7.5. Impact of a reduction of domestic feedgrain prices to world level prices on the non-commercial demand for feedgrains.

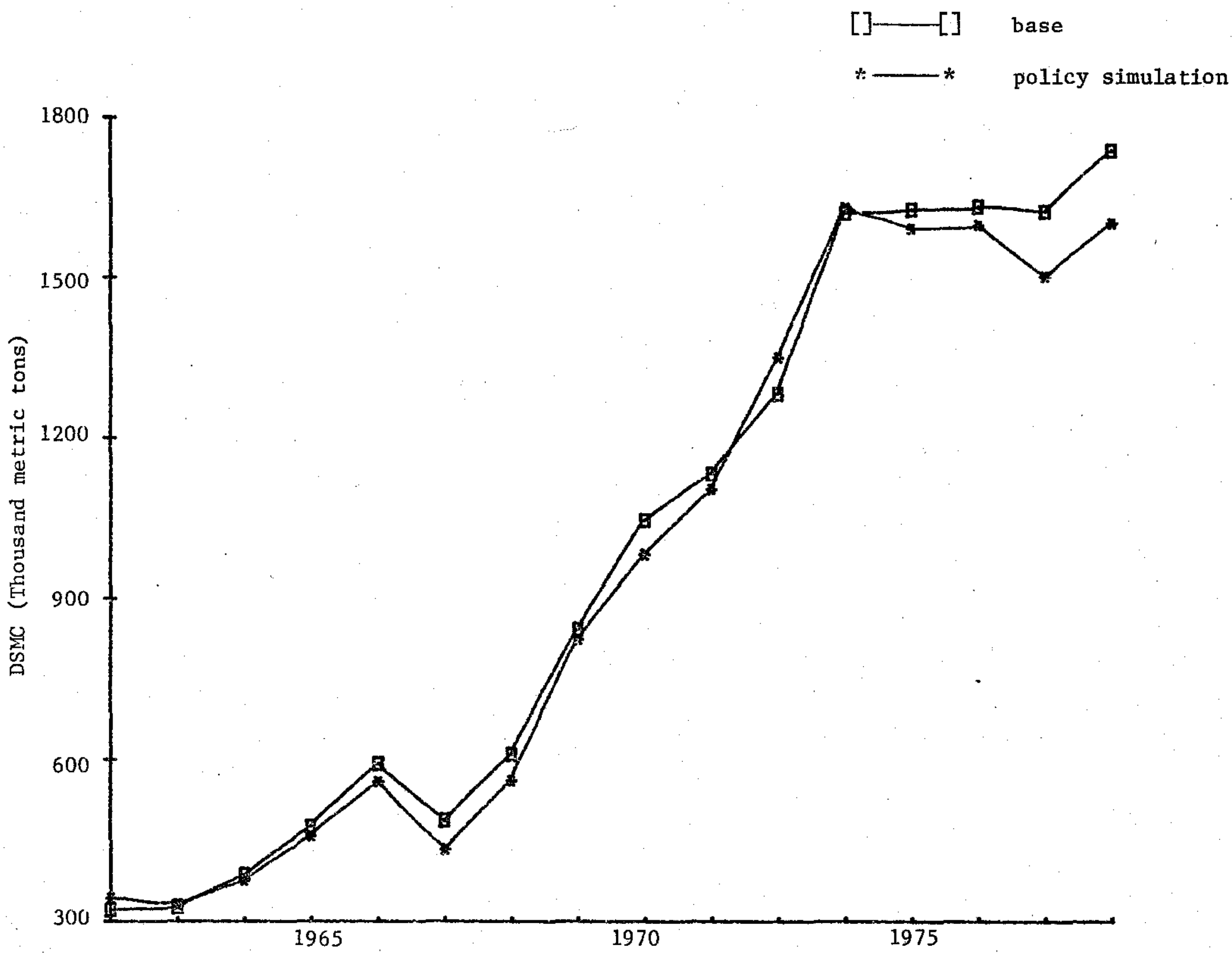

FIGURE 7.6. Impact of a reduction of domestic feedgrain prices to world level prices on the demand for soymeal by compounders.

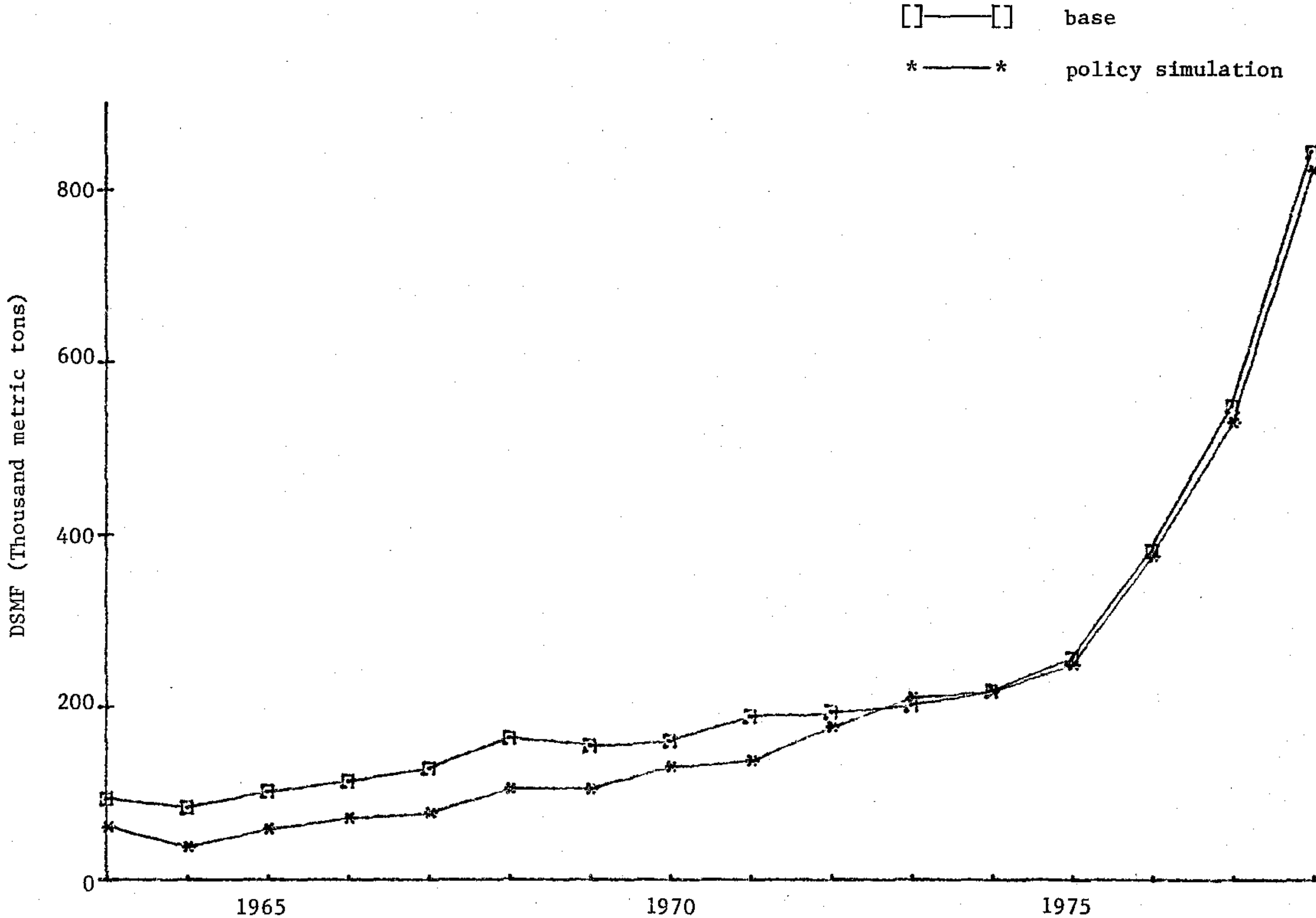

FIGURE 7.7. Impact of a reduction of domestic feedgrain prices to world level prices on the demand for soymeal by farmers.

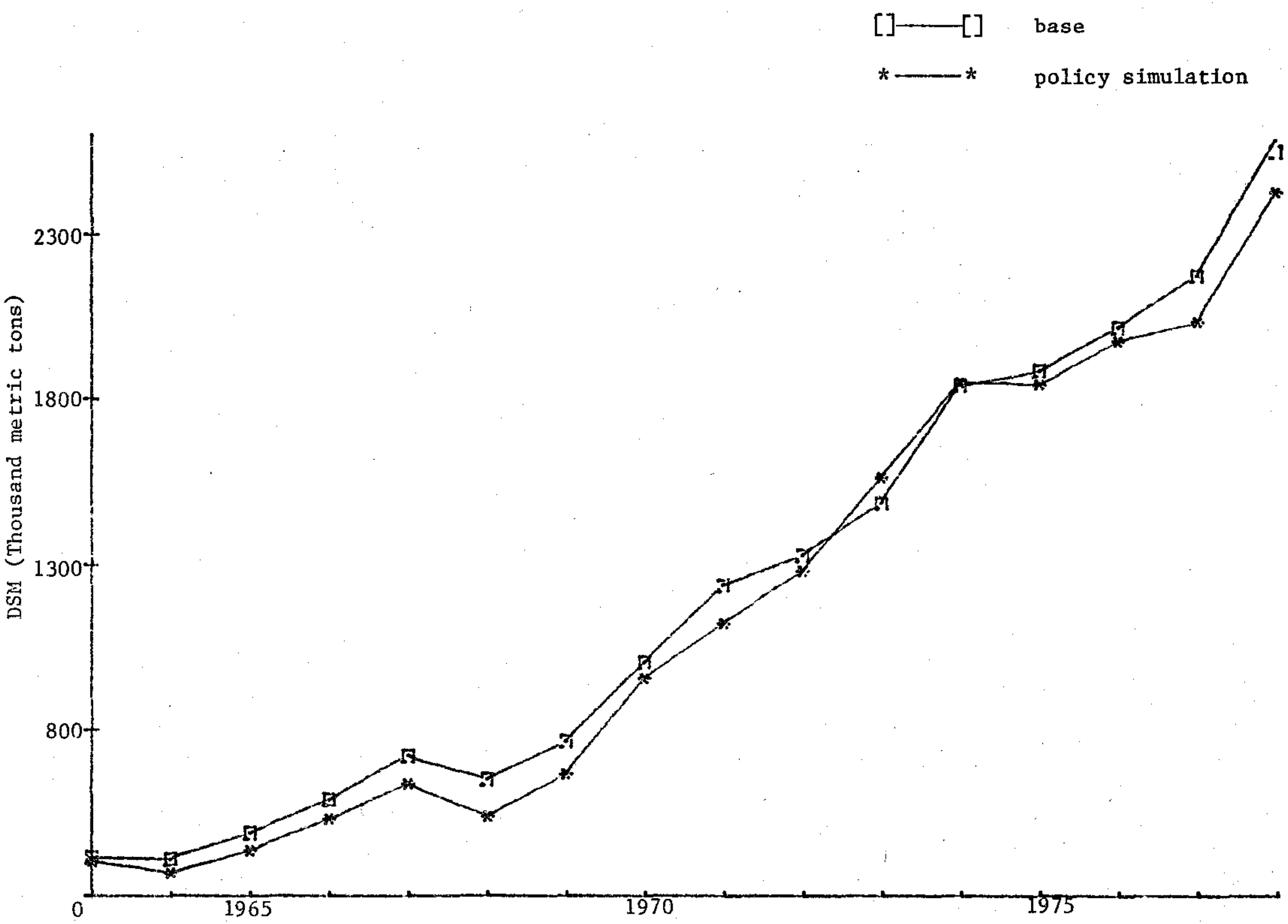

FIGURE 7.8. Impact of a reduction of domestic feedgrain prices to world level prices on the total demand for soymeal.

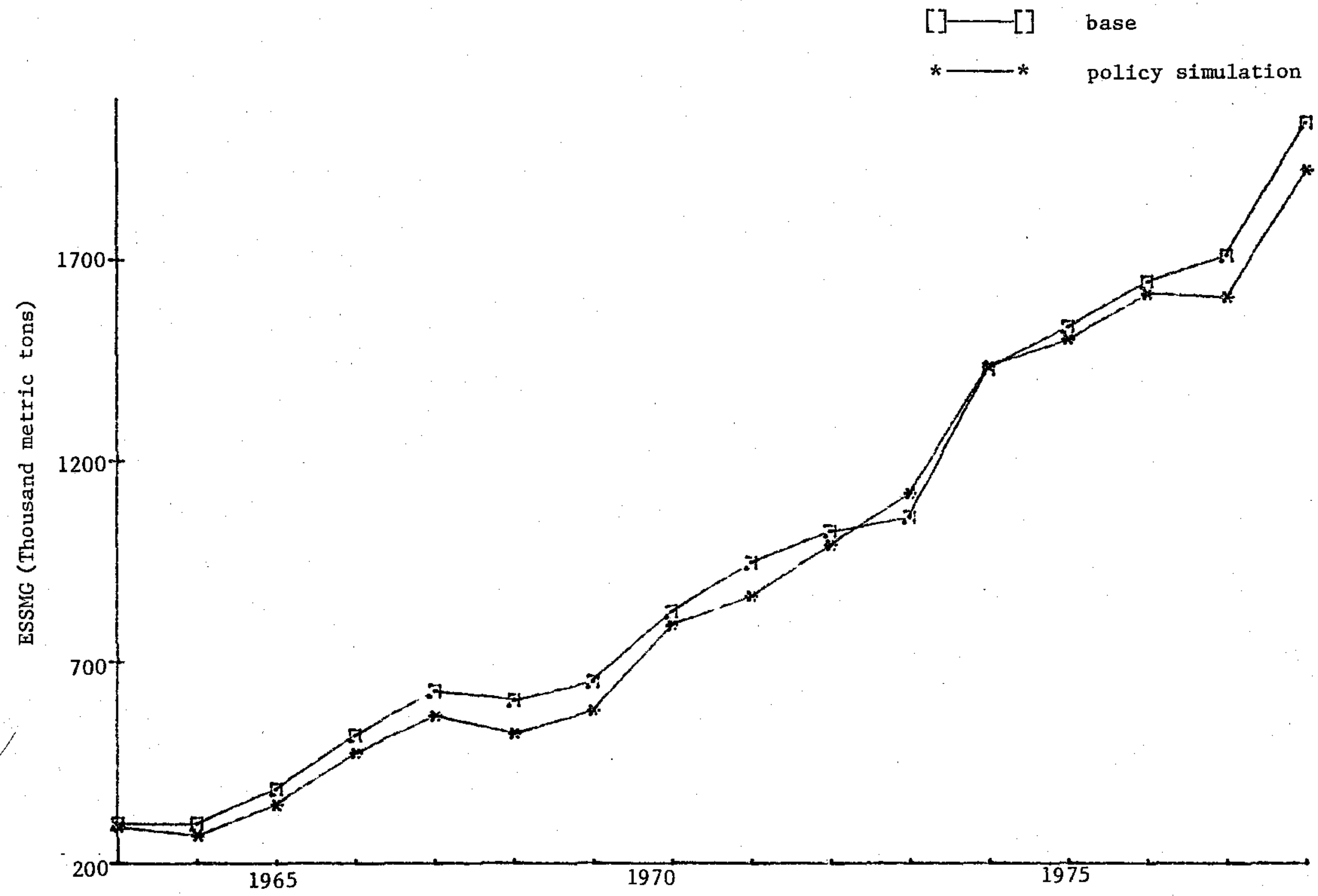

FIGURE 7.9. Impact of a reduction of domestic feedgrain prices to world level prices on the excess supply of soymeal

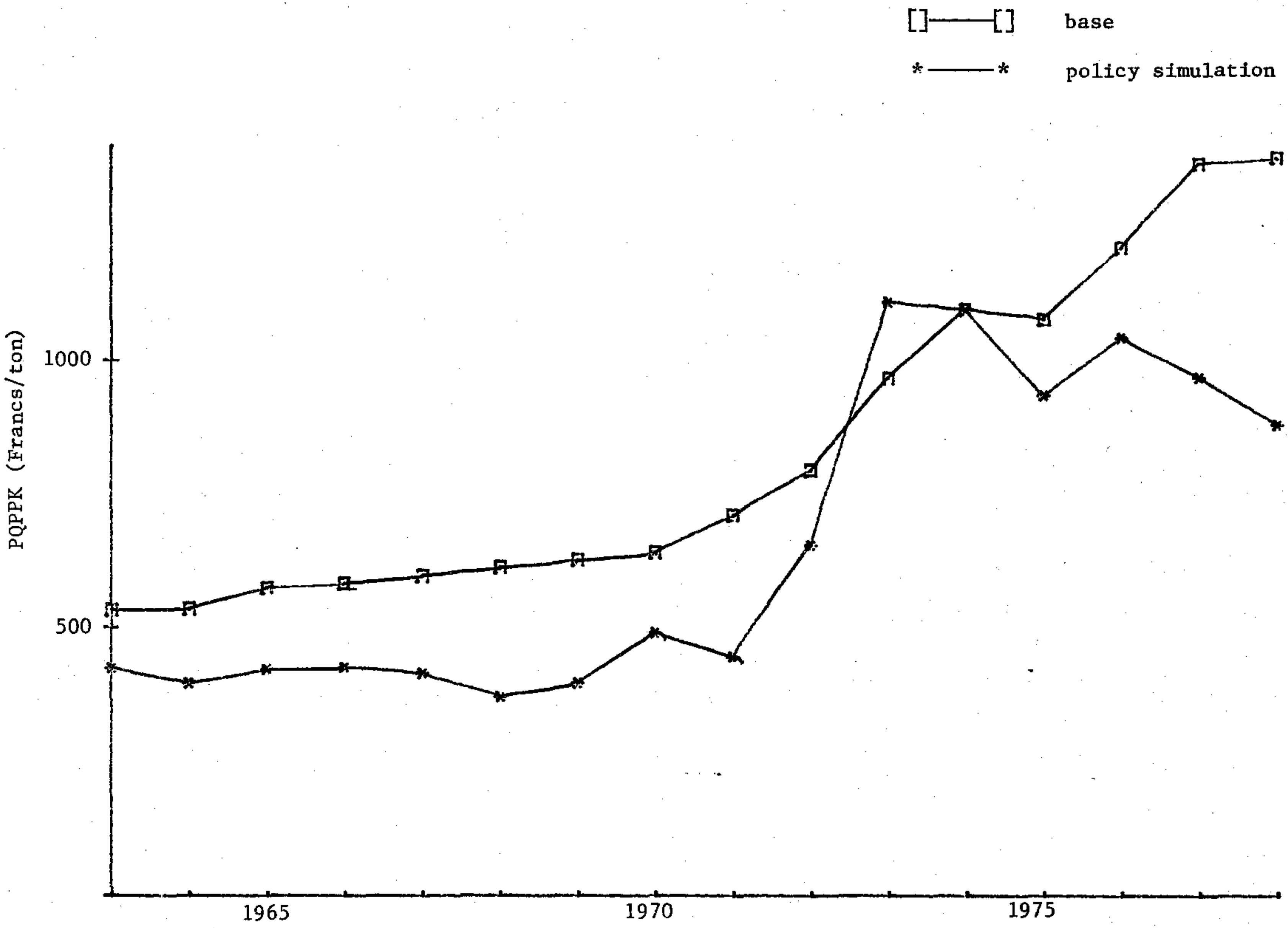

FIGURE 7.10. Impact of a reduction of domestic feedgrain price to world level prices on the price of compound feed for hogs.

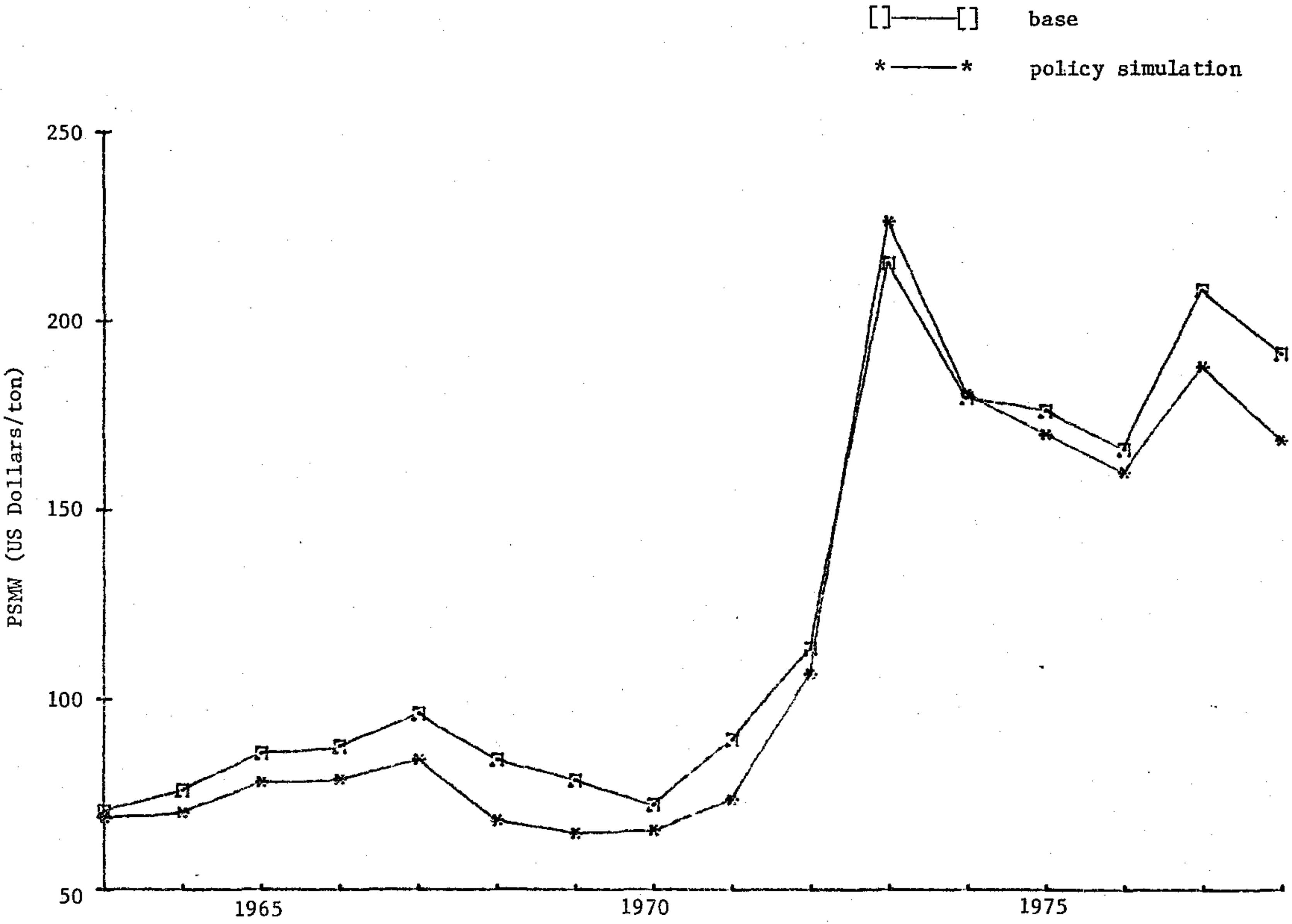

FIGURE 7.11. Impact of a reduction of domestic feedgrain prices to world level prices on the world price of soymeal.

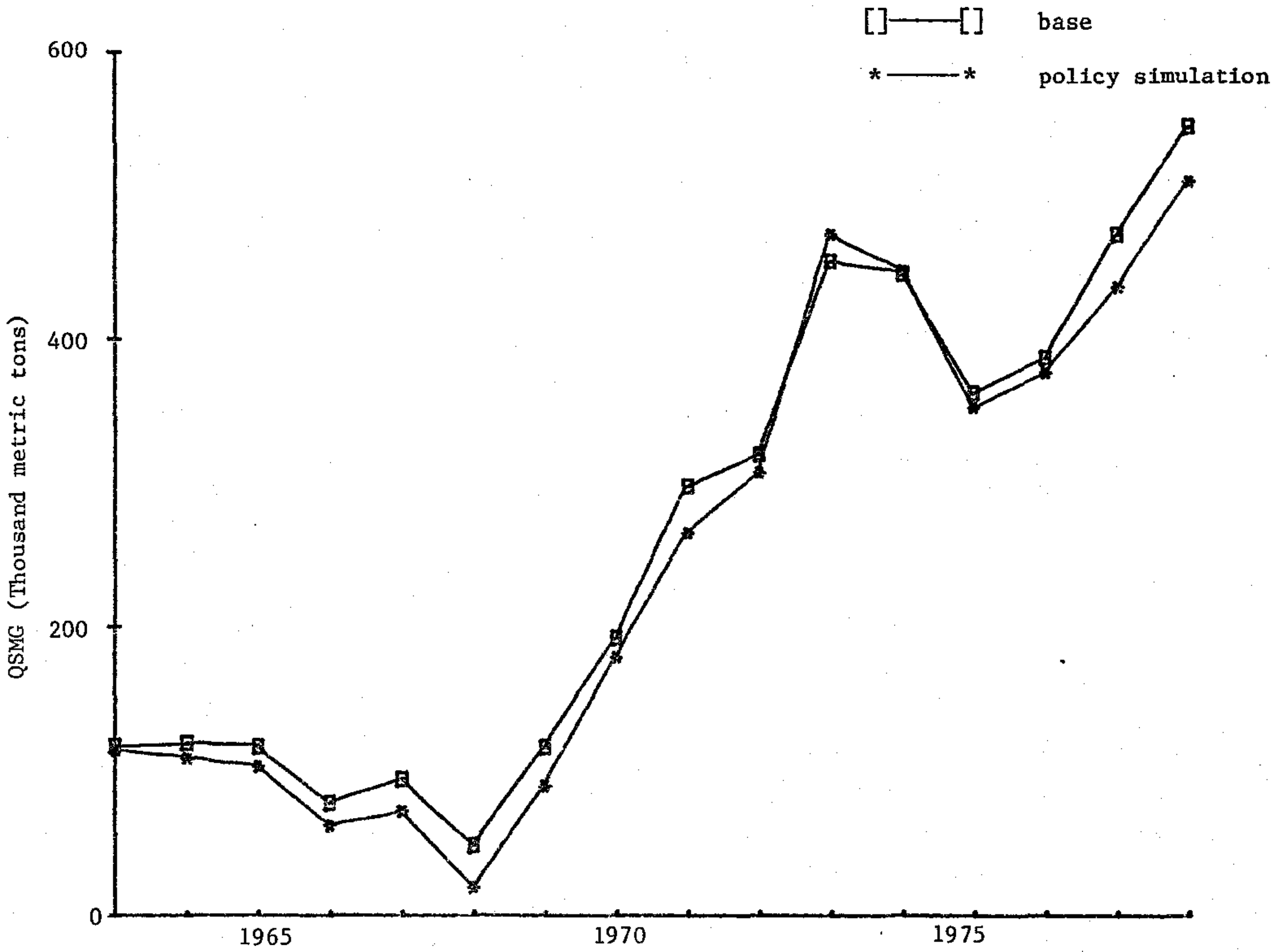

FIGURE 7.12. Impact of a reduction of domestic feedgrain prices to world level prices on the domestic production of soymeal.

restrictions on putting a tariff on soymeal. A tariff on soymeal may be necessary in order to favour the development of domestic high-protein sources.

Paarlberg (1977 and 1980) studied the impact of a 20 percent soymeal tariff on the West German and the EEC soybean complexes. A similar analysis based on the use of a two-country model is given by Figure 7.13. In this graphical representation of the world and French soymeal markets, the far right-hand graphs depict the French and Rest of World soymeal sectors. The middle graphs represent the trade sector with world prices of soymeal expressed in French francs in the upper diagram and U.S. dollars in the lower graph. For the sake of presentation, transfer costs are assumed to equal zero.

The imposition of a tariff on soymeal imports raises the domestic price to P'_d, whereas the world price expressed in U.S. dollars is lowered to P'_W. The establishment of these new equilibrium prices results from shifts in the excess supply and demand of the Rest of the World and France, respectively. French production of soymeal expands to q'_1, whereas domestic demand is reduced from q_2 to q'_2. Imports of soymeal by France decline from q_3 to q'_3. In the Rest of World soymeal market, similar shifts occur but in the opposite direction.

Since soymeal is linked to soybeans by a fixed technical and price relationship, the imposition of a tariff on soymeal imports leads to side effects which may offset the impact of such a policy. Thus, in the case of West Germany, Paarlberg (1977) has shown that, depending on the elasticities of the excess supply of soybeans and

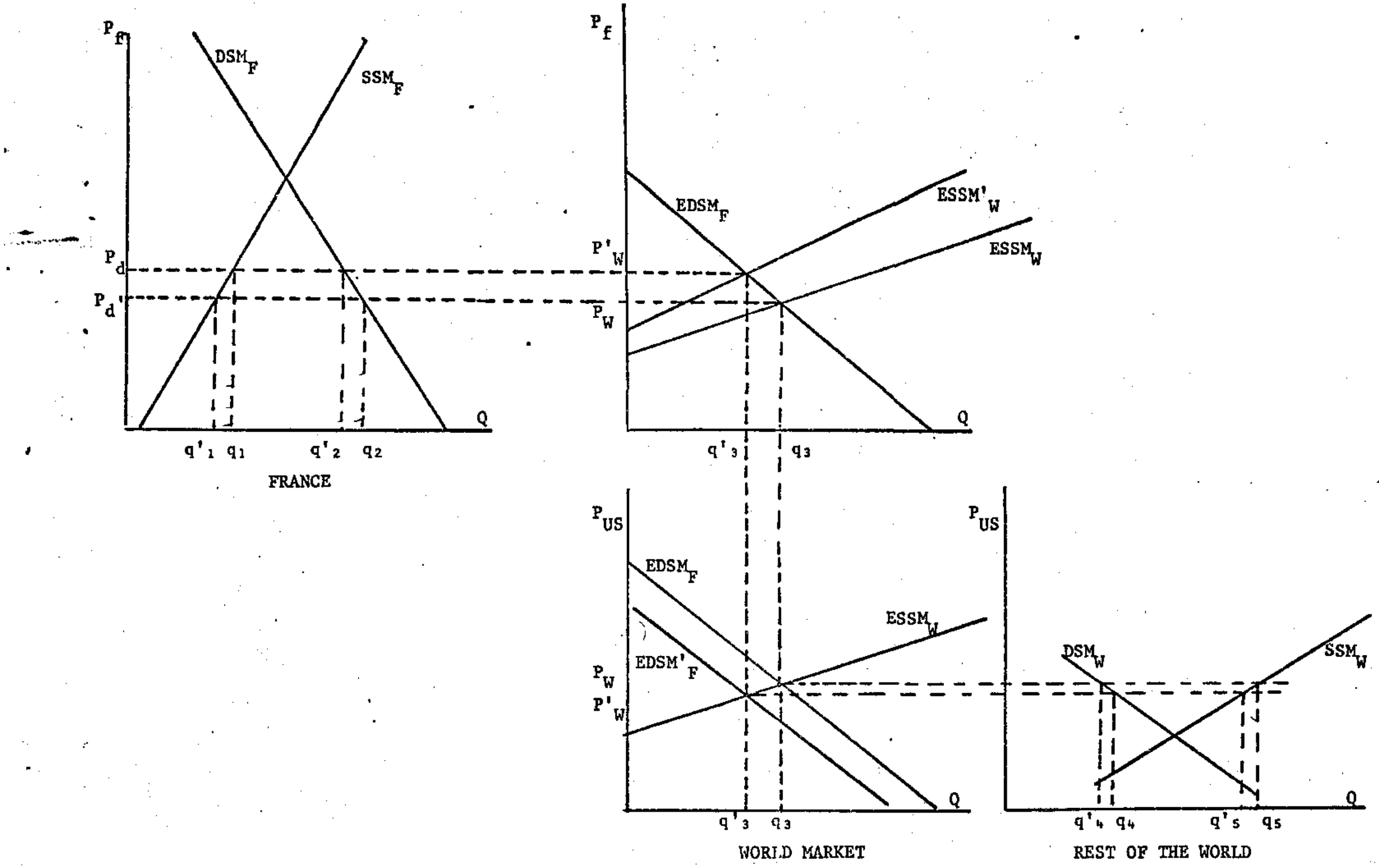

FIGURE 7.13. Effect of a 20 percent tariff on the French soymeal economy

SOURCE: Adopted from Paarlberg (1977, p. 119) soymeal and the specification of the model, the domestic price of soymeal may decline. For France, such results are unlikely, given the structure of the French soybean market and the acceptance of the small country assumption for France with respect to soybeans. With the increase in the domestic price of soymeal, French crushers process more soybeans, thereby requiring a larger quantity of soybean imports.

In other words, the protein dependence problem faced by France is switched from the soymeal to the soybean market. This might be helpful but only in terms of value added and in the diversification of imported supplies.

Table 7.5 reports the average simulated values of each endogenous variable for a 20 percent soymeal tariff during the 1962-1977 period, while Figures 7.14 to 7.18 show the time path of the variables subject to the greatest variation. Simulation results confirm the expected effects. With the exception of the demand for soymeal by farmers, variables describing the French soymeal market respond to a 20 percent tariff on soymeal imports. By contrast, the various demands for feedgrains and for compound feeds do not vary at all. These latter results might be expected since most of these demand variables are very price inelastic.

7.6. Conclusion

This chapter presents the results of policy simulations undertaken with the view of analyzing their effects on reducing soymeal imports. Four policies were selected and their impact on the demand,

TABLE 7.5. Effect of a 20 percent soymeal tariff on the French soybean economy for the 1962-1977 period

	Base Solution Average Values	20 Percent Soymeal Tariff Average Values	Percentage Change
Soybean crush (CRSOG)	288.72	313.03	10.4
Soymeal demand by compounders (DSMC)	868.75	846.35	- 4.97
Soymeal demand by farmers (DSMF)	193.17	192.38	- 0.31
World price of soymeal (PSMW)	115.05	104.94	- 9.09
Commercial demand for feedgrains (DCFGC)	4607.81	4638.31	0.77
Non-commercial demand for feedgrains (DCFGF)	7299.48	7314.85	0.2
Total demand for soymeal (DSM)	1071.93	1038.74	- 3.96
Total demand for compound feeds (TOTQCOMP)	6460.16	6435.67	- 0.4
Price of compound feeds for hogs (PQPPK)	773.20	791.34	2.24
Price of compound feeds for broilers (PQBR)	775.25	782.99	0.94
Price of compound feeds for laying hens (PQLH)	786.10	795.72	1.16
Price of compound feeds for beef and dairy cattle (PQBF)	606.09	617.79	1.82
Domestic supply of soymeal (QSMG)	230.98	250.43	10.4
Domestic supply of soyoil (QSLG)	51.48	55.82	10.4
Excess supply of soymeal (ESSMG)	853.39	800.75	- 7.73
Domestic price of soymeal (PSM)	639.58	696.44	8.53
Soybean oil trade balance (TRSL)	- 4.9	- 0.57	78.06

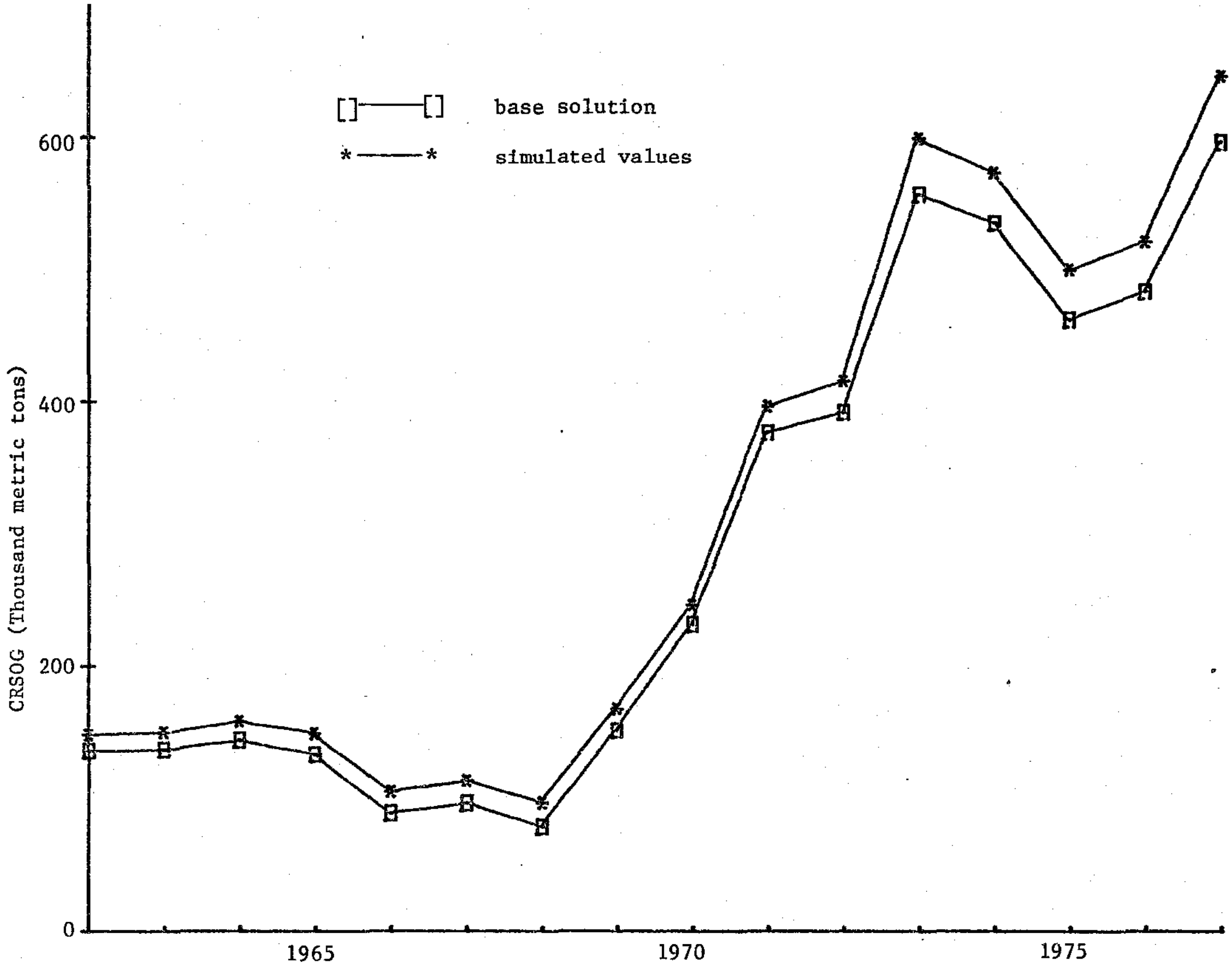

FIGURE 7.14. Impact of a 20 percent soymeal tariff on the demand for soybean crush in France between 1962 and 1977

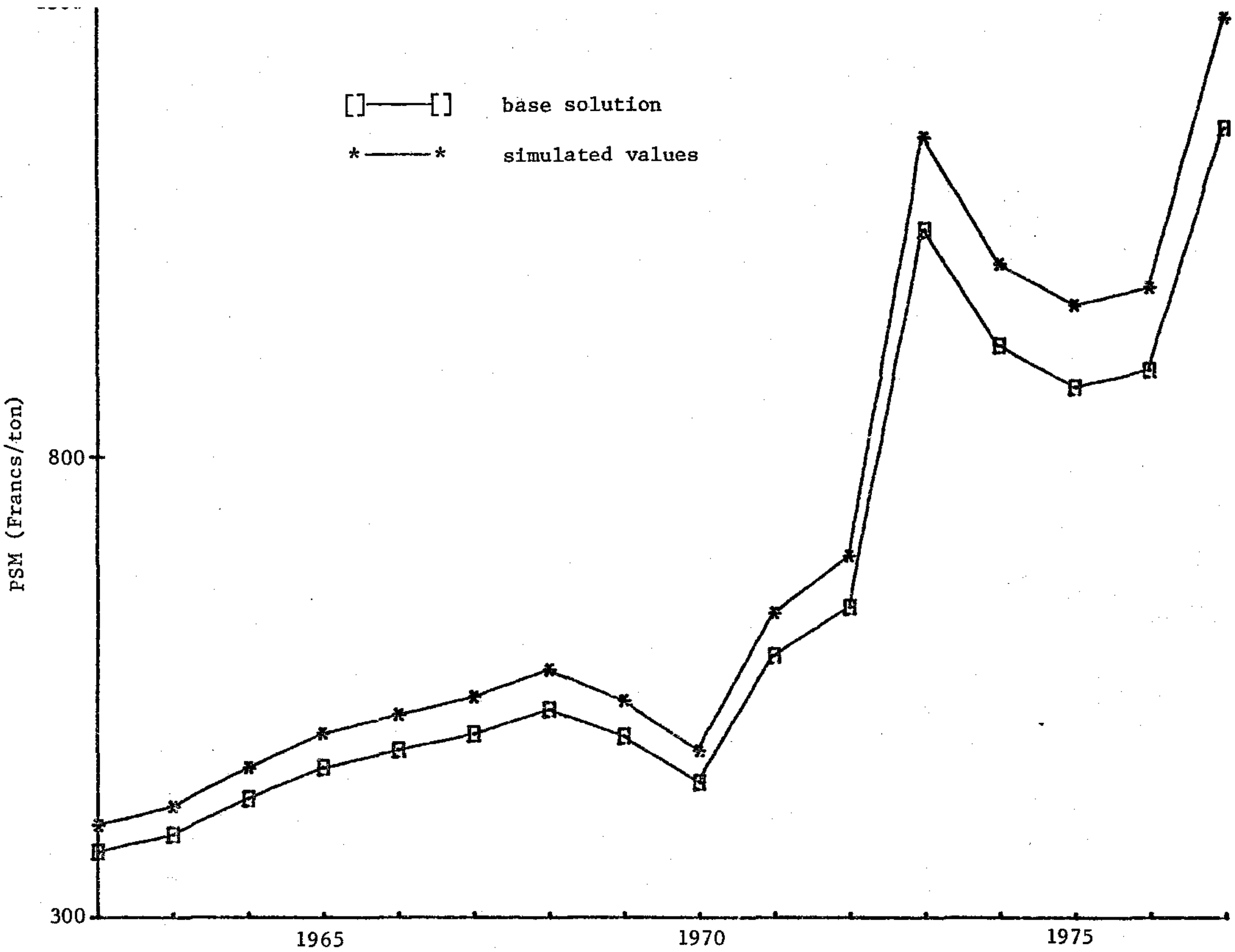

FIGURE 7.15. Impact of a 20 percent soymeal tariff on the domestic price of soymeal

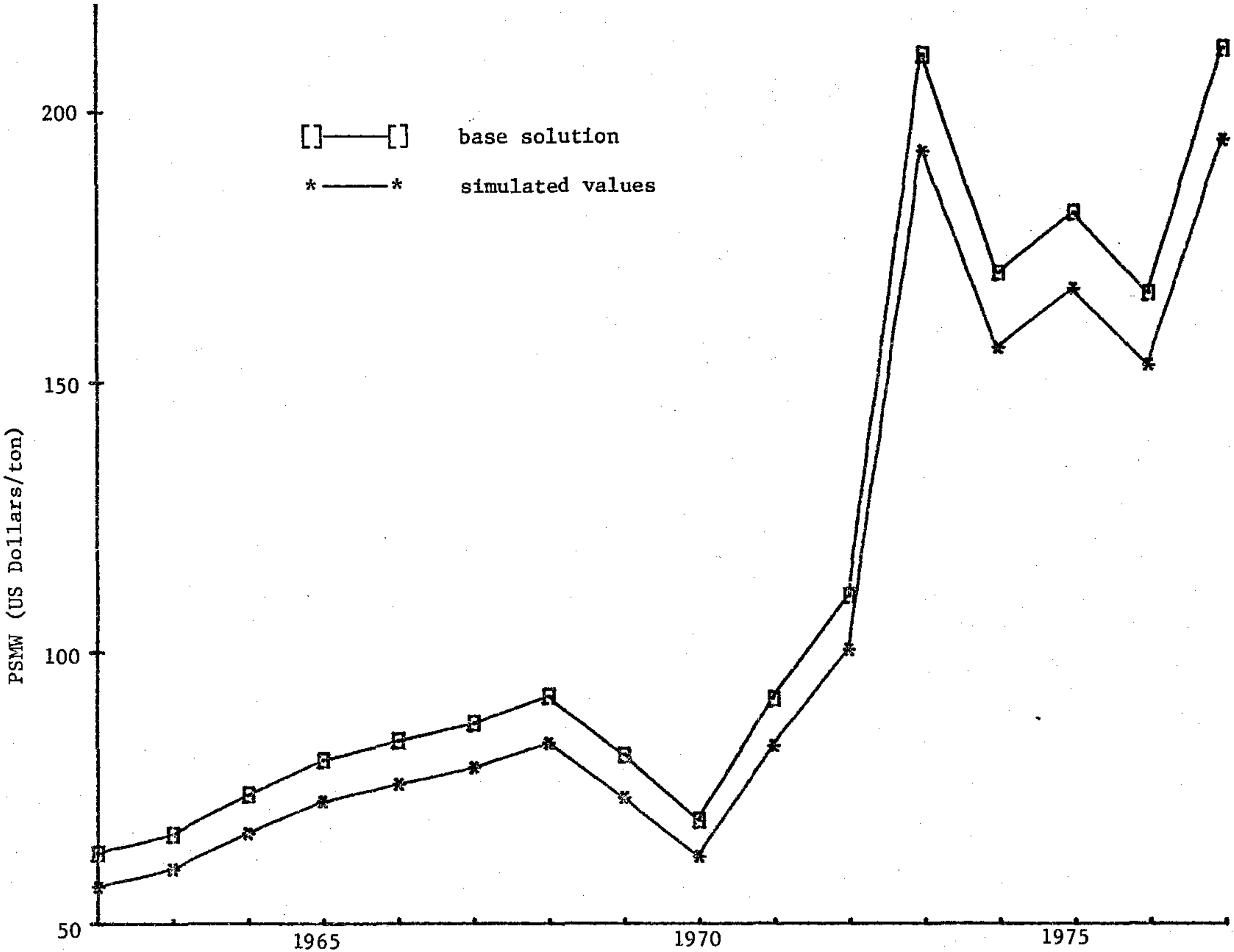

FIGURE 7.16. Impact of a 20 percent soymeal tariff on the world price of soymeal.

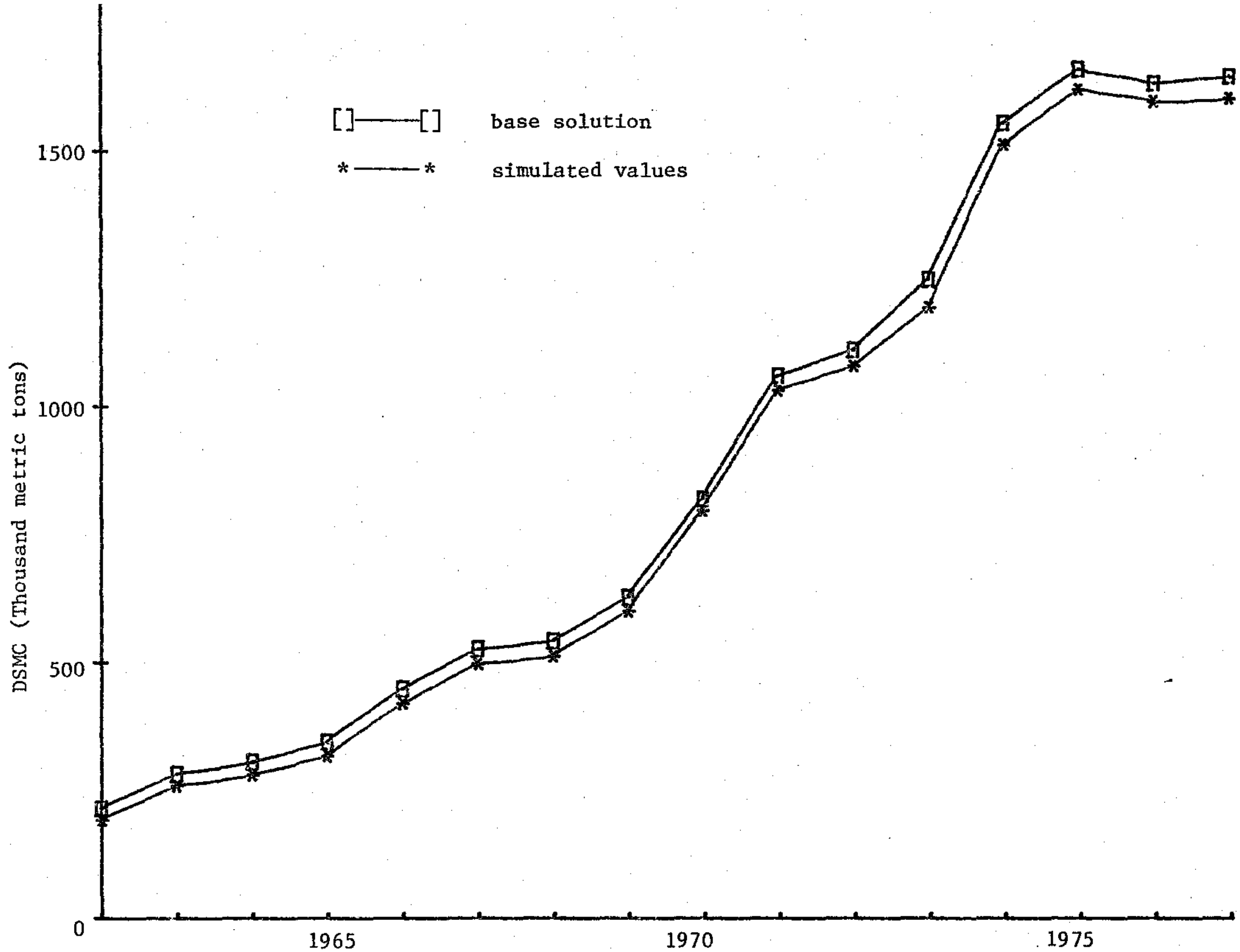

FIGURE 7.17. Impact of a 20 percent soymeal tariff on the demand for soymeal by compounders.

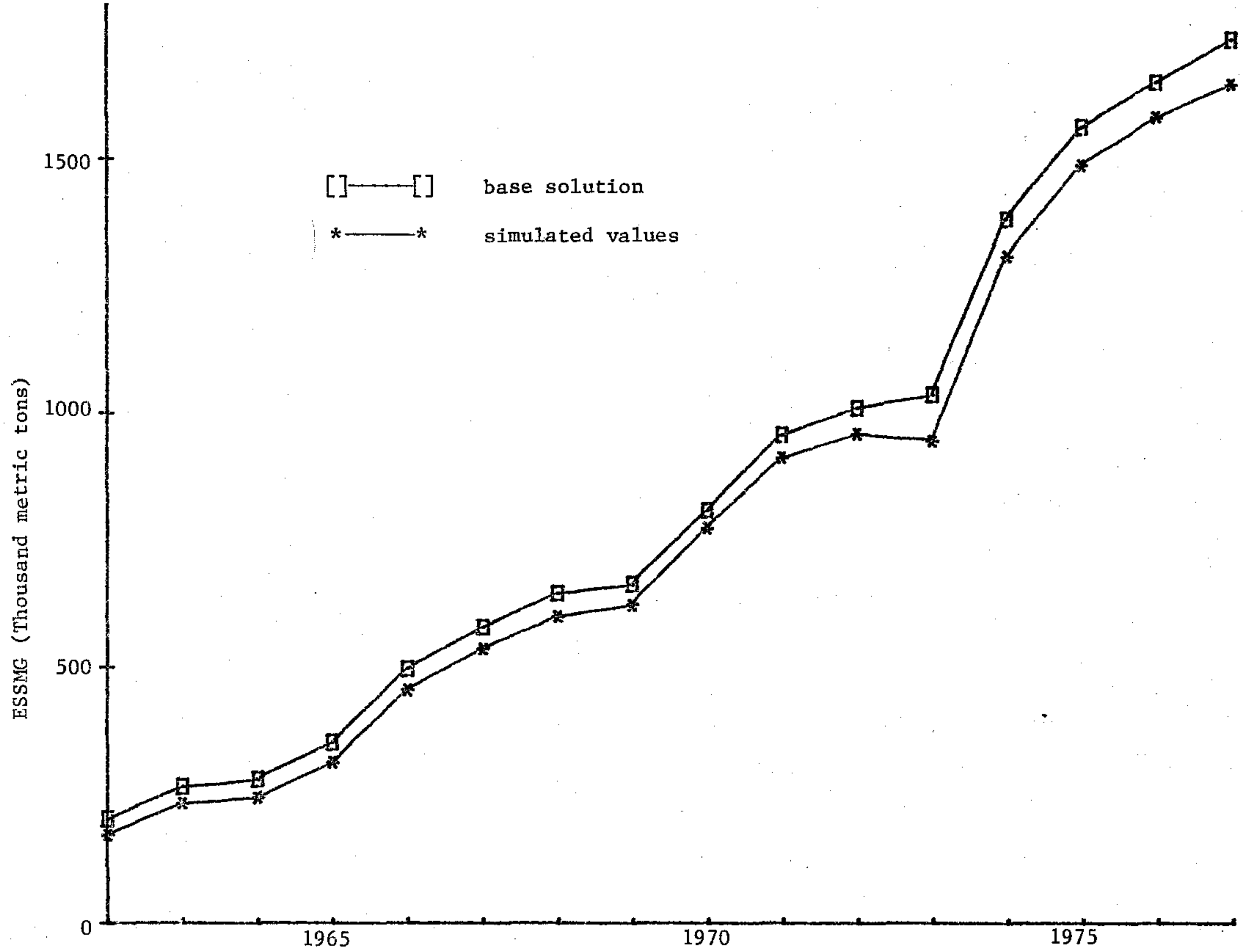

FIGURE 7.18. Impact of a 20 percent tariff on the excess supply of soymeal.

supply and price of soymeal, and on the demand for feedgrains were evaluated. Since the range of these policies is very broad, it is interesting to compare the effectiveness of the policies in reaching a higher level of protein independence. Although it is impossible to measure the social costs of each policy and hence the net social benefits, it is instructive to compare the implied impacts of these policies on the endogenous variables. In Table 7.6, the average impacts of each policy on the endogenous variables are compared. The following notation has been adopted to interpret this table: the letter S means that a policy has a very small effect on the endogenous variable, whereas an arrow indicates a strong impact and the direction of change.

Using these two criteria, it can be seen that all of the policies fulfill in varying degrees the prescribed objective with respect to the soymeal economy, while the demand for feedgrains is not subject to great changes.

TABLE 7.6. Impact of the different policies at the French crush, soymeal and feedgrain markets

	Policy I Increase in Crushing Capacity	Policy II Increase in the Quantity of Other High-Protein Feeds	Policy III Reduction of EEC Feedgrain Prices to World Price Level	Policy IV Tariff on Soymeal Imports
Demand for soybean crush (CRSOG)	↑	S	↓	↑
Demand for soymeal by compounders (DSMC)	S	↓	S	↓
Demand for soymeal by farmers (DSMF)	S	S	↓	S
Total demand for soymeal (DSM)	S	↓	↓	↓
Excess supply of soymeal (ESSMG)	↓	↓	↓	↓
Domestic price of soymeal (PSM)	↓	↓	↓	↑
World price of soymeal (PSMW)	↓	↓	↓	↓
Domestic supply of soymeal (QSMG)	↑	S	↓	↑
Commerical demand for feedgrains (DCFGC)	S	S	S	S
Non-commercial demand for feedgrains (DCFGF)	S	S	↑	S

Note: The arrow indicates the direction of changes and the letter S shows the existence of very small effects.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

8.1 Summary and Concluding Remarks

The general theme of this research has been the analysis of future trends in the demand for soybeans, soybean oil and soybean meal in France. The investigation has been conducted in light of the recent policy issues raised in France, and other EEC member countries, with regard to their dependence on imported protein sources and the central role played by imported soymeal in the feed-livestock complex.

An econometric model based on the microeconomic theory of the firm has been developed to represent, simultaneously, the three soybean markets and the French feed-livestock industry. The model allows for an assessment of the impact of a number of factors on the French soybean complex; namely, the role of the Common Agricultural Policy and the place taken by the feed manufacturing industry. With respect to the feed manufacturing industry the model captures the tremendous modifications in feeding practices experienced by French farmers for the past two decades, and presents an alternative way of incorporating technological innovations in economic relationships. The basic feature of this procedure is to take into account the adoption process attached to the increasing use of formula feeds by farmers in the corresponding demand specification.

Given the strong substitutability pattern prevailing in the

French vegetable oil market, the demand for soybean oil has been specified, taking into consideration the demand for different vegetable oils, including peanut and rapeseed oils. Furthermore, dummy variables and non-linearities in both variables and parameters have been included in the econometric model to capture the numerous structural changes that have taken place in the French soybean economy during the late sixties and 1970's.

The empirical results obtained using the model suggest the following conclusions on the demand patterns for soybeans, soyoil and soymeal in France. First, it has been found that structural factors identified in the course of the analysis and incorporated in the model explain a large part of the demand for soybean oil, peanut oil, rapeseed oil, the demand for soymeal by farmers and the demand for each compound feed. Second, as in any other study dealing with the EEC or single member countries' soybean complexes, the results obtained for France indicate that the demand for soybean products is highly price inelastic. Furthermore, elasticities computed for different time periods reveal a trend towards smaller values of price elasticities in the seventies than in the sixties.

Third, the French soybean model has satisfactory explanatory and predictive power. In terms of forecasting ability, the historical and projected trends for each endogenous variable conform with a priori expectations. Thus, assuming that the world oilseeds economy will evolve at a steady pace from 1978 onwards, it has been found that the demand for soymeal in France is predicted to expand at an annual growth rate of 3.32 percent between 1978 and 1982 and 1.53 percent between 1982 and 1985 with the price of soymeal remaining at the 1978 level until 1982 and declining slightly after this. The only shortcoming of the model concerns the soybean oil block which is not capable of predicting accurately the demand for different vegetable oils. This failure is essentially attributable to the dummy variables introduced in each demand equation and the likely occurrence of other structural changes in this market during the eighties.

Fourth, an important facet of this research has been to compare the effects of different agricultural policies aimed at reducing imports of soybeans and soymeal by France. Of the four policies considered, each of them has, in general, a significant impact on the total demand for soymeal and price of soymeal. However, these results should be interpreted with some caution because of the more inelastic price response of the excess supply for soymeal than expected.

8.2 Needs for Further Research

Although the model estimated in this study and the subsequent simulations provide valuable insights on the future evolution of the demand for soybeans and soybean products in France, there is no doubt that further research is required to understand more fully the French soybean economy and its functioning. Data collection, model specification, policy evaluation and regionalization of the demand pattern for soymeal are the four research areas which deserve more attention.

It has been pointed out that the lack of reliable data on some components of the French soybean economy and the feed livestock sector has hindered the specification of some economic relationships and has necessitated the utilization of proxy variables. In particular, it is desirable that attempts to collect statistical observations on the domestic prices of vegetable oils and the consumption of feed ingredients by class of livestock are undertaken.

The specification of the econometric model has several weaknesses which should be corrected. While good fits are obtained over the sample period, the soybean oil block presents serious deficiencies in regard to the role of structural factors in each demand equation for vegetable oils. In that respect dummy variables should be replaced by other modeling procedures that might be more effective.

Despite the fact that the model specification used to represent technological innovations in each demand equation for compound feeds gives valuable information on the growth process of this sector, more attention should be paid to the physical, institutional, economic and technical constraints underlying the process. Thus, better estimates of the penetration effect of compound feeds in the animal feed market might be obtained if the a priori information on the penetration process is explicitly incorporated in the demand equation for each compound feed. Another pitfall of the sub-model describing the compound feed industry is that not all types of compound feeds are incorporated in the model framework. In fact, it is of primary importance to extend the scope of this sub-model in order to embody other commercially mixed feeds, such as those fed to rabbits and pets which have not yet reached the saturation level.

Because of the latent autocorrelation problem appearing in the commercial demand for feedgrains and soymeal equations, one may question whether or not an econometric procedure is the most suited to represent the technical and economic links between the feed input markets and the manufacturing feed industry. Indeed, an alternative approach based on a linear programming model may alleviate some of the statistical problems and offers the advantage of taking into account the intersubstitutability patterns existing between feed ingredients.

Whereas "horizontal" relationships between the manufacturing feed industry and the on-farm sector of the animal feed market are well represented in the soybean model, the farm component of the demand for feed ingredients needs to be improved. In particular, a better specification of the demand for soymeal by farmers may be possible.

Although this research has focused on the domestic characteristics of the French soybean economy, it is acknowledged that several shortcomings exist in the price determination mechanism of the domestic and world soybean prices. As in Paarlberg's study on the West German soybean economy, the use and specification of an excess supply equation for French imports of soymeal does not yield very satisfactory results.

In terms of policy evaluation, the major shortcoming of the present model is that it rests on a partial price equilibrium mechanism for the soymeal market while the livestock and feedgrain sectors are exogenous. To overcome this problem, endogenous livestock and cereal sub-models need to be specified.

Lastly, given the geographical distribution of livestock and feedgrain activities in France, the impact of location should be emphasized more. In that regard, a regionalization of the demand pattern for soymeal and a study of the performance of the feed input markets in France would be very instrumental in explaining the actual expansion of the demand for soymeal in France.

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APPENDICES

APPENDIX A1

Throughout the thesis, a number of terms designating different feeds are employed. In order to prevent confusion, a classification system and definitions of the main feeds currently consumed in France are given in this appendix. Special attention is given to the various types of compound feeds whose definition varies from one country to another.

To establish an overall feed supply balance sheet, the French Ministry of Agriculture distinguishes three groups of feedstuffs (SCEES, No. 139, pp. 140-143): i) marketable feedstuffs which are differentiated according to their source of origin, i.e., plant, animal or derived from industry by-products; ii) non-marketable feedstuffs which roughly correspond to forage feeds; and iii) industrial products mainly made from chemicals such as urea. This categorization is not very helpful or convenient in classifying the different feed groups and feed ingredients used by French livestock producers. In fact, no separation between manufactured and non-manufactured, home-grown and purchased feeds appears in the Ministry's classification scheme.

The taxonomy presented by Longmire in a study of the U.K. animal feed market is much more functional and permits a clear differentiation of feed compounds from other feeds. In Figure 1.1, the group "compounds" comprises a number of cereals and other feed ingredients which are blended to provide a balanced and economical

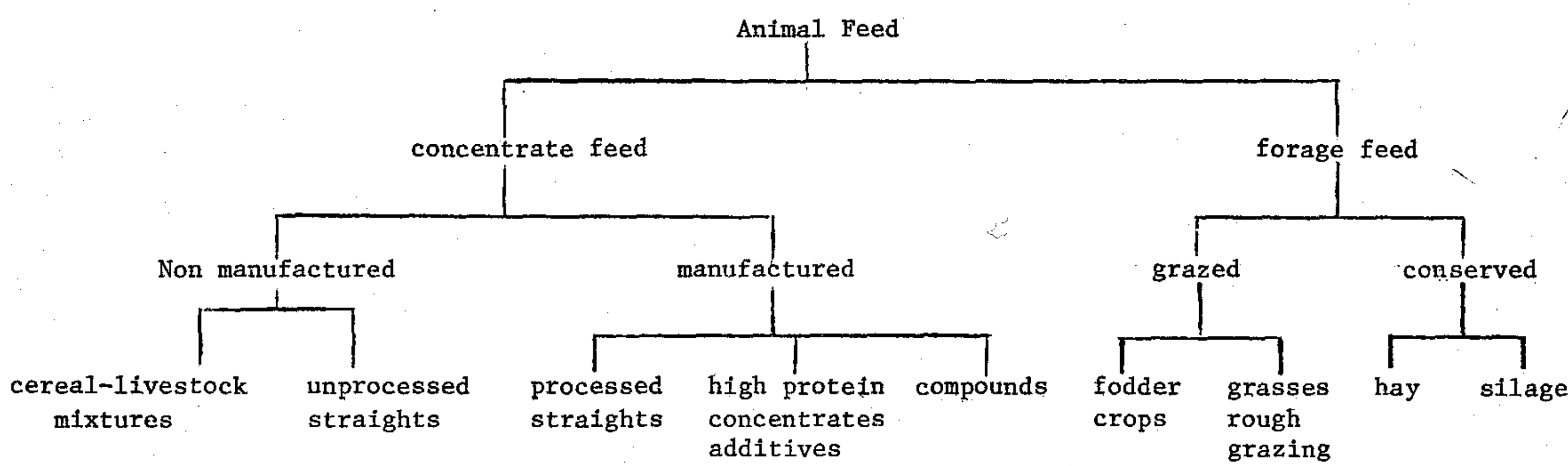

Figure 1.1 Taxonomy of animal feed

Source: Longmire

feed for livestock.

French regulations differentiate three kinds of compound feed (Foucault, pp. 18-20):

A. <u>Complete feeds</u> shall contain less than five constituents (including less than 20 percent mineral ingredients) belonging to at least three of the following four categories:

cereals and carbohydrates
cereals and pulses derivatives
oilcakes and other nitrogenous products
sundry supplements (additives, vitamin)

A complete feed, when administered in the quantities prescribed in the directions for use, are adequate under normal management conditions to afford to normal animals of the species and class concerned the full range of nutritional ingredients in their diet necessary for the breeding of animals.

B. <u>Supplements</u> supplement or balance the basic ingredients of a feed ration to afford normal animals full nourishment as defined above. Such products must also contain constituents belonging to at least two of the four categories referred to above (necessarily including various supplements).

C. <u>Premixes</u> can be a mineral compound, compound with vitamins, or nitrogenous and mineral compounds with vitamins. This last category contains more than 20 percent mineral ingredients. Compound feeds with vitamins must also contain in addition not less than 20 percent of crude high protein ingredients.

Because premixes are used by feed manufacturers to provide supplements and complete feeds, they are not considered in the empirical work. The lack of sufficient data involves aggregating complete feed and supplements into one group called compound feeds.

Feeds and feed ingredients which are of concern in this study are feed concentrates with high nutrient density. Underlying this latter group is the differentiation of feeds by type into two subsets:

i) high energy ingredients essentially formed by cereals and carbohydrates. More generally, an energy feed will be considered any ingredient whose contents in protein and crude fiber are lower than 20 percent and 18 percent, respectively (Church, p. 82).

ii) protein groups made up of products which contain more than 20 percent protein. In this latter category, soymeal and other oilseed cakes are the most representative.

The separation in Diagram 1.1 between manufactured and non-manufactured feeds allows for the delineation of compound feeds.

Another fruitful way of categorizing animal feeds for this research would have been to split feeds into home-grown and purchased groups. Such an approach which overlaps with the French classification system is difficult to undertake due to deficiencies in data.

APPENDIX A2

This appendix presents all the data, and assumptions employed to construct an average feed supply balance sheet for France, over the crop years 1971 to 1974 (July - June). To analyze fully the trade-offs between energy, high protein feeds and roughages, the French feed supply balance has been estimated in terms of feed units and digestible protein units. Similarly, to appreciate the importance of the feed manufacturing industry in the animal feed market, each feed ingredient has been broken down into three categories according to end-use:

i) on-farm consumption;
ii) directly bought by farmers; and
iii) purchased by feed compounders.

This breakdown is based on information available in the publications listed below and on a number of assumptions. Subsequently, the results obtained may not be exactly accurate but they are good indicators of the structure of the French Animal Feed Market. Due to the lack of reliable data, it has been impossible to investigate the French animal feed market by class of livestock. The classification of manufactured feed ingredients as a high energy or high protein feed inputs has been done along the lines adopted by animal nutritionists (Church, pp. 43-49). More specifically, it has been assumed that all feed ingredients that contain more than 20 percent crude protein are a member of the high protein feed group.

The conversion coefficients used to estimate each feed ingredient in terms of energy or digestible feed units are those currently used by the statistical services of the French Ministry of Agriculture.

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ONIC Statistics.

Assumptions

In order to allocate some of feed ingredients to each category and due to the lack of data, the following simplifying assumptions have been made:

cereal by-products were assumed to be bought exclusively by feed compounders.

oilmeals: The only oilmeals which farmers can buy directly are soymeal, peanut meal and linseed meal. Averaging the related data for the period considered yields the following percentage of the farm consumption with respect to the total demand for each concerned meal:

peanut meal	=	32 - 38 percent of the total consumption
linseed meal	=	10-14 percent
soybean meal	=	15-31 percent

dairy by-products: Of milk and dairy by-products, skimmed milk powder is assumed to be purchased exclusively by compounders.

other concentrates: include potatoes, sugar, animal fats and oils, brewery by-products and distillery by-products.

TABLE A2.1. Amounts of feedstuffs available for livestock in France in digestible protein units (1971-1974)

	On-farm Consumption	%	Directly Bought by Farmers	%	Purchased by Compounders	%	Total	%
Wheat	205.0	2.35	17.68	0.20	134.0	1.55	356.68	4.1
Barley	215.61	2.47	15.78	0.18	44.93	0.52	276.32	3.17
Corn	106.21	1.22	28.67	0.33	161.05	1.85	295.93	3.4
Other cereals	179.4	2.06	33.7	0.39	16.6	0.18	229.6	2.63
TOTAL CEREALS	706.22	8.1	95.73	1.1	356.58	4.1	1158.53	13.3
Cereal by-products					189.0	2.18	189.0	2.18
TOTAL OILCAKES			163.69	1.88	742.31	8.52	906.0	10.41
Soymeal			94.61	1.09	523.14	6.01	617.75	7.1
Rapeseed meal					58.75	0.67	58.75	0.67
Other meals			69.08	0.8	160.42	1.84	229.5	2.64
Fishmeal					48.5	0.56	48.5	0.56
Milk and dairy by-products	273.0	3.14			128.75	1.48	401.75	4.62
Lucern meal			20.67	0.24	41.33	0.47	62.0	0.71
Meat meal					84.75	0.93	84.75	0.93
TOTAL HIGH-PROTEIN FEEDS	273.0	3.14	184.36	2.12	1045.64	1.2	1503.0	17.24
Mollasses and sugar by-products					45.0	0.53	45.0	0.53
Other concentrates	14.75	0.17			41.75	0.48	56.5	0.65
TOTAL CONCENTRATES	993.97	11.41	280.09	3.21	1677.97	19.29	2952.03	33.92

TABLE A2.1. Continued

	On-farm Consumption	%	Directly Bought by Farmers	%	Purchased by Compounders	%	Total	%
Grass	3855.0	44.29					3855.0	44.29
Other forage feeds	1896.75	21.79					1896.75	21.79
TOTAL DIGESTIBLE PROTEIN	6745.72	77.5	280.09	3.21	1677.7	19.29	8703.75	100.0

TABLE A2.2. Amount of feedstuffs available in France in feed units (1971-1974)

	On-farm Consumption	%	Directly Bought by Farmers	%	Purchased by Compounders	%	Total	%
Wheat	2345.6	3.18	202.3	0.27	1533.6	2.05	4081.5	5.5
Barley	3717.5	5.03	272.1	0.37	774.7	1.05	4764.3	6.45
Corn	1873.2	2.54	505.6	0.68	2556.4	3.48	4935.2	6.7
Other Cereals	1818.61	2.46	340.86	0.47	168.52	0.24	2328.04	3.17
TOTAL CEREALS	9754.6	13.21	1320.86	1.79	5032.72	6.82	16019.04	21.82
Cereal by-products					1053.0	1.43	1053.0	1.43
Cassava					73.25	0.07	73.25	0.07
TOTAL OILCAKES			394.66	0.54	1930.09	2.61	2324.75	3.15
Soymeal			235.6	0.32	1302.65	1.76	1538.25	2.08
Rapeseed meal					172.75	0.23	172.75	0.23
Other meals			159.06	0.22	454.69	0.62	613.75	0.84
Fishmeal					76.25	0.1	76.25	0.1
Meat meal					130.75	0.15	130.75	0.15
Milk and dairy by-products	1850.25	2.5			778.75	1.1	2629.0	3.6
Lucerne meal			84.67	0.11	169.33	0.23	254.0	0.34
TOTAL HIGH PROTEIN FEEDS	1850.25	2.5	479.33	0.65	3085.17	4.19	5414.75	7.34
Mollasses and beet by-products			541.13	0.74	266.63	0.36	807.76	1.1
Other concentrates	325.0	0.44			298.5	0.4	619.5	0.84
TOTAL CONCENTRATES	11926.21	16.15	2341.52	3.17	9808.77	13.28	24076.3	32.6

TABLE A2.2. Continued

	On-farm Consumption	%	Directly Bought by Farmers	%	Purchased by Compounders	%	Total	%
Grass	35433.25	48.0					35433.25	48.0
Other forage feeds	14309.25	19.4					14309.25	19.4
TOTAL FEED UNITS	61668.71	83.55	2341.32	3.17	9808.77	13.28	73818.8	100.0

APPENDIX A3

CONSTRUCTION OF A TIME SERIES ON FRENCH SOLVENT CRUSHING CAPACITY

The first attempt to calculate crushing capacity in an EEC member country over a long period was undertaken by Paarlberg for West Germany. Using information produced in various Soybean Blue Books, he developed a time series which "contains 50 percent of the actual crushing capacity and is a good proxy indicative of trends in the German industry as a whole" (Paarlberg, 1977, p. 151). But the regression coefficient attached to the crushing capacity variable in the West German crush demand equation did not reflect the average effective rate of crushing capacity utilization over the study period indicating that a different procedure may be needed.

For France, information has been obtained from the following references:

i) American Soybean Blue Book published every year by the American Soybean Association;

ii) French professional publications, and various reports issued by the Comptoir National des Techniques Agricoles in 1976, 1977 and 1978;

iii) a study undertaken in 1961 by Spillsbury on behalf of the USDA on the West European soybean complex; and

iv) personal interviews with professionals in the European Federation of Oilseed Crushers.

The task of building a time series for France is facilitated by features specific to the French crushing industry, developed in Chapter II.

First, the French oilseed crushing industry has a volume of processing facilities which has remained constant in terms of capacity for the last fifty years. The only change has been an increase of the quantity of rapeseed and soybeans crushed at the expense of peanuts. As a result, it is assumed that the crushing capacity estimated by Spillsbury in 1961 at 1.65 to 1.8 million tons constitutes a bench mark for the evaluation of crushing capacity until the opening of the first large crushing plant in 1970.

Second, with the progressive concentration occurring in the French crushing industry, the number of plants has declined while the average size has increased. With the opening of the St. Nazaire Plant which has a capacity exceeding 300,000 tons, French crushing capacity increased greatly. As time goes and with the application of new technology in the crushing process, it is believed that most crushing plants are becoming more specialized in the crushing of a given oilseed. It is assumed that the data given by the different Soybean Blue Books captures this trend. However, this assumption is probably more accurate over the latter part of the study period.

Table A3.1 shows the data used to evaluate the French solvent crushing capacity devoted to soybeans.

The third and fourth columns of Table A3.1 contain final data, assuming that crushing plants operate three hundred days per year.

The final column of the table lists the estimated utilization rates of the plants which seem reasonable when compared to the quantity of soybeans crushed.

	Number of Plants Reported in the Soybean Blue Book		Daily Crushing Capacity of Plants (metric tons/day)	Yearly Crushing Capacity ('000 metric tons)	Quantity of Soybeans Crushed in France ('000 metric tons)	Utilization Rate
	Without Mention of the Crushing Capacity	With Mention of the Crushing Capacity				
1955	4	4	390	117	88	75.2
1956	2	2	225	67.5	66.7	98.8
1957	2	2	225	67.5	68	100.7
1958	2	2	225	67.5	53.8	79.7
1959	4	4	495	148.5	81.6	54.9
1960	4	4	495	306	176.2	57.6
1961	22	8	1,020	306	78.9	25.8
1962	21	7	1.070	321	144.9	45.1
1963	24	9	1,130	339	128.1	37.8
1964	22	8	1,010	303	191	63
1965	22	8	990	297	118	39.7
1966	21	8	980	297	121	40.7
1967	6	6	820	246	135	54.9
1968	9	6	820	246	52	21.1
1969	8	5	630	189	46	24.3
1970	9	6	1,840	552	423	76.6
1971	9	6	1,840	552	482	87.3
1972	7	6	2,240	672	484	67.9
1973	7	5	2,340	702	510	72.6
1974	7	5	2,340	702	568	80.9
1975	7	5	2,340	702	431	61.3
1976	7	5	2,340	702	524	74.6
1977	8	6	3,540	1,062	562	52.9

Source: Soybean Blue Book, CNTA, Spillsbury.

APPENDIX A4

DATA SOURCES AND PROBLEMS

This appendix presents the data, data sources and data problems encountered in this study. The presentation is made equation by equation with the data references and the definition of every variable.

Soybean Crush Demand (Equation 1)

The main problems encountered with the variables entering this equation concern the construction of a series on French solvent crushing capacity. The procedures used are fully described in Appendix A3.

Table A4.1 presents the complete set of data utilized in the estimation of the crush demand equation and in the computation of the soybean margin.

CRSOG: Quantity of soybeans crushed in France (1000 MT)

Source: FEDIOL, FFIOL.

CRSOCAA: Three year moving average of annual solvent crushing capacity in France (1000 MT)

$$CRSOCAA_t = \frac{CRC_{t-1} + CRC_t + CRC_{t+1}}{3}$$

where: CRC_t = the solvent crushing capacity in year t.

TABLE A4.1. Data used in soybean crush equation

	CRSOG	MSB	CRSOCAA	PSOG	PSLG	PSM	CRAAG	CRPNG	CRC
1956	66.7	74.24	82.3	385.3	1185.5	307.7	77.9	362.6	67.5
1957	68.0	92.93	67.5	405.2	1286.0	333.3	92.5	374.4	67.5
1958	53.8	153.08	137.0	420.9	1479.5	384.6	144.9	413.1	67.5
1959	81.6	101.82	174.0	465.8	1333.5	409.5	113.4	409.8	148.5
1960	176.2	88.80	253.5	460.1	1283.0	397.5	84.8	430.9	306.0
1961	78.9	100.59	311.0	531.1	1621.4	424.8	90.9	462.4	306.0
1962	144.9	70.54	306.0	505.8	1305.9	426.6	59.8	458.7	321.0
1963	128.1	82.22	321.0	531.1	1284.7	477.6	54.3	504.2	339.0
1964	191.0	82.39	313.0	551.7	1343.1	490.4	68.0	453.7	303.0
1965	117.5	62.86	299.0	587.9	1438.9	489.7	174.1	492.0	297.0
1966	121.0	24.65	280.0	603.2	1137.4	528.9	203.0	516.2	297.0
1967	135.0	50.54	263.0	588.9	1176.5	534.6	214.0	496.1	246.0
1968	52.0	33.54	226.0	549.8	968.3	511.3	309.0	523.2	246.0
1969	46.0	75.59	329.0	557.4	1149.5	532.6	347.0	446.7	189.0
1970	423.0	161.97	431.0	619.8	1769.4	579.1	341.0	315.0	552.0
1971	482.0	158.98	592.0	672.0	1868.1	618.4	581.3	217.0	552.0
1972	484.0	73.18	642.0	649.1	1278.5	615.2	616.0	106.0	672.0
1973	513.0	312.14	692.0	883.7	2134.2	1014.6	529.0	232.0	702.0
1974	567.6	375.93	702.0	1246.0	4403.2	1036.7	524.3	214.3	702.0
1975	431.0	80.69	702.0	1031.7	2658.2	809.0	379.0	197.0	702.0
1976	524.0	61.17	822.0	1095.7	2303.0	942.3	392.0	244.5	702.0
1977	561.8	159.66	942.0	1387.7	3121.3	1255.8	458.6	132.3	1062.0

Source: Blue Book, CNTA, FEDIOL and Spillsbury.

CRPNG: Volume of peanuts crushed in France (1000 MT)

Source: FEDIOL, FFIOL.

CRRAG: Volume of rapeseed crushed in France (1000 MT)

Source: FEDIOL, FFIOL.

MSB: Soybean margin (Francs/MT)

MSB = SLYIELD * PSLG + 0.8 * PSM - PSOG

where: SLYIELD = oil yield of soybeans
0.18 1956 to 1974
0.175 1975 to 1977

PSM = import unit value of soymeal (Francs/MT)

PSOG = domestic price of soybeans (Francs/MT)

PSOG = IMPSO * EXCH

where: IMPSO = import price of soybeans CIF Rotterdam in US Dollars/MT

Source: International Monetary Fund.

EXCH: Exchange rate (US Dollars/French Franc)

Source: International Monetary Fund.

Edible Oil Demand (Equations 3, 4 and 5)

As direct data on the consumption of different edible oils is not available in France, implicit oil disappearance has been calculated using the following formula:

edible oil consumption = volume of corresponding oilseed crushed * oil yield + imports of crude oil - exports of crude oil

In this expression, refined waste and stock variations have been omitted, due to the non-availability of appropriate data. All the observations utilized to evaluate consumption of soybean oil are compiled in Table A4.2.

Usually, for the sake of convenience and due to the lack of information, the oil yield is assumed to be constant. For a country like France which imports most of its oilseeds from various parts of the world, this condition does not hold. An in-depth investigation of FEDIOL statistical data reveals that a variation in oil and meal yields equivalent to 2 or 3 percent among EEC member countries occurs for different oilseeds and years. This variability in yields is significant for sunflower, rapeseed and groundnut oil. Soybean oil and meal extraction rates are more stable.

According to FEDIOL (pp. 6-8), three factors are the source of this variability in yields. First, seed quality varies from one region to another. Second, meal and oil quality differ because of different moisture contents and the existence or not of substances such as lecithin or gossypol. In the case of soybeans, if the seeds are not dehulled, the meal will have a lower protein content. Third, the method of seed processing, expelling or solvent extraction, also affects soyoil and meal yields.

As a result, oil yields based on data from FEDIOL have been assumed to follow the following pattern:

soybean:	0.175 (1975-1977),	0.18 (1956-1974)	
rapeseed:	0.41 (1956-1977)		
sunflower:	0.398 (1977),	0.397 (1971-1976),	0.385 (1957-1970)
peanut:	0.464 (1975-1977),	0.475 (1956-1974)	

TABLE A4.2. Data used in edible oil demand equations

	DSLG	DRNLG	DRLG	DSNFLG	PSLG	PRLG	PNLG	PDYG	CPI	DUM70	DUM75
1956	9.2	262.3	25.4	0.0	1185.5	1319.5	1291.5	141.72	51.5	0	0
1957	7.2	279.1	29.6	0.0	1286.0	1503.6	1503.6	156.25	53.2	0	0
1958	6.8	289.5	39.5	0.0	1479.5	1521.4	1603.0	177.55	61.2	0	0
1959	7.8	298.2	33.9	0.0	1333.5	1268.6	1722.1	191.74	65.0	0	0
1960	16.2	311.7	32.2	0.4	1283.0	1257.1	1877.1	212.74	67.4	0	0
1961	9.8	28.5	28.5	3.2	1621.4	1582.4	1859.3	230.97	69.6	0	0
1962	18.8	326.5	17.9	0.0	1305.9	1268.6	1572.8	264.93	72.9	0	0
1963	20.8	348.7	21.3	0.0	1284.7	1234.2	1538.4	295.73	76.4	0	0
1964	32.4	341.2	18.6	8.8	1343.1	1439.1	1798.9	321.72	79.0	0	0
1965	18.4	377.8	42.1	7.2	1438.9	1403.2	1733.9	346.02	81.0	0	0
1966	21.8	384.2	43.8	9.0	1137.4	1281.3	1554.4	372.93	83.2	0	0
1967	30.2	381.2	55.6	9.0	1176.5	1119.4	1532.4	409.77	85.4	0	0
1968	21.6	385.7	107.6	11.5	968.3	874.9	1467.2	445.62	89.3	0	0
1969	27.0	335.9	126.9	42.2	1149.5	1159.4	1918.8	497.8	95.1	0	0
1970	84.0	271.9	104.6	57.8	1769.4	1590.9	2301.3	561.07	100.0	1	0
1971	88.2	213.2	183.7	79.5	1868.1	1801.0	2722.8	631.37	105.5	1	0
1972	67.3	243.8	154.8	107.9	1278.5	1286.2	2361.7	709.07	112.0	1	0
1973	77.56	259.8	112.9	118.3	2134.2	1933.5	2658.0	855.66	120.2	1	0
1974	106.9	229.6	98.3	143.2	4403.2	3941.8	5709.0	941.84	136.7	1	0
1975	84.9	230.0	38.9	98.7	2658.2	2600.2	4044.2	1039.51	152.8	1	1
1976	104.87	305.8	44.0	93.9	2303.0	2182.1	3712.2	1234.06	167.5	1	1
1977	107.20	257.6	45.35	95.3	3121.3	3154.2	4569.2	1392.9	183.2	1	1

Domestic prices of edible oils are "world" prices adjusted by exchange rates and ad valorem import tariffs. World reference prices for soybean, rapeseed and peanut oil are CIF West Europe prices (in U.S. dollars/metric ton). Reference sources for these prices are USDA, Oil World and the FAO statistical year book. In the European Community, vegetable oils are subject to different import tariffs whose rate depends on the type of oil, amount of refining and intended final use. Among the various rates listed in the Commonwealth Services Bureau publications for France from 1956 to 1966 and the EEC countries after 1966, the rates selected correspond to non-specific crude oil imports destined to be consumed as manufactured feedstuff.

Statistical problems also arise in the measurement of French disposable income. The time series published by INSEE is not homogenous over the entire study period, with modifications in the definition of the series in 1970. This results in a discontinuity in the series in the late 1950's. To overcome this problem and since data on both series are available for 1959-1965, the disposable income figure is calculated as an average of these two series, for the same period.

DSLG: Consumption of soybean oil (1000 MT)

DPNLG: Consumption of peanut oil (1000 MT)

Source: FFIOL, FEDIOL.

DRLG: Consumption of rapeseed oil (1000 MT)

<u>Source</u>: FEDIOL, FFIOL.

DSNFLG: Consumption of sunflower oil (1000 MT)

<u>Source</u>: FEDIOL, FFIOL.

PDYG: Disposable income of French households (billons Francs)

1956-1958 = old series (base year 1962)
1959-1965 = average of oil and modified series
1966-1977 = new series (base year 1971)

<u>Source</u>: INSEE.

PSLG, PRLG and PNLG: the domestic prices of soybean oil, rapeseed oil and peanut oil obtained from the corresponding CIF import prices as follows:

$$\text{Domestic Price of Edible Oil} = \text{Import Price of Edible Oil} \left[1 + \text{Import Tariff} \right] * \text{Exchange Rate}$$

All the data required to compute the domestic price of oils are contained in Table A4.3.

DUM70 and DUM75 are dummy variables to capture the influence of structural changes occurring since 1970 in the French market for table oil.

CPI: Consumer price index

<u>Source</u>: INSEE.

TABLE A4.3. Data used to determine domestic soybean, rapeseed and peanut oil prices in France

	CIF Soybean Oil Price Rotterdam (US Dollar/Ton)	CIF Rapeseed Oil Price (US Dollar/Ton)	CIF Peanut Oil Price (US Dollar/Ton)	Exchange Rate (US $/Francs)	Tariff
1956	338.7	377.0	369.0	3.5	0.0
1957	306.2	358.0	358.0	3.5	0.0
1958	253.8	261.0	275.0	4.2	0.18
1959	232.3	221.0	300.0	4.94	0.162
1960	223.5	219.0	327.0	4.94	0.162
1961	286.9	280.0	329.0	4.94	0.144
1962	227.5	221.0	274.0	4.94	0.162
1963	223.8	215.0	268.0	4.94	0.162
1964	235.2	252.0	315.0	4.94	0.156
1965	269.7	263.0	325.0	4.94	0.08
1966	216.6	244.0	296.0	4.94	0.063
1967	216.5	206.0	282.0	4.94	0.1
1968	178.2	161.0	270.0	4.94	0.1
1969	198.3	200.0	331.0	5.27	0.1
1970	291.4	262.0	379.0	5.52	0.1
1971	306.0	295.0	446.0	5.55	0.1
1972	230.6	232.0	426.0	5.04	0.1
1973	436.0	395.0	543.0	4.45	0.1
1974	832.2	745.0	1079.0	4.81	0.1
1975	563.3	551.0	857.0	4.29	0.1
1976	438.0	415.0	706.0	4.78	0.1
1977	574.2	584.0	846.0	4.91	0.1

Source: USDA (1977a), FAO and Oil World, Commonwealth Service.

Demand for Soymeal (Equations 6 and 7)

Tables A4.4, A4.5 and A4.6 contain the data used in the estimation of the demand equations for soymeal used by farmers and feed compounders. Two major problems were encountered in the collection of statistical observations; first, how to separate the two demands for soymeal and, second, how to calculate the quantity of other high protein feed ingredients consumed in France.

Determination of the Demand for Soymeal by Farmers (DSMF) and by Feed Manufacturers (DSMC)

A two-stage procedure was utilized in estimating the two components of the demand for soymeal. In the first stage, the total consumption of soymeal was evaluated in a way similar to that of soy-oil, utilizing the expression below and data reported in Table A5.

Total Consumption of Soymeal (DSM)	=	Total Imports of Soymeal to France	+	Domestic Production of Soymeal	+	Stock Variation	-	Export of Soymeal

No statistical series on the end-use of soymeal are regularly published in France. The evaluation of these quantity aggregates is made possible by checking numerous reference sources listed in Table A4.5. These references provide estimates of the demand for soymeal by the animal feed industry. The consumption of soymeal at the farm level is obtained after subtracting this quantity from the total demand for soymeal.

TABLE A4.4. Data used in demand for soymeal equations

	DSMC	DSMF	PCFG	PSM	PQQPK	TOTQCOMP	TOTLIVWA	OMSOYA
1956	81.05	9.0	340.99	307.7	385.39	1528.77	1414.48	460.8
1957	90.09	10.0	346.57	333.3	403.67	1860.14	1391.88	444.8
1958	83.15	9.24	347.07	384.6	429.11	1861.19	1380.38	596.4
1959	125.43	55.08	380.73	409.5	476.9	2107.15	1531.97	591.9
1960	168.5	66.8	400.13	397.5	497.76	1927.77	1581.79	568.0
1961	143.76	58.56	402.04	424.8	491.29	2193.05	1675.59	661.8
1962	216.72	198.5	400.96	426.6	540.81	2839.72	1793.59	855.6
1963	329.0	98.27	420.72	477.6	553.5	3053.76	1730.88	873.11
1964	422.96	96.66	419.99	490.4	549.52	3220.41	1689.98	930.3
1965	470.19	96.91	435.44	489.7	558.97	3865.93	1788.58	1038.95
1966	615.45	94.1	437.38	528.9	566.94	4197.71	1862.88	1054.8
1967	639.19	92.91	441.72	534.6	576.32	4997.71	2017.39	1129.8
1968	688.52	89.86	444.51	511.3	613.4	4595.34	2084.68	1201.2
1969	750.0	86.5	451.77	532.6	610.0	5228.08	1970.38	1252.05
1970	998.82	168.7	482.84	579.1	686.65	6449.87	2086.09	1353.5
1971	1103.6	212.7	506.67	618.4	766.54	7075.37	2265.19	1269.1
1972	1187.0	229.1	544.34	615.2	783.96	8186.08	2225.18	1439.4
1973	1300.0	227.0	557.03	1014.6	984.56	9420.0	2237.89	1406.0
1974	1700.0	240.1	658.33	1036.7	1079.63	9560.17	2584.18	1226.1
1975	1600.0	230.2	670.41	809.0	1092.57	9523.97	2596.88	1270.6
1976	1716.0	401.3	768.95	942.3	1231.44	10470.6	2662.88	1524.8
1977	1600.0	538.2	828.85	1255.8	1387.24	10621.7	2529.08	1519.0

TABLE A4.5. Determination of the demand for soymeal by feed manufacturers in France

1956, 1957 and 1958: It has been assumed that 30 percent of the soymeal consumed in France was used by feed manufacturers. This figure was given by Spillsbury (p. 39) for the years 1956 and 1957.

1959: The data has been obtained from SCEES publications.

1960: The consumption of soymeal by compounders is an average of two statistics. The former derived from Spillsbury (p. 40) is 170 million tons; the latter contained in SCEES publications is 167,188 tons. The observation used for 1960 is 168,500 tons, accounting for 71.61 percent of the total demand for soymeal.

1961: This latter percentage has been applied to the total demand for soymeal.

1962: Taken from Foucault (p. 79).

1963: Obtained in Epp's report on "The Oilseeds Product Needs of the European Community, 1970". With respect to France, he mentioned that of the total consumption, approximately 77 percent is utilized in the formula feed industry.

1964 - 1968: For these years, the missing data have been obtained by interpolation techniques applied to the logarithms of the total demand for soymeal. For the estimation of the interpolated values of the total demand for soymeal, first find $\hat{DSM}$ given by:

$$(1) \quad \hat{DSM}_{1963+i} = DSM_{1963} + iT \qquad 1 < i < 5$$

where

$$T = \frac{DSM_{1969} - DSM_{1963}}{6}$$

and DSM_{1963} and DSM_{1969} are, respectively, the natural logarithms of the total demand for soymeal in France in 1963 and 1969.

Second, calculate the values of the total demand for soymeal by compounders using a straight line interpolation:

$$(2) \quad \hat{DSMC}_{1963 + i} = DSMC_{1963} + iTC \qquad \text{for } 1 < i < 5$$

where:

$$TC = \frac{DSMC_{1969} - DSMC_{1963}}{6}$$

and $DSMC_{1969}$ and $DSMC_{1963}$ are, respectively, the natural logarithms of the demand for soymeal by compounders in 1969 and 1963.

Third, the values of DSMC obtained by straight line interpolation are corrected by the incorporation of interpolation errors resulting from the use of expression (1). The final estimate of the demand for soymeal by feed manufacturers is given by:

$$(3) \quad \hat{\hat{DSMC}}_{i + 1963} = \hat{DSMC}_{i + 1963} + \frac{TC}{T} (DSM_{i + 1963} - \hat{DSM}_{i + 1963}).$$

1969: From Foucault (p. 79).

1970: Two sources of information for this years are available:

(1) Foucault who notes that 150 tons of soymeal were employed in 1970 to produce 1000 tons of compound feeds.

(2) Vachel (Annex 2, VI/14) provides an estimate of the quantity of soymeal consumed in France equal to 1088.2 tons. This corresponds to a conversion ratio of 159.72 tons of soymeal required to produce 1000 tons of formula feeds.

The average of these two conversion ratios yields a ratio of 154.86 tons for 1000 tons of compound feeds produced, which implies an annual consumption of soymeal by the formula feed industry equal to 998.82 thousand tons.

1971 and 1973: From SCEES (1975, p. 9).

1972: It has been assumed that the use of soymeal by the animal feed industry for this year accounts for 83.24 percent of the total demand for soymeal. This rate is derived from 1971 data.

1974: From SNIA (1975, p. 13).

1975, 1976 and 1977: Estimates from SNIA and reported in Charles Robert's reports.

However, data on the consumption of soymeal by compounders is missing for the mid-sixties. To obtain data for these years, an interpolation technique suggested by Friedman (1962, pp. 727-757) and summarized by Maddala (1977, pp. 206-207) was employed. The set of data selected has been obtained by an interpolation technique which aims at correcting the straight line interpolation. Since feed manufacturers are the main consumer of soymeal, it is assumed that the growth pattern of the total demand for soymeal and of the demand for soymeal by feed manufacturers are identical. As a result, the data selected is a function of DSM for the period 1964 to 1968. In addition, to reflect the exponential growth of the total demand for soymeal for this period, the interpolation technique is applied to the natural logarithms of the total demand for soymeal and the demand for soymeal by feed manufacturers. The different stages required to derive the relevant data are explained in Table A4.5.

Evaluation of the Variable OMSOYA: Quantity of Other High Protein Meals Consumed in France

This variable is an aggregate sum of oil and animal meals, other than soymeal and skim milk powder, consumed in France, measured in 46 percent soymeal equivalents, the most commonly utilized in France. The variable OMSOYA is estimated in terms of digestible protein. This is justified on the grounds that the feed requirements of livestock and, more particularly, monogastrics, are expressed in terms of digestible proteins (Church, pp. 143-164). The conversion coefficients utilized for this operation are those used by the SCEES to establish the feed supply balance in France (SCEES, Dec. 1975, pp. 140-177). Lastly, it should be borne in mind that the consumption of skim milk powder encompasses both consumption for compound feeds and milk replacers. It has been impossible to distinguish between these two end-uses due to the lack of available information.

Table A4.6 provides a detailed account of the data and data sources used to construct the variable OMSOYA.

DSMC: Demand for soymeal by feed compounders (1000 MT)

DSMF: Demand for soymeal by farmers (1000 MT)

PCFG: Prices of feedgrains (Francs/ton)

PSM: Import unit value of soymeal in French Francs/ton.

Source: French Customs.

POPPQK: Price of compound feed fed to hogs (Francs per metric ton)

Source: See Table A4.12.

TOTQCOMP: Total production of compound feeds

TOTQCOMP = QCOMPBF + QCOMPPK + QCOMPBR + QCOMPLH

TOTLIVWA: Production of beef and pork (1000 MT)

OMSOYA: Quantity of other high-protein feeds consumed in France in soybean meal 46 percent equivalents (1000 MT)

TABLE A4.6. Data used in determination of OMSOYA

	OMSOYA	DRAM	DSNFM	DFLM	DPNM	DPALM	DCOPM	DPSM	DFISHSM	DMTSM	DLUSM
1956	460.8	15.8	6.7	95.1	219.2	20.7	11.4	0.0	44.9	46.8	0.0
1957	444.2	27.1	1.9	87.1	138.5	12.7	8.8	0.0	43.6	75.1	0.0
1958	596.4	38.5	0.7	98.4	283.4	14.3	8.72	0.0	79.1	73.3	0.0
1959	591.9	32.1	9.9	89.6	258.4	14.1	7.6	15.6	87.7	77.0	0.0
1960	568.0	23.8	11.7	89.7	221.6	9.7	10.8	23.8	66.0	98.4	12.5
1961	661.8	18.1	20.0	97.5	261.0	9.0	10.8	28.2	107.6	98.7	9.9
1962	855.8	23.2	40.6	123.9	342.9	12.3	14.6	37.11	139.8	104.7	16.5
1963	873.1	27.1	26.4	132.7	323.1	29.0	12.6	74.23	132.2	92.7	23.1
1964	930.3	19.3	20.8	137.4	325.8	8.5	12.1	103.9	181.3	91.5	29.7
1965	1038.95	36.7	24.5	132.4	360.2	12.2	13.5	137.3	169.0	118.5	34.65
1966	1054.8	40.1	45.1	109.7	370.0	105.0	14.0	137.3	163.2	125.3	39.6
1967	1129.8	48.5	46.3	111.6	388.2	11.8	12.6	148.5	166.1	132.8	63.4
1968	1201.2	55.9	53.6	89.1	343.8	10.3	10.6	228.6	180.0	140.3	89.1
1969	1252.05	57.1	46.7	109.5	330.6	10.4	7.7	270.9	180.2	147.7	84.15
1970	1353.5	77.8	47.2	110.3	333.3	14.2	7.9	304.3	159.8	189.3	109.2
1971	1269.1	117.2	44.6	88.4	268.7	10.9	10.2	296.2	124.0	190.8	118.1
1972	1439.4	134.3	58.9	81.4	352.9	8.5	8.2	275.4	162.9	215.0	141.9
1973	1406.0	157.8	68.4	77.0	354.0	9.7	7.7	288.5	87.6	219.0	316.0
1974	1226.1	127.9	37.7	43.5	259.3	4.8	6.0	388.0	58.4	219.0	181.5
1975	1270.6	97.0	28.0	59.9	296.7	4.4	7.5	285.0	97.8	219.0	175.3
1976	1524.8	108.9	39.7	76.7	458.7	4.3	12.5	285.6	105.0	251.2	182.8
1977	1519.0	95.9	39.1	60.0	429.2	1.7	6.8	341.6	99.8	244.7	201.3

Note: OMSOYA: Quantity of other high protein feeds consumed in France (1000 MT)

OMSOYA = DRAM + DSNFM + DFLM + DPNM + DPALM + DCOMP + DPSM + DFISHSM + DMTSM + DLUSM

DRAM: Quantity of rapeseed meal demanded in France in soymeal 46 percent equivalents (1000 MT)

Source: FEDIOL and FFIOL (Conversion Rate: 0.67139)

DSNFM: Quantity of sunflower meal demanded in soymeal 46 percent equivalents (1000 MT).

Source: FEDIOL and FFIOL

Conversion Rate: 0.7257

DFLM: Quantity of flaxseed meal demanded in soymeal 46 percent equivalents (1000 MT)

Source: FEDIOL and FFIOL

Conversion Rate: 0.6737

DPNM: Quantity of peanut meal demanded in soymeal 46 percent equivalents (1000 MT)

Source: FEDIOL and FFIOL

Conversion Rate: 0.8676

DPALM: Quantity of palm kernel meal demanded in soymeal 46 percent equivalents (1000 MT)

Source: FEDIOL and FFIOL

Conversion Rate: 0.3593

DCOPM: Quantity of coconut meal demanded in soymeal 46 percent equivalents (1000 MT)

Source: FEDIOL and FFIOL

Conversion Rate: 0.4018

DPSM: Quantity of skim milk fed to livestock in soymeal 46 percent equivalents (1000 MT)

Source: Charles Robert. SCEES (Dec. 1975)

Conversion Rate: 0.7473

DFISHSM: Quantity of fishmeal consumed in soymeal 46 percent equivalents (1000 MT)

Source: FEDIOL and FFIOL

Conversion Rate: 1.4018

DMTSM: Quantity of meat meal consumed in soymeal 46 percent equivalents (1000 MT)

Source: Elz, Charles Robert.

Conversion Rate: 1.2884

DLUSM: Quantity of Lucerne meal consumed in France in soymeal 46 percent equivalents (1000 MT)

Source: Charles Robert, SCEES (Dec. 1975)

Conversion Rate: 0.330

Commercial and Non-Commercial Demand for Feedgrains (Equations 7 and 8)

Data relative to the variables incorporated in equations 7 and 8 are compiled in Table A4.7. The only problem encountered in the data collection concerns the estimation of the commercial and non-commercial demand for feedgrains on a calendar year basis instead of the usual crop year basis. To do so, it has been assumed that the consumption of feedgrains by farmers and feed manufacturers is uniformly distributed during the entire year. While this assumption is valid for hogs and poultry,[1] it is less plausible for beef cattle and dairy

[1] To check the plausibility of this assumption, an inspection of monthly consumption of feed cereals by feed manufacturers from 1969 onwards displays a non-seasonal pattern.

TABLE A4.7. Data used in feedgrain demand equations

	DCFGC	DCFGF	PSM	PCFG	PLIVG	TOTQCOMP	TOTLIVWA	QCOMPB
1955				340.0			1323.98	726.0
1956	1154.3	4442.54	307.7	340.99	2513.09	1528.77	1414.48	881.08
1957	1629.32	4578.21	333.3	346.57	3001.97	1860.14	1391.88	1000.59
1958	1966.68	4566.68	384.6	347.07	3599.60	1860.19	1380.38	896.18
1959	2242.17	5243.65	4095.0	380.77	3511.15	2107.15	1531.08	1032.58
1960	2214.3	5824.86	397.5	400.13	3737.2	1927.77	1581.79	905.29
1961	2235.9	5927.75	424.8	402.03	3834.37	2193.05	1675.59	1044.48
1962	2621.7	6037.93	426.6	400.96	3936.38	2839.72	1793.58	1505.39
1963	2822.9	6366.13	477.6	420.72	4423.81	3053.75	1730.08	1430.58
1964	2782.28	6930.69	490.4	419.99	4738.65	3220.41	1689.98	1585.29
1965	3194.16	6927.45	489.7	435.44	4792.34	3865.93	1788.58	2014.18
1966	3456.09	7175.8	528.9	437.38	5119.77	4197.71	1862.88	2263.79
1967	3650.48	7616.27	534.6	441.72	4876.97	4997.71	2017.39	2800.98
1968	3591.39	7994.99	511.3	444.5	4906.84	4595.34	2084.68	2520.08
1969	4062.57	7659.88	532.6	451.77	5518.39	5228.07	1970.78	2954.18
1970	4956.88	7421.12	579.1	482.34	5708.55	6449.87	2086.09	3847.08
1971	5164.19	7250.99	618.4	506.67	5889.7	7075.37	2265.19	4240.98
1972	5271.79	7416.15	615.2	544.32	6933.42	8185.08	2225.08	4913.58
1973	6249.37	8057.23	1014.6	557.03	7944.8	9420.0	2237.89	5671.0
1974	5955.69	8230.97	1036.33	658.33	7398.75	9560.17	2584.18	5681.58
1975	6172.08	7928.71	809.0	670.41	8331.88	9523.97	2596.88	5712.38
1976	6927.0	7261.16	942.3	768.95	8881.58	10470.6	2662.88	6467.69
1977	7235.09	6727.02	1255.8	828.85	9581.91	10621.7	2529.08	6546.0

cows for which consumption is highly seasonal. However, due to the lack of sufficient information on this question, the above assumption has been extended to the dairy and beef operations.

As a result, the consumption of feedgrains given for a crop year will be split into two unequal parts: 5/12th is allocated to the ending period of the crop year, namely August to December; and 7/12th is allocated for the next calendar year (January to July).

The determination of the demand for feedgrains on a calendar year basis is then obtained by summation of these two parts. Table A4.8 provides the calculated data for corn, soft wheat and barley.

DCFGC: Total commercial demand for feedgrain, calendar year (1000 MT)

Source: ONIC

DCFGF: Total non-commercial demand for feedgrains, calendar year (1000 MT)

Source: ONIC

PSM: Import unit value of soymeal (Francs/MT)

PCFG: Aggregate price of feedgrain, including soft wheat, corn and barley (Francs/MT)

Source: INSEE (1962-1977), Farnsworth and Friedmark (1956-1961)

Weights: 0.4155 (Barley) 0.2973 (Corn) 0.28715 (Soft Wheat)

Source: INSEE and ONIC.

TABLE A4.8. Data on commercial and non-commercial demand for corn, soft wheat and barley in France on a calendar year basis

	Barley		Soft Wheat		Corn	
	On-Farm	Commercial	On-Farm	Commercial	On-Farm	Commercial
1956	2280.3	593.08	1208.75	213.85	953.5	347.4
1957	2676.6	725.60	760.24	467.95	1140.4	395.8
1958	2025.8	728.94	1500.50	768.37	1040.4	469.4
1959	2117.6	1137.7	2193.48	629.7	932.6	474.8
1960	2433.12	954.9	2428.47	706.45	963.3	553.0
1961	2654.44	1009.58	2024.33	344.17	1249.0	882.2
1962	2873.0	1157.82	2025.15	425.9	1139.8	1038.0
1963	2873.8	1087.23	2328.26	753.8	1164.1	981.9
1964	2941.49	1137.0	2481.72	520.7	1507.5	1124.6
1965	3014.7	1301.49	2797.98	855.4	1114.8	1038.3
1966	3168.9	1381.6	2684.23	942.0	1322.7	1132.5
1967	3514.3	1518.6	2710.4	762.4	1391.6	1369.5
1968	3814.8	1430.9	2679.32	590.0	1500.9	1570.5
1969	3671.6	1491.4	2558.41	1071.6	1429.9	1499.6
1970	3637.9	1508.0	2417.55	1594.8	1365.7	1854.1
1971	3469.5	1018.7	2248.61	1500.0	1532.9	2645.5
1972	3475.4	735.8	2229.77	1780.5	1711.0	2755.5
1973	4002.0	1067.4	2288.95	2209.6	1766.3	2972.4
1974	3846.5	1430.7	2406.48	1130.6	1978.0	3394.4
1975	3845.5	1376.11	2258.33	1117.3	1824.9	3678.7
1976	3568.4	1628.0	2124.59	940.0	1568.3	4359.0
1977	3235.0	1955.0	2152.44	1292.0	1339.6	3988.1

PLIVG: Aggregate producer price of livestock including pork and beef (Francs/ton)

Weights: 0.54934 (Beef) 0.4506 (Pork)

Source: SCEES (Dec. 1978), SCEES (Dec. 1971)

TOTQCOMP: Total production of compound feed (1000 MT)

TOTQCOMP = QCOMPBR + QCOMPLH + QCOMPBF + QCOMPPK

TOTLIVWA: Production of beef and pork (1000 MT)

QCOMPB: Production of pork and beef and diary cattle compound feed (1000 MT)

Compound Feed Demand (Laying Hens, Hogs and Broilers)
(Equations 10, 11 and 12)

Table A4.9 presents all the time series required to estimate the different demand equations for compound feeds with the exception of dairy and beef cattle. Some problems arise in the determination of production of each compound feed. These series are provided by professional organizations and, as pointed out by Foucault (pp. 28-29), they may under-estimate the real production because they do not incorporate output data of small companies which are not members of these organizations. Omission of small plants is likely to be more harmful early in the sample period than more recently. The existence of observations on the demand for compound feeds for laying hens and broilers is only available since 1965. Prior to that date, these two

TABLE A4.9. Data used in formula feed demand equations

	QCOMPLH	QCOMPBR	QCOMPPK	QPLCW	EGGS	QPKCW	TIME	PLH	PH	PQLH	PBR	PQPPK
1956	296.53	351.15	597.19	310.0	403.0	693.19	2	13.7	2590.0	448.0	472.0	385.38
1957	393.52	466.02	581.0	330.0	437.0	659.19	3	14.3	2980.0	460.58	484.51	403.66
1958	441.81	523.2	540.29	340.0	457.0	662.79	4	16.56	3270.0	473.38	498.36	429.11
1959	491.97	582.60	669.89	320.0	498.0	748.19	5	15.88	3220.0	524.92	540.33	476.9
1960	468.12	554.35	599.79	333.0	506.0	720.79	6	15.63	3490.0	548.63	554.16	497.76
1961	525.85	622.72	733.69	366.0	520.0	723.0	7	16.15	3730.0	546.16	557.48	491.29
1962	610.89	723.43	1042.39	460.0	532.0	815.69	8	16.5	3420.0	578.25	587.41	540.81
1963	743.13	880.03	955.89	494.0	533.0	761.79	9	19.2	4270.0	601.84	606.52	553.5
1964	748.61	886.51	1077.79	531.0	579.0	749.89	10	14.8	4030.0	600.2	610.13	549.52
1965	847.79	1003.96	1400.09	555.0	582.0	840.79	11	18.05	3820.0	611.17	618.99	558.97
1966	885.41	1048.51	1630.5	558.0	587.0	853.09	12	17.85	4510.0	617.75	622.87	566.94
1967	1005.71	1191.02	2069.29	575.0	613.0	900.89	13	16.65	4020.0	623.24	630.08	576.32
1968	950.11	1725.14	1862.19	579.0	612.0	893.59	14	15.73	3940.0	653.96	658.34	613.4
1969	1069.0	1204.89	2127.79	602.0	628.0	819.19	15	17.2	4590.0	660.0	660.0	610.0
1970	1196.33	1406.46	2780.79	637.0	658.0	903.09	16	15.69	4500.0	702.79	698.73	686.65
1971	1280.45	1553.94	3188.69	652.0	647.0	1008.19	17	18.51	4390.0	747.5	733.98	766.54
1972	1439.45	1832.05	3629.39	716.0	673.0	1063.89	18	20.3	4780.0	782.89	759.19	783.96
1973	1629.55	2119.45	4026.5	809.0	720.0	1077.89	19	22.97	6110.0	919.5	883.32	984.56
1974	1765.82	2112.77	4232.39	820.0	735.0	1104.89	20	24.17	5520.0	1003.98	990.28	1079.63
1975	1773.48	2038.11	4196.69	823.0	768.0	1128.69	21	22.97	6140.0	1050.04	1041.82	1092.57
1976	1761.13	2241.76	4435.0	865.0	755.0	1162.59	22	28.5	6860.0	1190.51	1121.62	1231.44
1977	1790.42	2285.27	4531.0	903.0	763.0	1188.89	23	39.5	7000.0	1853.46	1281.22	1387.24

quantities were reported as one group of feed. Thus, the missing data for broilers and laying hens is obtained, assuming that the production share of these two feeds in the total production of fowl compound feed has remained constant between 1956 and 1964. The appropriate share used for these calculations is the average share for the period 1965-1977. Data relative to total production of compound feeds for broilers include not only production of chicken compounds, but also other feeds fed to turkeys and other poultry.

QCOMPPK: Demand for hogs compound feed (1000 MT)

Source: Foucault (Annexes), SNIA (1978)

QCOMPBR: Demand for broiler compound feed (1000 MT)

Source: Foucault (Annexes), SNIA (1978)

QCOMPLH: Demand for laying hen compound feed (1000 MT)

Source: Foucault (Annexes), SNIA (1978)

QPLCW: Total production of poultry (1000 MT)

Source: SCEES (Feb. 1978), Leflambe

EGGS: Total production of eggs (1000 MT)

Source: 1956-1958 Leflambe
1959-1977 SCEES (Dec. 1975), Eurostat

QPKCW: Total production of pork (1000 MT)

Source: SCEES (Dec. 1971, Feb. 1978)

TIME: Time trend, where 1955 = 1, 1956 = 2, ... etc.

PLH: Producer price of eggs (Francs/100 eggs)

<u>Source</u>: 1955-1971 Eurostat
1972-1977 FORMA

PH: Producer price of hogs (Francs/ton slaughtered weight)

<u>Source</u>: 1957-1961 SCEES (Dec. 1971)
1962-1977 INSEE

PQLH: Price of compound feed for laying hens (Francs/MT)

PQBR: Price of compound feed for broilers (Francs/MT)

PQPPK: Price of compound feed for pork (Francs/MT)

<u>Compound Feed Demand for Beef and Dairy Cattle</u> (Equation 13)

Because of the lack of appropriate data, it has been impossible to disaggregate the demand for compound feeds into separate dairy and beef components. As a result, the variables representing livestock production and price are aggregate measures. Livestock production is expressed in cereals equivalents and prices are weighted by beef and dairy production expressed in cereal equivalents. The weights used for cereal equivalents are derived from grain utilization rates contained in Regier (1978, pp. 64-66). These rates which are available for 1962-1975 and 1985 have been calculated for each year of the sample using linear interpolation.

TABLE A4.10. Data used in beef formula feed demand equation

	QCOMPBF	PFBF	PQBF	PRMLG	DUM7376	TIME
1956	283.89	1333.7	357.22	1021.86	0	2
1957	419.59	1621.77	369.25	1161.72	0	3
1958	355.89	2036.35	386.83	1281.11	0	4
1959	362.69	2120.07	416.07	1422.67	0	5
1960	305.5	2206.38	418.2	1712.19	0	6
1961	310.79	2271.32	406.83	1974.48	0	7
1962	463.0	2560.01	447.18	2139.03	0	8
1963	474.63	2589.54	474.45	2355.52	0	9
1964	507.5	2981.55	470.48	2453.54	0	10
1965	614.09	3072.31	478.84	2678.76	0	11
1966	633.29	3127.23	486.58	2978.87	0	12
1967	731.69	3192.89	486.58	3374.33	0	13
1968	657.89	3305.22	511.88	3726.23	0	14
1969	826.39	3726.72	510.0	3666.25	0	15
1970	1066.29	4040.62	500.56	3877.5	0	16
1971	1052.29	4367.29	589.03	4211.25	0	17
1972	1284.19	5076.65	598.03	4265.81	0	18
1973	1644.5	5487.52	733.52	4459.92	1	19
1974	1449.19	5705.92	805.87	5348.71	0	20
1975	1515.69	6433.37	818.84	5540.54	0	21
1976	2032.69	6728.98	892.02	5713.34	1	22
1977	2015.0	7105.23	1007.44	5440.56	1	23

TABLE A4.11. Data used to calculate aggregate milk and beef production and prices

	QBFCW	PRODMILK	CBF	CMILK	PMILK	PBF	FPBF	PRMLBFGR
1955	783.29	18636.0	0.608	0.0239	25.0	2.46	1390.43	921.64
1956	721.29	19951.5	0.692	0.0262	26.0	2.46	1330.70	1021.86
1957	736.69	20786.5	0.777	0.0285	27.0	3.02	1621.77	1161.72
1958	717.59	21418.0	0.866	0.0308	30.90	3.87	2036.05	1281.11
1959	782.89	20606.0	0.946	0.0331	35.02	3.75	2120.07	1422.67
1960	861.0	23291.0	1.031	0.0354	33.99	3.94	2206.38	1712.19
1961	952.59	24200.0	1.115	0.0377	34.17	3.93	2271.32	1974.48
1962	977.89	24139.0	1.2	0.04	36.16	4.36	2560.01	2139.03
1963	968.89	26253.0	1.285	0.0423	38.02	4.5	2589.54	2355.52
1964	940.09	26156.0	1.369	0.0446	39.0	5.37	2981.55	2453.54
1965	947.79	27733.0	1.454	0.0469	39.3	5.60	3072.31	2678.76
1966	1009.79	28980.0	1.538	0.0492	40.0	5.62	3172.23	2978.87
1967	1116.5	30335.0	1.623	0.0515	41.17	5.58	3192.89	3374.33
1968	1191.09	31447.0	1.708	0.0538	41.32	5.70	3305.22	3726.23
1969	1151.59	28516.0	1.792	0.0562	42.61	6.28	3726.72	3666.25
1970	1183.0	28325.0	1.877	0.0585	46.3	6.71	4040.62	3877.5
1971	1257.0	28701.0	1.962	0.0608	46.3	7.13	4367.29	4211.25
1972	1161.19	29937.0	2.046	0.0631	49.84	8.7	5073.85	4264.81
1973	1160.0	30397.0	2.131	0.0654	54.4	9.46	5487.52	4459.92
1974	1479.29	30607.0	2.215	0.0677	57.46	8.94	5705.92	5348.71
1975	1468.1	30910.0	2.3	0.07	64.48	10.14	6433.37	5540.54
1976	1500.29	30801.0	2.33	0.072	68.82	10.55	6723.98	5713.34
1977	1340.1	30780.0	2.36	0.074	70.38	11.71	7105.23	5440.56

QBFCW: Production of beef (1000 MT)

Source: SCEES (Dec. 1971, Feb. 1978)

PRODMILK: Milk production in France (1000 MT)

Source: SCEES (Dec. 1975), Eurostat

PBF: Producer price of beef (Francs/kilo) (slaughtered weight)

Source: INSEE, SCEES (Dec. 1971)

PMILK: Producer price of milk, 34 percent fat (Francs/kilo)

Source: Eurostat, SCEES (1966)

CBF: Kilograms of grain fed per kilogram of beef produced in France

Source: Regier (1978)

CMILK: Kilograms of grain fed per kilogram of milk produced in France

Source: Regier (1978)

QCOMPBF: Demand for compound feed fed to beef (1000 MT)

Source: Foucault (Annexes), SNIA (1978)

PQBF: Price of compound feed (Francs/MT)

PRMLG: Milk and beef production in cereal units, obtained from the following expression:

$$PRMLG = CMILK * PRODMILK + CBF * QBFCW$$

FPBF: Aggregate price of beef and dairy products (Francs/MT)

$$FPBF = \frac{(PMILK * CMILK * PRODMILK + PBF * CBF * QBFCW)}{PRMLG} * 1000$$

<u>Price of Compound Feed</u> (Equations 14, 15, 16 and 17)

The Institut National de la Statistique et les Enquêtes Economiques publishes a quarterly cost index for agricultural inputs. When disaggregated, this index contains price indices for supplements and complete feeds fed to the main classes of livestock. In order to obtain price series of compound feeds, in absolute terms, the price indexes were multiplied by the 1969 prices given by Foucault (p. 85):

price of compound feeds for cattle	510 francs/ton
price of compound feeds for hogs	610 francs/ton
price of compound feeds for poultry	660 francs/ton

The price of compound feeds are missing for the period 1956-1959. To overcome this problem, observations were created, using the price equations (16 to 20) estimated for the period 1960 to 1977.

PQPPK: Price of hog compound feed (Francs/MT)

<u>Source</u>: INSEE, Foucault

PQBR: Price of broiler feed (Francs/MT)

<u>Source</u>: INSEE, Foucault

PQLH: Price of laying hen mixed feed (Francs/MT)

<u>Source</u>: INSEE, Foucault

TABLE A4.12. Livestock price data

	PQPPK	PQBR	PQLH	PQBF	PSM	PFG	DW	W
1955								1.25
1956	385.38	472.0	448.0	357.22	307.7	340.99	0.0	1.25
1957	403.66	484.5	460.58	369.25	333.3	346.57	0.04	1.29
1958	429.10	498.36	473.38	386.83	384.6	347.07	0.16	1.45
1959	476.9	540.33	524.92	416.0	409.5	380.73	0.10	1.55
1960	497.76	554.16	548.62	418.2	397.5	400.13	0.06	1.61
1961	491.29	557.48	546.16	406.82	424.8	402.03	0.02	1.63
1962	540.8	587.41	578.25	447.18	426.6	400.96	0.07	1.70
1963	553.5	606.52	601.84	474.55	477.6	420.7	0.13	1.83
1964	549.52	610.13	600.2	470.48	490.4	419.99	0.05	1.88
1965	558.97	618.9	611.17	478.84	489.7	435.44	0.08	1.96
1966	566.94	622.87	617.75	486.58	528.9	437.8	0.12	2.08
1967	576.32	630.1	623.24	486.58	534.6	441.7	0.04	2.12
1968	613.4	658.34	653.96	511.88	511.3	444.5	0.49	2.61
1969	610.0	660.0	660.0	510.0	532.6	451.77	0.55	3.16
1970	686.6	698.73	702.79	550.56	579.1	482.34	0.26	3.42
1971	766.5	734.0	747.5	589.03	618.4	506.67	0.33	3.75
1972	784.0	759.19	782.89	598.03	615.2	544.32	0.44	4.19
1973	984.6	883.32	919.5	733.5	1014.6	557.03	0.76	4.95
1974	1079.6	990.28	1003.98	805.87	1036.7	558.33	1.14	6.09
1975	1092.6	1041.82	1050.0	818.83	809.0	670.4	1.18	7.27
1976	1231.4	1121.62	1190.5	892.0	942.3	768.95	1.06	8.33
1977	1387.2	1281.22	1353.46	1007.44	1255.8	828.85	1.07	9.4

PQBF: Price of dairy feed (Francs/MT)

Source: INSEE, Foucault

PSM: Domestic price of soymeal (import unit value) (Francs/MT)

PFG: Price of feedgrains (Francs/MT)

DW: First differences of minimum wage in France (Francs/hr)

$$DW = W_t - W_{t-1}$$

Source: INSEE

Exports of Soymeal to France by the Rest of the World (Equation 21)

The variable ESSMG is equivalent to the total imports of soymeal by France. This aggregate variable encompasses the exports of soymeal to France by important soymeal producers (U.S.A., Brazil and Benelux), as well as shipments from neighbouring countries to France, such as West Germany and England.

As discussed in Chapters IV and V, the world price of soymeal is an aggregate price of U.S. and Brazil export soymeal prices weighted by the respective export share of both countries to France.

The world price of alternative meals should represent all other meals traded in the world high-protein meal market. In specifying and estimating the total demand for soymeal in importing countries, Williams (pp. 179-181) incorporated as a proxy for price of other meals a composite price of the four most important meals consumed and competing with soymeal, namely peanut meal, fishmeal, linseed meal and cottonseed meal, weighted by each respective exporter's share. For France, as cottonseed meal is not consumed, the price of this commodity has not been incorporated in the price of other meals (POMW).

Because the time period is a calendar year, it has been necessary to adjust the quantity of soybeans crushed in the main producing areas to this time period. For Brazil and Benelux, no peculiar problems are reported and series are available on a calendar year. For the U.S., the annual series related to the crushings of soybeans are estimated on a crop year basis and need to be re-adjusted.

All the data required to build all the exogenous variables are compiled in Tables A4.13 and A4.14.

POMW: World price of alternative meals. Sum of the price of peanut meal, linseed meal and fishmeal, each weighted by the respective meal's (in soymeal equivalents) share of world trade of the three meals (US dollars/MT)

Weights:	0.305	IMPNM
	0.095	IMPFLM
	0.6	IMPFISM

Source: Williams

CRSOWO: Volume of soybeans crushed by countries exporting soymeal to France, including U.S.A., Belgium, Netherlands and Brazil.

CRSOWO = CRSOWBR + CRSOWUS + CRSOWB + CRSOWH

HGPOPUS: Hog production in the U.S. (1000 head)

Source: FAO

TABLE A4.13. Data used in excess supply function

	ESSMG	PSMW	POMW	CRSOQ	HGPOPUS	PSMUS	PSMBR	U.S. Export Share	Brazilian Export Share
1955	31.2	68.41	139.44	8055.08	50474.0	68.41	0.0	1.0	0.0
1956	40.4	57.90	137.43	7989.32	55173.0	57.90	0.0	1.0	0.0
1957	49.3	54.03	125.42	8870.13	51703.0	54.03	0.0	1.0	0.0
1958	52.8	62.6	130.0	9922.79	50980.0	62.6	0.0	1.0	0.0
1959	112.0	71.13	132.70	11367.4	58045.0	71.13	0.0	1.0	0.0
1960	100.0	70.63	100.06	11376.7	59026.0	70.63	0.0	1.0	0.0
1961	155.5	73.25	110.25	11582.0	55506.0	73.25	0.0	1.0	0.0
1962	306.15	78.25	122.34	12967.3	57000.0	78.25	0.0	1.0	0.0
1963	325.5	85.52	121.73	13444.4	58883.0	86.24	67.0	0.9561	0.0439
1964	394.41	82.89	131.25	13173.7	58119.0	85.22	69.0	0.9728	0.0272
1965	484.85	85.5	155.29	14118.1	50792.0	85.84	73.0	0.9493	0.0507
1966	619.03	92.19	151.28	15818.7	47414.0	93.24	79.0	0.9247	0.0753
1967	625.93	94.59	135.95	16687.5	53249.0	95.29	82.0	0.9516	0.0484
1968	739.52	91.29	121.93	17171.6	58777.0	92.2	91.0	0.92	0.08
1969	802.78	89.19	143.32	19194.7	60632.0	90.25	79.0	0.9103	0.0897
1970	843.31	92.5	164.95	23092.0	57046.0	93.86	83.0	0.8745	0.1255
1971	939.39	96.39	144.62	23496.5	67433.0	97.83	90.0	0.8193	0.1807
1972	1047.52	111.69	200.62	24312.7	62507.0	113.12	108.0	0.7203	0.2797
1973	1147.25	225.5	440.24	23870.4	59180.0	211.34	265.0	0.7362	0.2638
1974	1521.8	179.39	310.21	28766.8	61106.0	192.23	149.0	0.7034	0.2966
1975	1499.4	159.85	323.93	27914.0	54693.0	168.85	149.0	0.547	0.4530
1976	1718.4	179.81	310.82	32863.6	49267.0	177.78	182.0	0.5264	0.4736
1977	1703.75	218.33	369.48	32596.1	54934.0	222.57	215.0	0.4412	0.5588

ESSMG: Quantity of soymeal imported by France (1000 MT)
Source: FEDIOL, FORMA

PWMW: World price of soymeal in U.S. dollars/MT. Sum of Brazilian and U.S. export soymeal prices weighted by the respective exporter's share of soymeal exports.

TABLE A4.14. Data used to construct world soybean crush and the world price of other protein meals

	CRSOWBR	CRSOWUS	CRSOWB	CRSOWH	IMPNM	IMPFLM	IMPFISM
1955	100.0	7793.08	20.0	142.0	112.0	104.0	159.0
1956	100.0	7672.8	40.2	176.3	110.0	105.0	156.5
1957	112.2	8535.63	34.5	187.8	98.0	84.0	145.9
1958	117.92	9550.88	41.16	212.83	87.0	75.0	160.6
1959	135.2	10854.67	82.93	294.6	101.0	97.0	154.5
1960	179.4	11018.73	145.82	327.5	98.0	88.0	103.0
1961	176.5	11031.52	97.28	276.7	93.0	85.0	123.0
1962	220.79	12264.55	128.96	353.0	102.0	95.0	137.0
1963	263.64	12740.86	104.9	335.0	106.0	101.0	133.0
1964	280.52	12327.18	151.0	415.0	108.0	100.0	148.0
1965	406.0	13149.1	147.0	416.0	119.0	103.0	182.0
1966	426.0	14828.7	165.0	399.0	111.0	131.0	175.0
1967	353.82	15658.68	235.0	440.0	111.0	102.0	154.0
1968	536.35	15849.25	249.0	537.0	105.0	100.0	134.0
1969	661.93	17411.77	267.0	854.0	101.0	98.0	172.0
1970	1098.2	20598.8	314.0	1081.0	123.0	97.0	197.0
1971	1699.0	20244.51	348.8	1203.79	116.0	95.0	167.0
1972	2371.95	20187.75	331.0	1422.0	144.0	140.0	239.0
1973	2829.4	19371.0	449.0	1221.0	305.0	231.0	542.0
1974	4515.7	22013.1	738.0	1500.0	226.0	190.0	372.0
1975	5767.6	20189.4	671.0	1286.0	186.0	181.0	265.0
1976	6688.9	23769.7	911.0	1494.0	218.0	197.0	376.0
1977	8480.0	21829.6	792.0	1495.0	254.0	206.0	454.0

IMPNM: EC import price of peanut meal, CIF European ports (US Dollars/MT)
Source: USDA, Oil World

IMPFLM: EC import price of linseed meal, CIF European ports (US Dollars/MT)
Source: USDA, Oil World

IMPFISM: EC import price of fishmeal, CIF Hamburg (US Dollars/MT)

Source: USDA (1977), Oil World

CRSOWBR: Volume of soybeans curshed in Brazil (1000 MT)

Source: Williams (1977)

CRSOWUS: Volume of soybeans crushed in the U.S.A. (1000 MT)

Source: USDA

CRSOWB: Volume of soybeans crushed in Belgium (1000 MT)

Source: FEDIOL

CRSOWH: Volume of soybeans crushed in the Netherlands (1000 MT)

Source: FEDIOL (1960-1977)

PSMUS: U.S. export price of soymeal (average unit value) (US Dollars/MT)

Source: FAO, Soybean Blue Book (1955-1958)

PSMBR: Brazilian export price of soymeal (average unit price) (US Dollars/MT)

Source: FAO

APPENDIX A5. Supply and disappearance of soybeans and soybean products in France (1955-1977)

	1955	1956	1957	1958	1959	1960	1961	1962	1963
Soybeans									
crushed	87.0	66.7	68.0	53.8	81.6	176.2	78.9	144.9	128.1
Soyoil									
production[1]	15.8	12.2	12.2	9.68	14.69	31.72	14.2	26.1	23.1
imports	--	0.8	0.5	0.9	0.6	0.8	1.6	1.5	1.35
exports	--	3.6	5.5	3.7	7.4	16.3	5.9	8.7	3.6
consumption	15.8	9.2	7.2	6.9	7.9	16.2	9.9	18.9	20.85
Soymeal									
production[2]	70.4	53.36	54.4	43.04	65.28	140.96	63.12	115.92	102.48
imports	31.2	40.4	49.3	52.8	112.0	100.0	155.5	306.15	325.5
exports	13.2	3.7	3.6	0.1	1.0	9.2	2.2	3.65	6.12
stocks	--	--	--	-3.35	4.24	3.54	-14.1	-3.19	5.41
consumption[3]	88.4	90.06	100.1	92.39	180.52	235.3	202.32	415.23	427.27

Notes: [1] Soyoil production 0.18 * CRUSH (1955-1974) 0.175 * CRUSH (1974-1977)

[2] Soymeal production 0.8 * soybeans crushed

[3] Consumption of soymeal = Production of Soymeal + Soymeal Imports + Stock Variation - Exports of Soymeal

APPENDIX A5. Continued

	1964	1965	1966	1967	1968	1969	1970	1971	1972
Soybeans crushed	191.0	117.5	121.0	135.0	52.0	46.0	423.0	482.0	484.0
Soyoil									
production[1]	34.4	21.15	21.78	24.3	9.36	8.28	76.14	86.76	87.12
imports	1.28	1.17	3.05	7.96	13.25	19.13	37.19	43.69	39.52
exports	3.2	3.96	3.04	2.06	0.99	0.44	29.32	42.29	59.37
consumption	32.5								
Soymeal									
production[2]	152.8	94.0	96.8	108.0	41.6	36.8	338.4	385.6	387.2
imports	394.41	485.85	619.03	625.93	739.52	802.79	843.3	939.39	1047.52
exports	3.85	7.36	3.29	3.47	3.12	3.85	8.82	12.0	17.8
stocks	-3.74	-5.39	-2.97	1.64	0.39	0.77	-5.35	3.28	-0.83
consumption[3]	539.61	567.1	709.57	732.1	778.39	836.51	1167.53	1316.27	1416.09

APPENDIX A5. Continued

	1973	1974	1975	1976	1977	1978
Soybeans						
crushed	513.0	567.6	431.0	524.0	561.8	746.8
Soyoil						
production[1]	92.34	102.17	75.43	91.7	98.32	130.69
imports	47.76	85.2	89.99	93.4	90.53	109.8
exports	62.54	80.9	80.48	80.3	81.64	126.4
consumption			84.94	104.8	107.21	114.09
Soymeal						
production[2]	410.4	454.08	344.8	419.2	449.4	597.4
imports	1147.26	1521.82	1499.42	1718.4	1703.75	2276.2
exports	29.52	26.85	22.81	23.48	17.24	10.4
stocks	-1.16	-8.95	8.78	3.14	2.27	-1.9
consumption[3]	1526.98	1940.1	1830.19	2117.26	2138.18	2861.3

APPENDIX A6

SOME PRELIMINARY ECONOMETRIC RESULTS ON THE FRENCH SOYBEAN MODEL

(1) Demand for soymeal by compounders: initial specification

Estimation technique: OLS

R^2 = 0.982 DW = 2 Nbr. obs. = 22 Range = 1956-77

$$DSMC = -40.9111 + 0.9329\ TOTQCOMP - 174.952\ \frac{PSM}{PCFG} - 0.0286\ OMSOYA$$

t: (-0.28) (12.95) (-1.732) (-0.23)

(2) Demand for soymeal by compounders: with constrained coefficients associated with OMSOYA

Estimation technique: OLS

R^2 = 0.9189 DW = 0.476 Nbr. obs. = 22 Range = 1956-77

$$DSMC = 471.768 - 199.183\ \frac{PSM}{PCFG} + 0.2924\ TOTQCOMP - OMSOYA$$

t: (-0.716) (16.07) (constrained)

(3) Excess supply of soymeal: ESSMG

Estimation technique: OLS

R^2 = 0.983 DW = 1.14 Nbr. obs. = 22 Range = 1956-77

$$ESSMG = -291.451 + 3.55386\ PSMW - 1.2181\ POMW + 0.06204\ CBSOWO$$

t: (-1.36) (1.885) (-1.353) (12.13)

$$- 0.00571\ HGPOPUS$$

t: (-1.494)

(4) <u>Demand for Feedgrains by Compounders</u>: DCFGC

Estimation technique: OLS

$R^2 = 0.984$ DW = 0.81 Nbr. obs. = 22 Range = 1956-77

$$DCFGC = 1974.1 + 0.53847\ TOTQCOMP - 1091.41\ \frac{PCFG}{PSM}$$

t: (2.78) (19.685) (-1.519)