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by

Gustavo A. Nores

In Partial Fulfillment of the

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of

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As is customary, I hasten to say that all the errors and shortcomings of this study are obviously my own responsibility.

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LIST OF ABBREVATIONS

ADW = average dressed weight

ALW = average liveweight

beef = beef and veal

BCRA = Banco Central de la Republica Argentina

CLI = Cost of Living Index (1960=100)

dollar = U.S. dollar

DP = dressing percentage

e.c.w. = equivalent carcass weight

EEC = European Economic Community

FOB = Free on Board

GDP = Gross Domestic Product

JNC = Junta Nacional de Carnes (National Board of Meat)

kg. = kilogram

peso = Argentine Peso

p.w. = product weight

S.E.A.G.= Secretaria de Estado de Agricultura y Ganaderia.

ton = metric ton

---- = zero

ABSTRACT

Nores, Gustavo Adolfo, Ph.D., Purdue University, June 1972. Quarterly Structure of the Argentine Beef Cattle Economy: A Short-Run Model, 1960-1970. Major Professor: Joseph Havlicek, Jr.

To understand the short-run structure and price formation mechanism of the beef cattle economy is extremely important in Argentina. Large fluctuations characterized by a strong cyclical path which has been observed in the real price of beef cattle, constitute an important source of disturbance in the overall economy. This study focuses on the analysis of the industry's short-run structure in an effort to understand its dynamic characteristics and to explain the observed price fluctuations. Special attention is given to the evaluation of specific policies such as exchange rate policy, rationing, maximum retail prices and credit policy which had been implemented during the last decade.

The economic model is based on a theory of investment behavior of producers and on traditional demand theory. Four statistical models were specified and estimated. These differ in (a) the level of aggregation of slaughter supply equations, (b) whether or not average slaughter weights are regarded as variables or assumed to be constant at mean sample values, and (c) whether or not domestic demand and demand for exports are specified at the farm level or at the final retail and FOB levels when the behavior of intermediaries and of export packers is

explicitly taken into consideration. The interdependency among the large components of the beef cattle economy are analyzed on the basis of the most aggregated model.

All four models are specified as simultaneous systems of linear equations in which slaughter volume and quantities consumed and exported react to and determine price. These models correspond to simultaneous equations blocks of more complete block recursive systems, in which the other block(s) are formed by an equation explaining the inflow of animals to the herd (the number of calves born) and stock accounting equations connecting stocks and flows.

The empirical evidence indicates that slaughter of different categories of animals are characterized by seasonal patterns reflecting the seasonality in births and pasture availability. Availability of pastures varies with the season and so does slaughter response to price changes. In the short-run and in the absence of a pasture constraint the slaughter of all categories of animals (including steers) decreases as beef prices go up or input prices go down. This constitutes new and solid evidence that, not only do cattle producers respond to price changes in the expected direction, but also that they respond promptly (within the quarter) and in significant magnitude.

The empirical evidence also indicates that farm prices are, in the short-run, highly sensitive to both real wage rate and net effective exchange rate. This has strong policy implications since, under the present system, the levels of these variables are either set or highly influenced by government decisions. As beef prices go up exports, which are more price elastic than domestic demand, start declining.

This induces the government to devalue (reduce export duties or increase export subsidies) in an attempt to maintain the level of exports. The quantity adjustment is thus forced into domestic consumption. Since domestic demand is rather inelastic with respect to price and slaughter reacts inversely to price, the required adjustment in price to clear the market is larger than the initial increase. At the new price level a further devaluation is needed to maintain the level of exports. This process continues until the new output from an increased herd reaches the market. In summary, exchange rate policy directed toward stabilizing beef exports results in distabilization of price.

CHAPTER I

INTRODUCTION

The relative importance of beef cattle within the Argentine agricultural sector and of beef exports as a source of exports earnings is widely known and has been extensively discussed in the literature.[1/] Briefly, beef cattle production accounts for about 30 percent of the gross value of agricultural output and for about 64 percent of the gross livestock product. During the last decade, about one fourth of the volume of beef production was exported accounting for more than 25 percent of the total value of exports. At the same time, beef holds an important position in the Argentine diet. Argentina's per capita consumption of beef is one of the highest in the world. That is, the beef cattle activity is the most important single enterprise in the agricultural sector, beef exports have been and still are one of the main sources of export earnings, and beef is a basic consumption good for the Argentines.

Large fluctuations have been observed in the real price of beef cattle at the farm level; particularly during the last decade and

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[1/] For detailed information about the relative importance of beef cattle, characteristics of production and marketing, and the role of prices, the reader is referred to Kohout [25], Fienup, Brannon and Fender [12], Herrmann and Branson [23], Jarvis [24], Peffer [32], Liboreiro [26] and Nores [31].

a half. This may be observed in Figures 1 and 2. Even sharper fluctuations have been exhibited by the price of beef cattle relative to grains [Figure 3]. Since cattle are raised only in the open range and fed on natural and improved annual or perennial pastures, cattle raising and fattening activities compete with crops for the land input. Previous studies have shown that these fluctuations in relative prices have affected the allocation of resources between livestock and crops.[2/]

As a consequence of fluctuations in slaughter and prices, consumption and exports have varied substantially [Figures 4 and 5] and consequently export earnings have varied also. This has, in turn, affected the capacity to import. Furthermore, since imports consist mainly of critical inputs and basic raw materials, leaving very little room for import substitution, variations in exports and hence in import capacity, do affect the overall development process.

Effects of Price Fluctuations in Terms of Production, Exports and Overall Price Stability

Beef has a weight of twenty percent of the official Cost of Living Index (CLI). Although it is generally accepted that this index overestimates the beef share of the consumer basket, it gives an idea of the impact that changes in the nominal retail price of

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[2/] See Jarvis [24], Yver [44], and Nores [31].

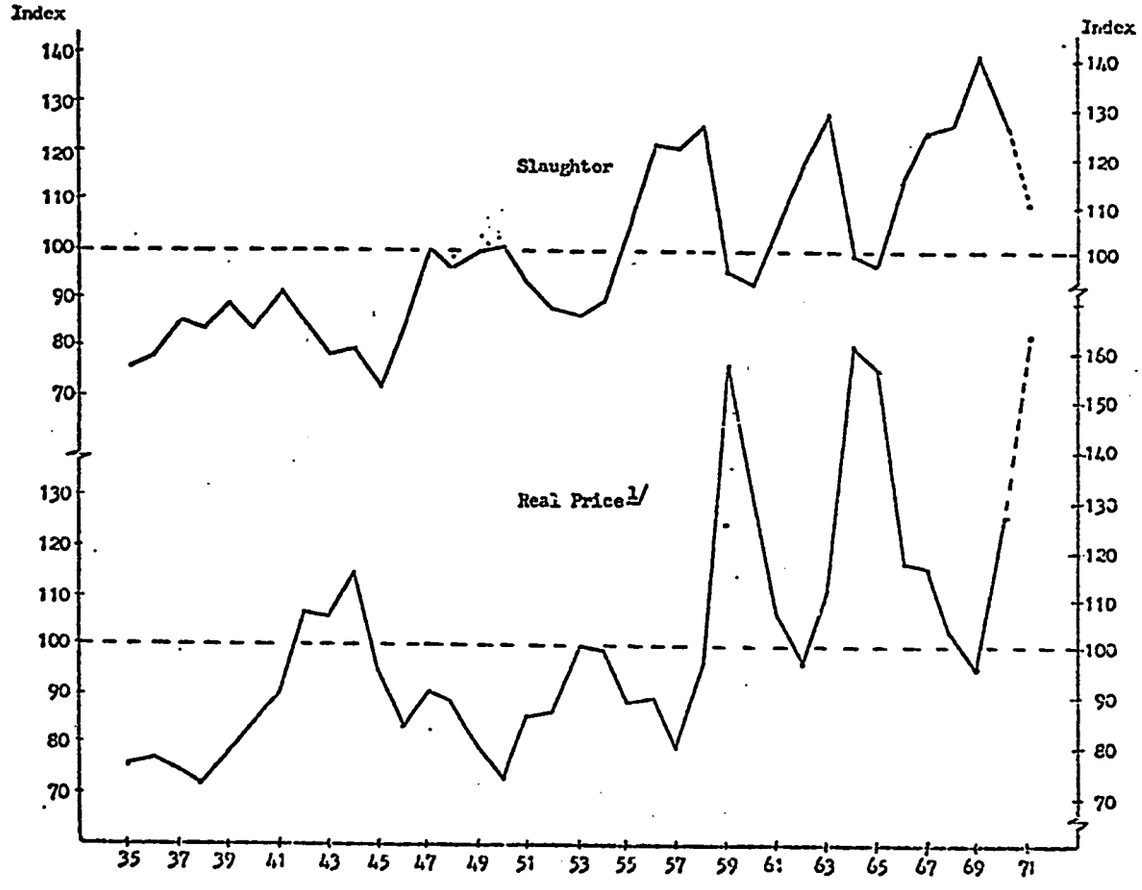

Figure 1. Index of Real Price of Beef Cattle at the Farm Level and Index of Volume of Beef Obtained from Slaughter, 1935-1970 = 100.

1/ Nominal Price deflated by the Cost of Living Index; average for the period 1935-1970 = 100.
Source: Junta Nacional de Carnes

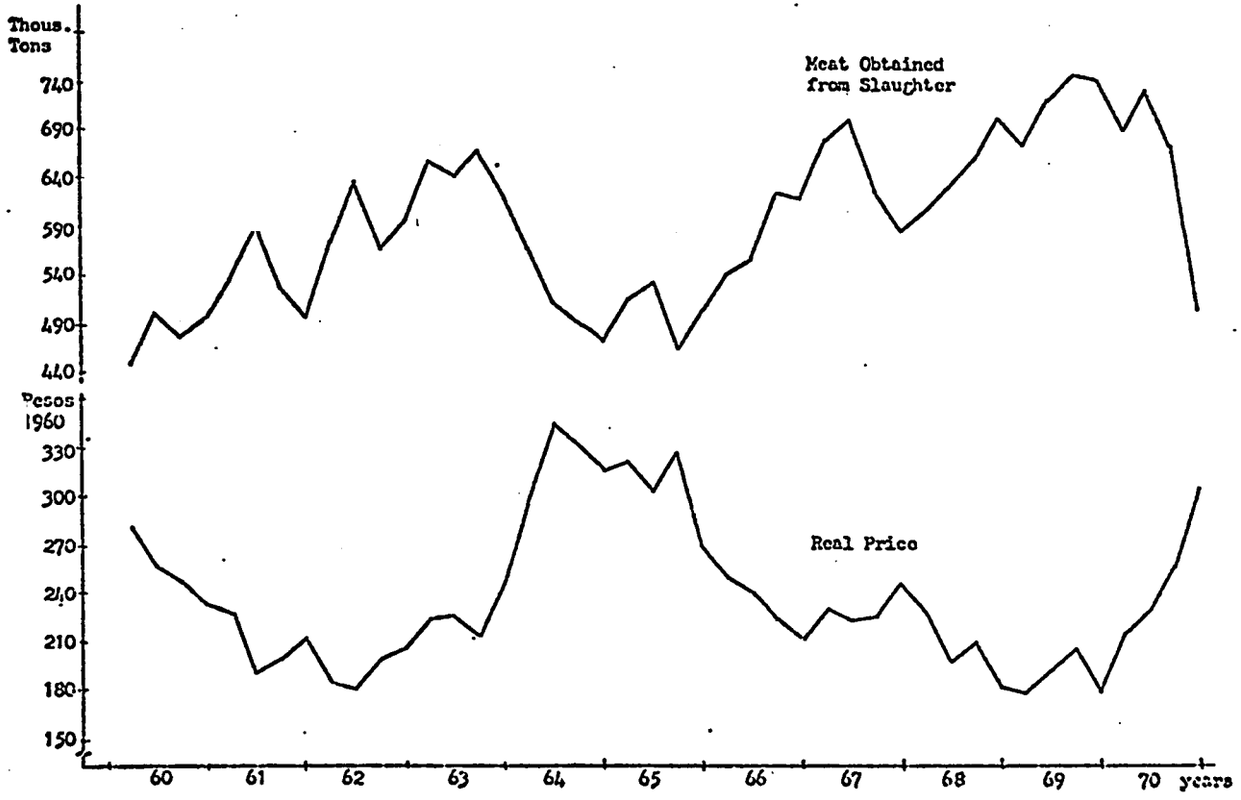

Figure 2. Real Price of Beef Cattle at the Farm Level and Volume of Meat Obtained from Slaughter, I/1960-IV/1970.

Source: computed on the basis of information obtained from Junta Nacional de Carnes; for computational procedure see Appendix E.

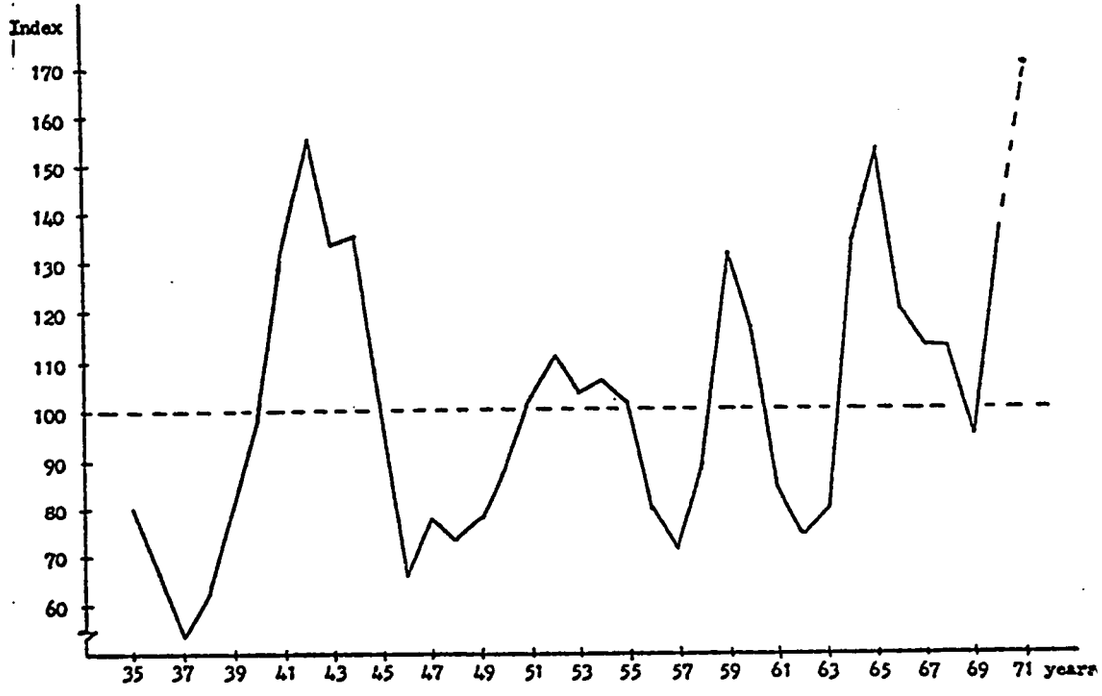

Figure 3. Index of Real Price of Beef Cattle relative to Grain Prices, 1935-1970.

Source: Computed on the basis of information obtained from Junta Nacional de Carnes and Bolsa de Cereales; for computational procedure see Norse [31, Appendix A]; average for the period 1935-1970 = 100.

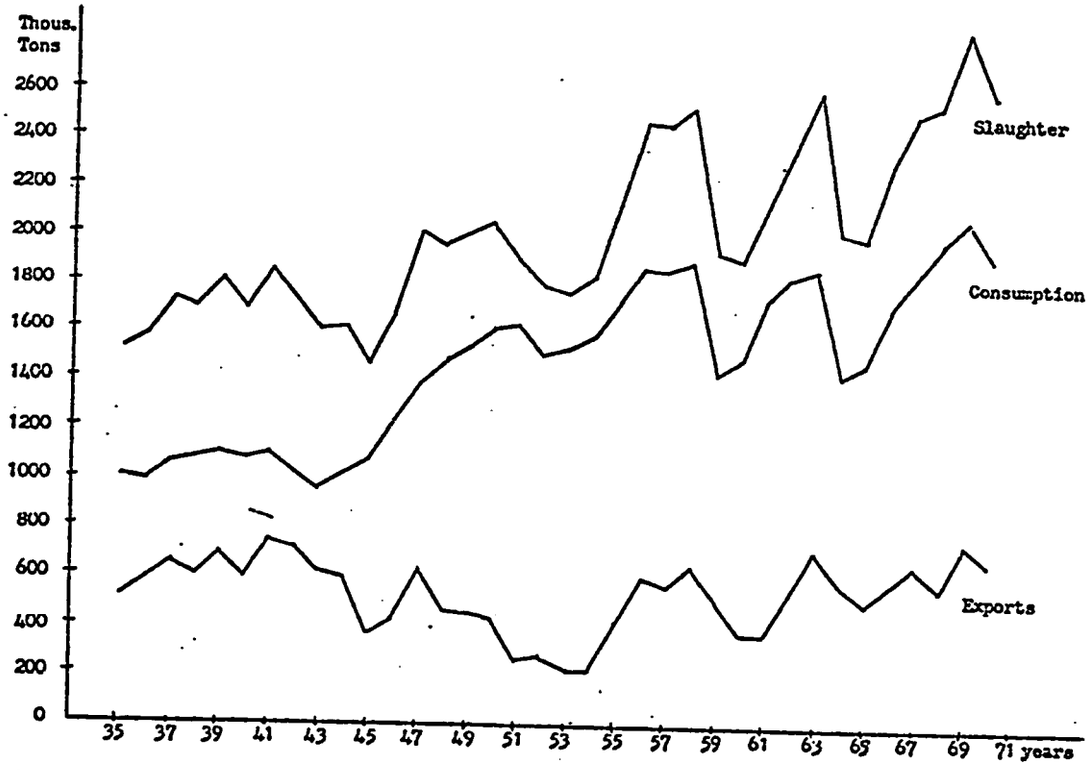

Figure 4. Annual Volume of Beef Obtained from Slaughter, Domestic Consumption and Exports of beef, 1935-1970.

Source: Junta Nacional de Carnes.

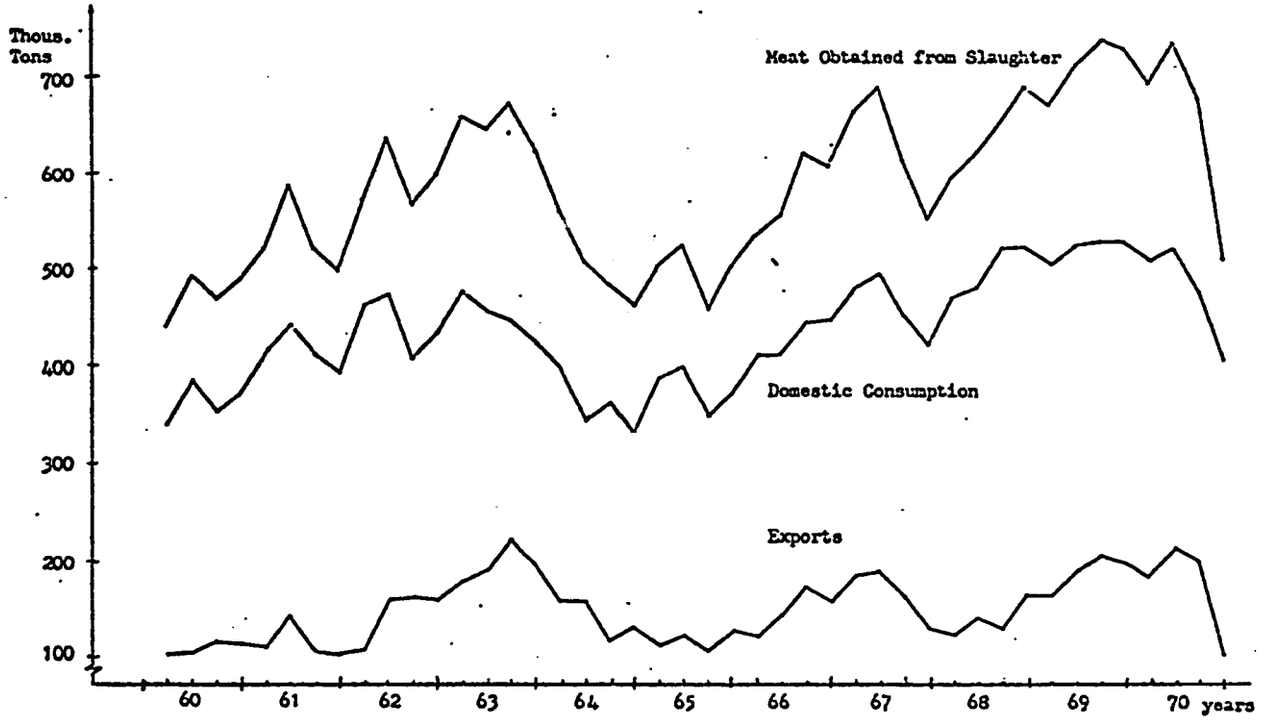

Figure 5. Quarterly Volume of Meat Obtained from Slaughter, Domestic Consumption and Exports of beef, I/1960-IV/1970.

Source: computed on the basis of information obtained from Junta Nacional de Carnes; for computational procedure, see Appendix E.

beef have on the real wage level. Moreover, since labor unions and employers hold periodic "bargaining rounds" where negotiations usually start with an increase in nominal wages close to that of the CLI, fluctuations in the price of beef end up having a substantial impact on the overall price level.

On the export side, fluctuations of domestic price that are not paralleled by the international price do affect the actual volume of exports. Irregular flows at varying prices are by no means attractive to the main importing countries - EEC, UK, USA and Spain - which are more inclined to quota systems and regulations of inflows of beef to make them consistent with their domestic price policy. Also, as was pointed out earlier, variation in exports that affect import capacity do affect the overall development process.

On the production side, price instability tends to discourage potential investment in improvements such as permanent pastures, storage facilities, wells, fences, etc.[3/] The farm enterprises not only tend to emphasize short-run type of investments but also tend to be organized in a diversified form in order to cope with price uncertainty and, at the same time, be of a flexible form so as to be able to move toward the most profitable activity in the future without incurring substantial capital losses. Since cattle are fed on pastures rather than on grains, cattle raising and crops are

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[3/] See Kohout [25] and Liboreiro [26].

less complementary to each other than otherwise. One would hypothesize that under riskless conditions and given relative prices, farmers would tend to specialize in the activity for which their land is most suitable. However, if they are risk averters and relative prices fluctuate substantially, they will tend to be less specialized. If farmers believe that they can improve their knowledge as time goes on they will tend to keep their farms as flexible and as adaptable as possible.[4/] The result is a smaller aggregate volume of beef production than under certainty conditions.

In summary, the large fluctuations, which are characterized by a strong cyclical path in the real price of beef cattle, constitute an important source of disturbance in the overall economy. Price fluctuations of this nature and magnitude not only affect the allocation of resources within the agricultural sector leading to substantial capital losses and gains in the production activity, but also cyclically endanger export earnings, consumers' real income and the overall price stability. Thus, one might conclude that a smaller degree of price instability may be desirable for the case of beef in Argentina. However, given the important role played by prices in a market economy, more information is needed about the causes of such wide price fluctuations before meaningful evaluation of alternative policies directed to avoiding or reducing such fluctuations could be made.

[4/] This problem has been extensively considered in the literature, see Hart [20, 21,22], Stigler [35], Marschak [29], and Tintner [39,40,41].

Causes of Price Fluctuations

In recent years, considerable interest has been placed in studying the problem of price fluctuations. Three independent pieces of research[5/] have implicitly or explicitly attempted to provide an explanation of the cyclical phenomenon observed in the Argentine beef cattle economy. The explanations, although with different degrees of sophistication and different in version, are mostly based on similar theories of investment behavior in the cattle industry and corroborated by empirical evidence for the period 1935-1966. The cycle is explained in a cobweb fashion. With the length of the production period being longer than the observation unit (the year), quantity supplied reacts to price movements with a certain lag. However, while in the "cobweb model" supply is assumed predetermined, in this particular case short-run slaughter supply reacts inversely to current price. This is due to the fact that certain categories of animals may be considered intermediate products or capital goods. Animals are not only output but also inputs in production. Any decision to increase production implies withholding from slaughter. Since animals of different age and sex have different maturity or discounting horizons (because of different feed conversion ratios and characteristics as breeders) it is reasonable to expect different reactions to price expectations in terms of the number of animals of each category slaughtered or withheld.

[5/] Nores [31, 1969], Jarvis [24, 1969] and Yver [44, 1971].

As beef prices go up it becomes profitable for the producer to keep all animals for a longer period. However, in the aggregate and in the short-run, the cattle industry may be constrained by the availability of pastures. If this constraint is effective, there will be an increase in the opportunity cost, or shadow price, of pasture land. As a result and because as beef prices rise, different discounting horizons cause some animals to become more valuable as capital goods than as slaughter animals, it pays the cattle firm to adjust its portfolio to the new capital value situation by altering the composition of its sales.[6/]

The observable short-run phenomenon in the aggregate would be an increase in sales of animals closer to their optimum slaughter weight and a decrease in sales of animals such as females and young animals which have a longer discounting horizon. Evidently, the magnitude of these changes will depend on the effectiveness of the pasture constraint, on how quickly availability of pastures may be increased, on the opportunity costs of pastures, and on price expectations. Nonetheless, the observable short-run phenomenon will be a decrease in total slaughter as prices go up. This accelerates the price cycle in its upward swing making it steeper with respect to current price than in the case of a predetermined supply. In the long run as new animals from an increased herd

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[6/] See Yver [44, pp. 17-23].

enter marketing outlets and slaughter increases, beef prices (in real terms) start the downward swing and the cycle is reversed. Ex post, the observed peakness and amplitude of the cycle also depend on exogenous factors affecting both slaughter supply and market demand, such as droughts, population increase, consumer's income, prices of substitutes, effective exchange rate, and restrictions of access to foreign markets.

Another element contributing to the cycle is the inelasticity of demand. The more price inelastic the demand facing the slaughter supply, the wider will be the price fluctuations. The empirical evidence provided by previous studies[7/] tends to support this assertion. In the last decade and a half, exchange rate and export tax policy tended to make derived demand for exports more price inelastic by modifying the effective exchange rate so as to maintain the level of exports by partially absorbing variations in cattle prices. Hence, the cycle is being forced - at least partially - onto the domestic market, and being absorbed by domestic consumption. This, given short run inelasticity of domestic demand, contributes to price fluctuations.

The studies cited earlier (footnote 5) have contributed to the understanding of the structure of the Argentine beef cattle economy,

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[7/] See footnote 5, page 10.

its dynamics, and its problems. However, some pertinent questions remain to be answered.

First, the empirical estimates obtained and hence, estimates of the underlying structures, are based on annual data for the period 1935-1966.[8/] This period includes not only World War II but also one can presume different supply and demand structures. On the production side, improved pastures have consistently gained relative to natural pastures as a percentage of total grazing land.[9/] New breeds were introduced and a considerable switch among breeds occurred during the period.[10/] Hybrid seeds, pesticides and insecticides were introduced in the crop sector. This type of output increasing technological change would have, ceteris paribus, modified the opportunity cost of land. If technological change has occurred, there is no a priori reason to believe it has occurred at the same pace in both the beef cattle and grain sectors. Thus, supply structure might have changed in which case estimates of the structure based on such sample period (1935-1966) might differ substantially from the current underlying structure. Explaining supply by relative prices does not solve the problem of statistical inference. Simply because the beef-grains

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[8/] The research done by Jarvis [24] is based on fiscal year data for the period 1937/38 - 1966/67.

[9/] See Kohout [25] and Windsberg [43].

[10/] As a result of changing demand conditions in favor of leaner beef, the percentage of Shorthorns fell from 75 in 1937 to 34 in 1960 in favor of Aberdeen Angus and others; see Jarvis [24, pp. 453-456] and Kohout [25].

price ratio has (or has not) changed does not mean that the relative profitability of the enterprises has (or has not) changed.

There have also been changes which may have resulted in different structures on the demand side, particularly in the demand for exports. The composition as well as destiny of beef exports changed considerably during the period. The movement was toward a highly diversified composition of exports in terms of both, beef products and destinations. In the late 1940's and early 1950's about 85 percent of beef exports went to England, while by the mid 1960's the EEC had already surpassed England as the principal buyer.[11/] Since import policies and restrictions vary over time, from country to country and from product to product, it is reasonable to expect that the structure of the foreign demand for Argentine beef faced today might be different from the one faced twenty or more years ago.

Moreover, from 1947 to 1959 the beef cattle economy was subjected to a whole arsenal of policy measures that ranged from maximum retail prices to minimum prices for cattle, from export surcharges and an overvalued exchange rate to a regime of subsidies to export packers to compensate losses and assure a 10 percent return on their capital. Because of the latter it was not feasible to obtain a reliable "net export price received by packers" during the period

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[11/] In 1969 Argentina exported beef products to more than sixty countries. Also a higher degree of industrialization has been achieved in beef exports. Exports of beef cuts began in 1966 and by 1970 were larger in e.c.w. volume than the traditional exports of chilled and frozen carcasses. Exports of cooked and frozen beef which started in the late 1950's also grew considerably during the period.

for which the subsidy was effective. Maximum retail prices and minimum cattle prices, if effectively enforced, would also lead to inaccuracies in the structural estimates.[12/] So, one might argue that there is need, in terms of realism, to deal with a more up dated structure. That is, there is a need to estimate the underlying structure from more recent data.

There is also need to explain the behavior of producers, consumers and export packers within the year. This is particularly important for two reasons. First, since cattle are raised and fattened in the open range, current and expected availability of pastures may or may not be an effective constraint depending upon the particular season involved.[13/] Thus, the reaction of producers to price changes may differ from season to season. Second, price

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[12/] Even if provisions in the estimation were made to take account of the possible changes in structure introduced by policy actions-through the use of dummy variables-inaccuracies would be present since policy actions of this nature imply constraints on variables and not necessarily shifts of intercept or slope coefficients.

[13/] Temperature as well as rainfall show a definite seasonal pattern. The following table illustrates rainfall averages for the period 1958-1970.*

Quarter		Breeding Region	Fattening Region	Pampean Region (total)
I	Summer	260.05	298.10	285.25
II	Fall	164.89	137.72	146.90
III	Winter	164.90	114.91	131.80
IV	Spring	239.49	287.52	271.29
Quarterly Average		207.33	209.56	208.81

*In milimeters per quarter; For source see Appendix E.

fluctuations within the year are relevant from the policy making point of view because of the tremendous impact that changes in beef prices have on the cost of living. They are also relevant from the export packers point of view since they need to be able to anticipate prices in order to make appropriate contractual arrangements.

Furthermore, by working with annual data, previous studies were unable to detect or quantify the effect of short-run policy actions. This is particularly true in the case of policies such as: rationing or "beefless days" enforced for short periods of time, or modifications in the level of the exchange rate (devaluations) or in the level of export duties (surcharges). Under a fixed exchange rate system, the heavy inflationary process observed in the economy during the last two decades motivated successive devaluations of the "peso" from time to time. These devaluations were in most cases accompanied by changes in the export tax-subsidy structure so as to soften the immediate impact of such drastic policy actions, and leave room for its periodic reassessment in accordance with the movement in the relative domestic-export price of beef. Since the short-run effect of policy actions of this nature is highly controversial in Argentina, its evaluation and quantification is considered to be of importance

The Problem

As was mentioned earlier, there are enough reasons to argue that certain degree of price stability may be desirable. Given the role or prices in a market economy, questions could be raised about the

level around which price should be stabilized, about the range within which price should be allowed to vary, and about the most appropriate instruments to achieve such stability.

Price stability is widely accepted today in Argentina as a policy objective, with the qualification that the level around which price is stabilized:

a. provides enough incentives to increase production in the long run, so as to allow for the maintenance of traditional levels of per-capita consumption, and for a level of exports which provides for an import capacity consistent with the development plans;

b. allows export packers to compete in the international market; and

c. is consistent with the policy objectives of overall price stability and maintenance of the real wage levels.

The first of these qualifications calls for a minimum price level while the other two call for a maximum level of farm price. All of them imply certain degree of price stability and are objectives of short-run and long-run nature. Since their achievement may be incompatible, - as it may be in the case of short-run price stability and long-run increase in production, - there is a clear need for an understanding of the short-run dynamics of this economy in order to evaluate and quantify the short-run and long-run effects of policy actions. This is so because policies are implemented at a given point in time

and the beef cattle economy is not at any moment in steady equilibrium but in a dynamic and cyclical path, which is constantly being modified by exogenous factors and shocks. Hence, policies should not be evaluated only on the basis of their long-run impact, but also in relation to the particular circumstances at the moment of their implementation, and with respect to their short-run effects.

Exogenous factors and shocks are the initial causes that through changes in prices induce the cyclical reaction of slaughter. They are in fact continuously affecting market demand and slaughter supply. Consequently, the observed prices are short-run equilibrium prices which reflect:

a. the lagged reaction of slaughter to previous price situations caused by external shocks and changes in exogenous factors that occurred at different moments in the past; and

b. the current levels of market demand and slaughter affected by current shocks and exogenous factors.

Before meaningful evaluation of alternative policy strategies directed toward achieving the above mentioned objectives can be made, reliable knowledge is needed about the nature of these exogenous factors and shocks and their short-run and long-run effects.

This study attempts to go just one step further than previous studies in analyzing the structure of the Argentine beef cattle economy, its dynamics and its problems, by focusing on the short run. To this end, a quarterly model is developed and estimates of

its parameters, based on data from a more recent period (I/1960-IV/1970) are obtained. The economic model in generic form is presented in Chapter II and the estimates are presented and analyzed in Chapter III. Chapter IV deals with evaluation of the model and suggestions for further research arising from the findings and limitations of this study. The main conclusions of the analysis are presented in Chapter V.

CHAPTER II

ECONOMIC MODEL

Short Run Slaughter Supply

The theory of investment behavior in the cattle industry has been discussed in the literature[1/] and there is no need to repeat it here. Only its main highlights and its implications in terms of short-run slaughter supply (shorter than a year) will be briefly commented upon.

Assuming that the firm maximizes the present net discounted value of the animals in the herd for their remaining lifetime, that animals are fed optimally during their lifetime and taking into account the additional output in the form of calves that a female animal can produce, the following implications of such optimizing behavior are reproduced in abridged form from Yver:[2/]

1. the elasticity of capital price with respect to beef price is: (i) larger for female animals than for male animals and (ii) positive and highest at birth and declines monotonically towards unity as the animal approaches the optimum slaughter age, at which point it equals unity.

1/ See Jarvis [24, pp. 25-103], and Yver [44, pp. 6-23].

2/ Yver [44, p. 19]. The elasticity of capital prices with respect to beef price (or feed price) is defined as the relative change in the value of an animal as a capital good due to a change in relative beef price (or feed price). For a rigorous derivation and definition of these concepts, see [44, pp. 9-15].

2. the elasticity of capital price with respect to feed price is: (i) larger in absolute value for female than for male animals; and (ii) negative and largest in absolute value at birth and declines monotonically toward zero as the animal approaches the optimum slaughter age, at which point it equals zero.

3. if both beef and feed prices increase at the same ratio, the capital prices of all animals will increase in this same ratio and the optimum slaughter age does not change.

4. an increase in beef price or a decline in feed prices will increase the optimum slaughter age of all animals in the herd.

As beef prices go up it will pay the firm to keep all animals for a longer period since the optimum slaughter age has increased. Consequently, if there is no effective pasture constraint, in the aggregate there will be a decrease in slaughter of all animals. The decrease in the slaughter of female and younger animals will be larger than the decrease in slaughter of animals closer to the optimum slaughter age given that the elasticity of capital price with respect to beef price is larger for the former than for the latter.

However, in the aggregate and in the short run[3/], the cattle industry may be constrained by the availability of pastures. If this constraint is effective, as beef prices goes up there will be an increase in the opportunity cost or shadow price of pasture land. As a result of this and because of different discounting horizons, some animals become more valuable as capital goods than

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[3/] Short-run is defined as a period not long enough to allow for improvement or seeding of new pastures to increase carrying capacity.

others (relative to their slaughter value) and the cattle firm will find it profitable to adjust its portfolio to the new capital value situation by altering the composition of its sales. Animals closer to the optimum slaughter age will be sold to provide room for female and younger animals.

Since the effectiveness of availability of pastures as a constraint varies from season to season, the observable phenomenon with regard to sales of animals closer to the optimum slaughter age will depend on the particular season involved and on previous weather which influenced current pasture conditions.

Accordingly, the slaughter supply function for each category of animals is hypothesized to be:

$$(1)\ \text{Slaughter}_j = f_j\left(\begin{matrix}\text{Farm}\\ \text{Price}\end{matrix};\ \begin{matrix}\text{Seasonal}\\ \text{Dummies}\end{matrix};\ \begin{matrix}\text{Previous}\\ \text{Weather}\end{matrix};\ \begin{matrix}\text{Availability}\\ \text{of Credit}\end{matrix};\ \begin{matrix}\text{Beginning}\\ \text{Stock}_j\end{matrix}\right)$$

where $j = (1,\ldots,6)$ refers to categories of animals (steers, young steers, cows, heifers, calves and bulls respectively).

The reason for introducing "availability of credit" as an exogenous variable is that any decision to increase the herd, i.e., to reduce slaughter implies investment; implies an increase in the use of capital as a factor of production. Assuming a perfect capital market the price of the factor (the effective interest rate) would affect investment, hence the behavior of producers with regard to slaughter.

However, in Argentina the nominal interest rate applied to loans has been smaller than the inflation rate.[4/] This means that the real interest rate has been negative and since the allocation of credit portfolio among sectors and activities within sectors depends mainly on policy decisions at the Central Bank level and other official institutions, the investment flow in the beef cattle sector depends - among other things - on the availability of credit as a resource. In this study the flow of credit, measured by the change in the real net balance of loans granted to the sector, is incorporated in the model as an exogenous variable explaining the level of slaughter.[5/]

Another variable not present in explicit form in the firm's investment function is the beginning stock of animals of the corresponding category. It has been incorporated in the aggregate slaughter function, because at that level the size of the stock will condition the flow (investment = stock - slaughter). That is desired stock

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[4/] This assertion is valid since 1955 with the exception of the first half of 1969, and refers only to commercial banking operations which, by far, represent the largest source of loans for the agricultural sector. During this period, over 88 percent of the loans granted to the sector came from four official institutions: Banco Nacion, Banco Provincia de Buenos Aires, Banco Provincia de Santa Fe y Banco Provincia de Cordoba.

[5/] No attempt is made here to incorporate availability of credit in the objective function at the firm level since such a constraint is effective only at the aggregate level.

adjustment to a change in price (desired investment) is by definition the difference between actual and desired stock. Thus, it can be shown that actual (beginning of the period) stock enters the slaughter function as an explanatory variable.[6/]

Stock-Flow Relationship

In a similar way as slaughter is a function of beginning stock, ending stock (beginning of the next period) is a function of current slaughter, except that the relation is of ex-post accounting nature and of the following linear form:

$$(2)\ \text{Stock}_{j,t+1} = \text{Stock}_{j,t} + C_{j,t} - \text{Slaughter}_{j,t} - \text{Mortality}_{j,t} - G_{j,t}$$

where $C_{j,t}$ is the number of animals that enter the jth category from the corresponding younger category (calves born in the case of j = calves); and

$G_{j,t}$ is the number of animals which leave the jth category and move to the next older category (heifers to cows, young steers to steers, etc.).

Since $G_{j,t}$ equals $C_{i,t}$ when the ith category is next in order to the jth category for the aggregate of all animals, the accounting equation is:

$$(3)\ \text{Stock}_{t+1} = \text{Stock}_t + \text{Number of Calves Born}_t - \text{Slaughter}_t - \text{Mortality}_t$$

where the only inflow to the herd is given by the number of calves

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[6/] See Nores [31, pp. 36-39, footnote 10].

born alive during the period and the outflows are given by slaughter and mortality in terms of number of animals.

Independently of whether or not slaughter supply and demand are simultaneously determined or functions of predetermined variables, stocks at the end of the period (beginning of the next) are variables which are endogenous to the system given that they are functions of current slaughter. Since the number of calves born enters the stock equation corresponding to the category of calves (and hence the aggregate), the equation explaining the number of calves born also belongs to the system. However, in as much as current price is determined by slaughter supply and demand, with disregard to ending stocks and the number of calves born, the matricies of coefficients of endogenous and predetermined variables can be partitioned in a block recursive fashion, where the "lower-numbered" blocks correspond to supply and demand equations (plus market clearing condition and other definitional identifies) while the "higher-numbered"blocks correspond to the stock accounting equations and the equation explaining the number of calves born.[7/] It should be noted, however, that such relationships belong to the system and hence, must be considered when forecasting or when computing equilibrium paths and equilibrium elasticities from the model.

Influence of Climate on Slaughter

Weather, current and past, not only affects current pasture conditions and hence price of feed and the effectiveness of

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[7/]This issue will be discussed in more detail in Chapter III.

availability of pastures as a constraint, but also affects net calving[8/] and feed conversion rates. For expository purposes the effect of weather on pastures is denoted as effect "A", the effect of pasture availability on slaughter as "B", the effect of weather on calving rate as "C" and the effect of weather on the feed conversion ratio as "D".

Since there is no observation on pasture availability or pasture prices neither effect "A" nor effect "B" can be measured directly. However, a combination of these effects can be measured indirectly by introducing appropriately lagged weather indices in the slaughter equation.

In the aggregate slaughter consists of two observable interdependent dimensions: the number of animals slaughtered and their average live weight. The effect of pasture availability on the number of animals slaughtered is denoted as "BN" and the effect of pastures on their average weight "BW". The time sequence of these effects can be visualized in Figure 6.

Since weather has a definite seasonal pattern[9/], a seasonal pattern in pasture availability and hence in both slaughter and average weight can be expected. Intercept shifters (dummy variables) are introduced in the model to take account of such "normal seasonal patterns" in sales and average weight, which are the result of

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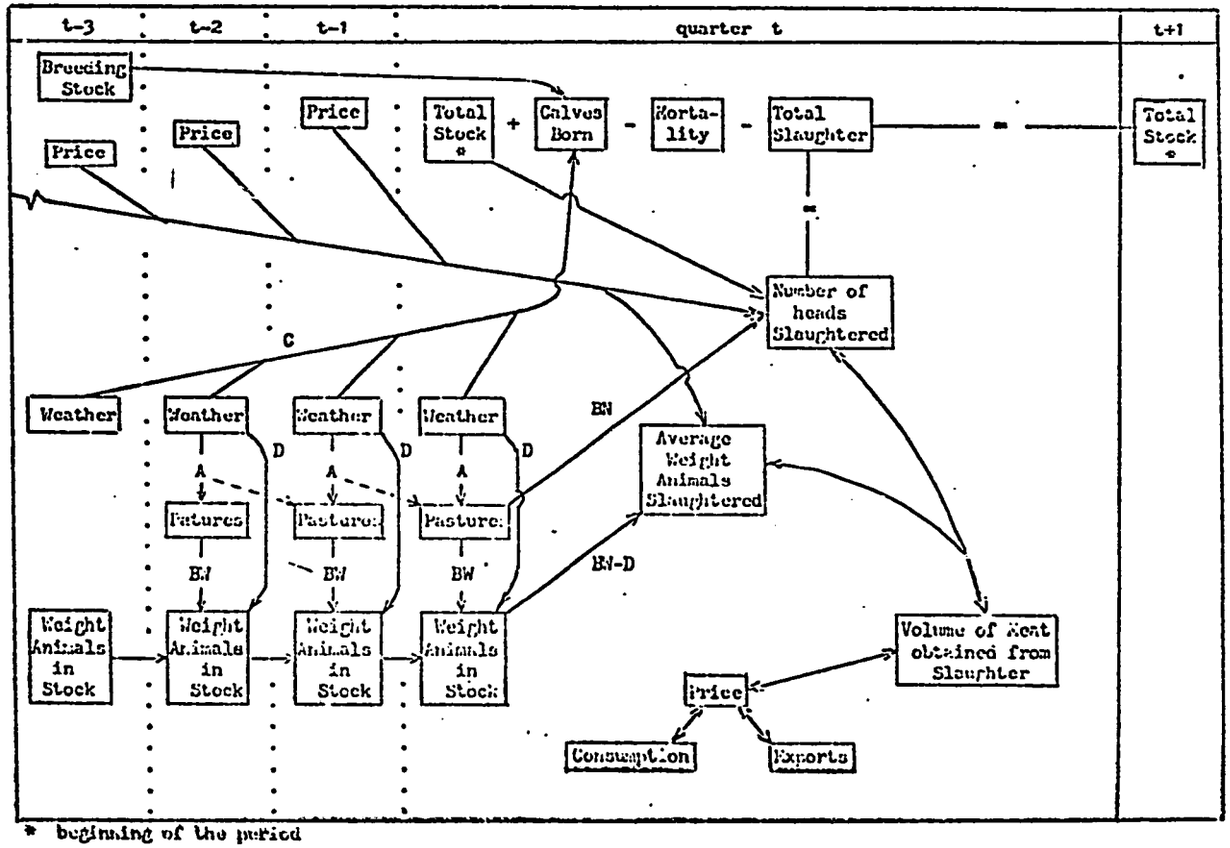
[8/] Defined as the proportion of calves born and alive - after, say, three months - relative to the breeding herd. Weather affects biological parameters such as fertility, calving and mortality rates (calf mortality in particular).

[9/] See footnote 13/ Chapter I.



* beginning of the period

Figure 6. Schematic of Influence of Weather on Slaughter of Beef Cattle.

aggregate behavior of producers due to "normal" weather conditions. To take account of "abnormal" weather conditions an average rainfall index for the Pampean Region was constructed, and expressed as percentage of the mean of the corresponding quarter. It is introduced in the model with one and two quarter lags. Temperature was omitted in the index because of lack of data. Hence, while the dummy variables attempt to measure the "normal" BN and BW-D effects, the weather variables exclude temperature and thus, the resulting estimates of the "abnormal" BN and BW-D effects should be interpreted with caution.

The second observable non-independent dimension of slaughter is average live weight. Because of the need to deal with homogeneous units of measurement on both supply and demand sides average live weight per category of animals is converted, at the observed dressing percentage to average dressed weight (ADW).

Given that average dressed weight per category has been relatively stable throughout the sample period[10/], two approaches can be taken with regard to model specification: (a) they may be assumed constant or (b) they may be considered as endogenous variables, in which case corresponding equations should be introduced in the model explaining them. These equations are similar to those explaining the number of animals slaughtered in each category, that is

(4) $ADW_{j,t} = g_j$ (Farm Price; Seasonal Dummies; Weather; $ADW_{j,t-1}$)

[10/] The coefficient of variation for the individual categories ranged from .026 to .058; see Appendix C, Table 15.

except that the stock variables are excluded and previous average dressed weights are included because the current weight of an animal is a function of feeding and climatic conditions that prevailed during all of its lifetime. Both of these approaches (a) and (b) will be considered although the assumption of constant weight - approach (a) - will be adopted in the simplest version of the model.

Domestic Demand

On the demand side, two alternative specifications are considered. In the simplest version a farm level domestic demand function is postulated where

$$(5)\quad \text{Domestic Demand}_t = f\left(\text{Farm Price}_t\ ;\ \text{Per-Capita Income}_t\ ;\ \text{Population}_t\ ;\ \text{Price of Substitutes}_t\ ;\ \text{Beefless days Dummy}_t\right)$$

and t denotes quarters. The introduction of a dummy variable as an intercept shifter to represent rationing or beefless days is an attempt to measure whether or not such a policy had any significant effect on consumption. In the alternative specification an attempt is made to measure consumer behavior directly at the retail level and infer the behavior or processors and intermediaries as a group with regard to marketing margins. The corresponding equations are

$$(6)\quad \text{Domestic demand}_t = h\left(\text{Retail Price}_t\ ;\ \text{Per capita Income}_t\ ;\ \text{Population}_t\ ;\ \text{Price of Substitutes}_t\ ;\ \text{Beefless days dummy}_t\right)$$

$$(7)\quad \text{Retail Price}_t = i\,(\text{Farm Price}_t\ ;\ \text{Volume Marketed}_t\ ;\ \text{Maximum Retail Price Dummy}_t)$$

This last function explains the price that the marketing group is willing to charge for the beef output, in terms of the price they have to pay for the beef cattle input and the quantity available for marketing.[11/] Note that if equation (7) is substituted for retail price in (6), and therefore retail price is eliminated,- the resulting equation equals farm level domestic demand (5) in as much as the volume marketed by intermediaries equals domestic demand (consumption).[12/]

Demand for Exports

The corresponding simplest version on the export side is the farm level demand for exports:

$$(8)\quad \text{Demand for Exports} = f\,(\text{Farm Price}_t\ ;\ \text{Price of Substitutes International Market}_t\ ;\ \text{Income of Importing Countries}_t\ ;\ \text{Net Effective Exchange Rate}_t\ ;\ \text{Volume of Exports}_{t-1}\ ;\ \text{Hoof and Mouth disease in England Dummy}_t)$$

Three equations correspond to the alternative specification of the Model: (9) foreign FOB demand for Argentine beef, (10) export packers behavioral equation and (11) net export price definitional identity.

11/ For a more detailed analysis of the nature of this function see [Nores, 31, footnote 12/ Chapter II].

12/ The only different between the resulting equation and equation (5) is that maximum retail price is excluded from the latter. As will be seen later, the evidence indicated that maximum retail prices represented a constraint in that particular variable having no effect on farm price.

$$(9)\quad \text{Demand for Exports}_t = i\,(\text{FOB Price}_t\ ;\ \text{Price of Substitutes International Market}_t\ ;\ \text{Income of Importing Countries}_t\ ;\ \text{Volume of Exports}_{t-1}\ ;\ \text{Hoof and Mouth disease in England Dummy}_t)$$

$$(10)\quad \text{Net Export Price}_t = f\,(\text{Farm Price}_t\ ;\ \text{Volume Marketed}_t)$$

$$(11)\quad \text{Net Export Price}_t = (\text{FOB Price in US\$})_t \cdot (\text{Net Effective Exchange Rate in pesos per dollar})_t$$

where the net effective exchange rate (NEER) is defined as the effective exchange rate (EER) times one minus the export surcharge rate (r), plus the export subsidy rate (s), minus the export tax rate (e).

$$(12)\quad \text{NEER}_t = \text{EER}_t\,(1 - r_t + s_t - e_t)$$

It should be noted that reduction of equations (9), (10) and (11) to a single equation would yield the farm level demand for exports (8) postulated in the simplest version. A market clearing condition of the form:

$$(13)\quad \sum_j (\text{Slaughter}_{jt}) \cdot (\text{A.D.W.}_{jt}) = \text{Domestic Consumption}_t + \text{Beef Exports}_t - + \text{Exports on Foot}_t$$

closes the system, where exports on foot are assumed to be exogenous.[13/]

[13/] Exports on foot during the 1960's have been relatively small in magnitude (less than 2.3 percent of total slaughter) and in all cases each shipment needed the special approval of the Government. Such was not the case in earlier period, in which exports on foot were relatively more important. One could still argue that exports on foot are at least partially endogenous and that shipments (continued on page 32).

The above equations attempt to explain the aggregate behavior of each of the groups of decision units. In this form the set of equations may be said to represent "the Argentine beef cattle economy," in terms of the variables considered relevant from an economic standpoint. Equations (1) and (4) deal with the behavior of producers. Equations (5), (6), and (7) deal with domestic demand, and equations (8), (9), (10), and (11) with demand for exports. All equations have been specified as generic as possible since alternative specifications of the model are considered. Although alternative specifications yield different statistical models, the underlying economic model is in this case the same. It is based on a theory of investment behavior of producers and on traditional demand theory.

The issue of statistical model specification is considered in Chapter III, where the statistical model corresponding to the simplest and most aggregate specification of the structure is presented and analyzed. Statistical models corresponding to alternative specifications of the structure are presented and analyzed in Appendix B.

13/ Continued.
approval were more easy to obtain when cattle prices were low than when cattle prices were high. However, its small magnitude during the sample period, the fact that the special approval of the government was required for each shipment, that such approval depended on bilateral agreements with the importing countries and, if at all, would have been affected by price with a certain lag, and the lack of data on FOB price obtained by exports on foot, lead to consider this variable as predetermined on quarterly basis.

CHAPTER III

STATISTICAL MODEL

Model Specification

Model specification with respect to level of aggregation depends on the nature of the hypotheses formulated. In the particular case of the cattle industry it calls for specification of separate slaughter functions for each category of animals since their capital value depends on age and sex.

In this study, the model is first specified in aggregate form such as to reflect the interdependency among the large components of the beef cattle economy. That is, the interdependency among slaughter supply, domestic demand and demand for exports. Slaughter is divided into two main categories: (1) steers and (2) other animals. This disaggregation is based on the fact that while steers can only be held for a short period of time, all other animals except culled animals, may be kept for a longer time span given their longer maturity or productive horizon.

Because of simplicity considerations, average dressed weights (ADW) of animals slaughtered are assumed to be constant (at mean sample values) in the first version of the model. In the second version, ADW's of the corresponding categories of animals are considered endogenous variables and thus, four additional equations

equations are incorporated into the system. Two of these explain ADW's and two define the volume of meat obtained from slaughter of the corresponding (steers and others) categories.

In a third version, slaughter of each of the six categories is explained by a separate function assuming constant (at mean values) ADW's. The fourth and last version incorporates ADW's as variables and thus, eighteen equations form the supply side. Six explain the number of animals slaughtered per category, six explain the ADW, and six define the volume of meat obtained from slaughter of each category. Only the first aggregate version of the model will be presented in this Chapter, the other three are presented in Appendix B.

With regard to the demand side, demand functions may be specified at the final retail and FOB levels considering the behavior of intermediaries and export packers or directly at the farm level. Although both of these approaches are attempted here, the latter is considered in the simplest aggregate version of the model. As will be seen later, the reason is that farm prices are considered more reliable than retail and FOB prices. In the third and fourth versions of the model, retail and FOB foreign demand for Argentine beef are specified, as well as equations explaining the behavior of both marketing groups in relation to price spreads.

With respect to form, all equations are specified (assumed) linear in variables and parameters. This specification implies

restricting the hypersurfaces describing the behavior of each group in the system to constant slopes in all dimensions, i.e., with respect to each endogenous and predetermined variable irrespective of their magnitude. This may cause over or under-shooting when validating the model within the sample or when forecasting if the true functions are not linear. However, simplicity considerations and the fact that some equations in the system (the market clearing condition and the stock accounting equations) are by definition linear in the variables lead to specifying all other equations in the system as linear in the variables.

With respect to the nature of the interrelationship among variables, the model is specified as a simultaneous system of equations where slaughter quantity and quantities demanded by both domestic and foreign markets react to and determine price. That is, it is hypothesized that in the aggregate producers react to price within the quarter. This hypothesis is based on the assumption that expectations about future prices are affected by current prices as well as by previous prices. As long as current price affects and is affected by the behavior of producers and consumers, the system is simultaneous in price and quantities. However, as it was pointed out earlier, there are other variables in the system that are affected by slaughter and price, such as the number of calves born and ending stocks.

Completeness of the Model: Stock-Flow Relationship

The number of calves born in any given quarter may depend on current price and certainly depends on previous prices and weather,

as well as on the size of the breeding herd three quarters ago. The equation explaining the number of calves born belongs to the system in as much as future slaughter depends on the inflow of animals to the herd. End of the quarter stock per category also belongs to the system in as much as it will affect future slaughter and production.

However, these endogenous variables (number of calves born and ending stocks) are affected by, but do not affect, certain other endogenous variables in the system such as slaughter and price. That is, the cause-effect relationship is strictly unidirectional. Accordingly, the complete model can be partitioned in a block recursive fashion where the "lower-numbered" block consists of a simultaneous equation subsystem where slaughter supply and both domestic and foreign demand are affected by and determine price. The "higher-numbered" block(s) are formed by the equation explaining the number of calves born and the accounting equations determining ending stocks.

The fact that the model is block recursive in nature becomes relevant when (a) evaluating hypotheses and validating the model and (b) when considering the identification of the equations within each block.

Hypotheses Evaluation and Validation of the Model

The complete linear system can be expressed in compact form

$$B\,Y = \Gamma\,X + U$$

where B is a square matrix of coefficients of endogenous variables, Y is the vector of endogenous variables, Γ is a matrix of coefficients of the predetermined X variables, and U is a vector of disturbance terms. The estimates $\hat{B}$ and $\hat{\Gamma}$ of the structural parameters B and Γ are hereon called "structural estimates". If the $\hat{B}$ matrix is non-singular and the system is simultaneous each endogenous variable (Y) can be expressed as a function of all predetermined variables (X's) in the system

$$Y = \hat{B}^{-1} \hat{\Gamma} X + \hat{B}^{-1} \hat{U} = \tilde{\Pi} X + \tilde{V}$$

where $\tilde{\Pi}$ is the matrix of reduced form estimates.

However, if the system is block recursive as it is in this case, each endogenous (Y) variable can only be expressed as a function of some predetermined variables: those which belong to the equations present in the corresponding and "lower-numbered" blocks. This is so, because if

$$B = \left[\begin{array}{c|c} B_{11} & 0 \\ \hline B_{21} & B_{22} \end{array}\right] \quad \text{and} \quad \Gamma = \left[\begin{array}{c|c} \Gamma_{11} & 0 \\ \hline \Gamma_{21} & \Gamma_{22} \end{array}\right]$$

with B_{11} and B_{22} being square non-singular matrices, then

$$\hat{B}^{-1} = \left[\begin{array}{c|c} \hat{B}_{11}^{-1} & 0 \\ \hline \hat{A}_{21} & \hat{B}_{22}^{-1} \end{array}\right] \quad ; \text{ hence } \quad \tilde{\Pi} = \left[\begin{array}{c|c} \hat{B}_{11}^{-1} \hat{\Gamma}_{11} & 0 \\ \hline \tilde{\Pi}_{21} & \hat{B}_{22}^{-1} \hat{\Gamma}_{22} \end{array}\right]$$

where

$$\hat{A}_{21} = - \hat{B}_{22}^{-1} \quad \hat{B}_{21} \; \hat{B}_{11}^{-1}$$

$$\hat{\Pi}_{21} = - \hat{B}_{22}^{-1} \; \hat{B}_{21} \; \hat{B}_{11}^{-1} \; \hat{\Gamma}_{11} + \hat{B}_{22}^{-1} \; \hat{\Gamma}_{21}$$

That is, the reduced form estimates of the "lower-numbered" block $\tilde{\Pi}_{11}$ can be obtained directly from the structural parameters corresponding to such block $[\hat{B}_{11}^{-1} \; \hat{\Gamma}_{11}]$, without regard for the "higher-numbered" block(s), the one(s) corresponding to ending stocks and the equations explaining the number of calves born in this case.

This has implications in terms of hypothesis evaluation and validation of the model. Hypotheses can be formulated about the sign and the magnitude of structural parameters (β's and γ's) or about equilibrium solutions of the system relative to exogenous variables (π's); i.e., about combinations of structural parameters (β's and γ's). It must be pointed out that while the structural estimates ($\hat{\beta}$'s and $\hat{\gamma}$'s) describe "unadjusted" behavior of each group - producers, consumers, etc. - , reduced form estimates ($\hat{\pi}$'s) describe the resultant of "adjusted" behavior or equilibrium outcomes reflecting the joint reaction of the different groups to changes in certain (endogenous) variables in the system; changes which come about as consequence of initial changes in exogenous factors.

The maintained hypothesis may be evaluated on the basis of the structural estimates ($\hat{\beta}$'s and $\hat{\gamma}$'s). However, such an evaluation is

not "sufficient" unless the model is validated by the reproduction of the observed phenomenon. That is, unless the observed pattern of the endogenous variables within the sample is reproduced on the basis of reduced form estimates($\hat{\pi}$'s). In the particular case considered here, validation (in this terms) of the model is feasible irrespective of the equations explaining the number of calves born and ending stocks equations.[1/] No attempt is made here to incorporate these equations into the model because, as it will be seen later,[2/] the extreme complexities involved and the strigent assumptions required to obtain quarterly estimates of stocks per category. Excluding these equations from the system implies that "interim and total multipliers", hence "interim and long run equilibrium elasticities", cannot be obtained.[3/] However, in light of the usefulness of short-run information, to evaluate the maintained hypothesis and to obtain "current period impact multipliers" make the effort worthwhile.

The fact that the model is block recursive in nature also becomes relevant when considering the identification of the equations within each block.

Identification

The statistical problem of identification in the case of recursive and block recursive systems have been analyzed in detail by Fisher.[4/] A system of equations is called "block recursive" if

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[1/] This is due to the block recursive nature of the model.
[2/] See Appendix A.
[3/] See Yver [44, pp. 36-41].
[4/] Fisher [13, pp. 92-126].

(a) the matrix of coefficients of endogenous variable is block triangular and (b) the variance-covariance matrix of disturbances is block diagonal.[5/] If these assumptions are met, each block of equations can be treated separately when considering the identification properties. Consequently, identification of the equations which belong to the block given by slaughter supply and demand functions (plus market clearing condition and other definitional identifies), assuming that conditions (a) and (b) hold, will here be considered independently of the equations explaining the number of calves born and the ending stock accounting equations.

The necessary (order) condition for identification of structural equations is that the number of variables excluded from the equation in question must be at least equal to the number of endogenous variables minus one. According to this condition all stochastic equations in the four versions of the model are over-identified.

The necessary and sufficient (rank) condition for identifiability of a structural equation is that the rank of the submatrix of [B, Γ] that contains all the coefficients corresponding to the variables not present in the equation in question be exactly equal to the number of endogenous variables in the system minus one. It can be shown that there is no a priori evidence that these conditions are

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5/ That is, the disturbance from any equation in any block is known to be uncorrelated in the probability limit with the disturbance from any equation in a different block, although it might be correlated with disturbances corresponding to equations in the same block.

not fulfilled for any given stochastic equation in any of the four alternative specifications of the model. However, because the true values of the parameters are unknown, the question of whether such conditions are in fact satisfied cannot be answered. The estimates obtained for the parameters will provide a basis for a more complete analysis of the identification properties of the model.

Identification properties were analyzed here on the basis of a full linear model. That is, they were analyzed after the non-linear equations (those defining volume of meat obtained from slaughter and the net export price - FOB price transformation identity) present in versions 2, 3, and 4 of the model, were linearized. This linearization was done by means of Taylor's expansion series evaluated at mean values. The errors introduced by this linearization procedure are analyzed in Appendix C.

The evaluation of the identification properties after linearization is certainly only a short-cut to evaluation of the identification properties in the case of non-linearity in the variables.[6/] It assumes that there are no errors of linearization. However, the procedure adopted here is based on the fact that the non-linear functions are only identities with known coefficients and no disturbance term and hence, their identification is not in question.

[6/] See Fisher [13, pp. 127-151].

Definition of the Variables

The data used in the estimation of the parameters of the model are quarterly time series for the period I/1960-IV/1970 which were chosen and elaborated so as to approximate as closely as possible the economic variables. Lack of availability of reliable secondary data represented one of the main obstacles which had to be overcomed. The source of each series and the computational procedure utilized to obtain each empirical variable used in the estimation are described in Appendix E.

The variables present in the simplest version of the model (Model 1) are:

Endogenous Variables

Y_1 = number of steers slaughtered (thousand head).

Y_{21} = number of others animals slaughtered (thousand head).

Y_{15} = domestic consumption (thousand tons dressed weight).

Y_{18} = farm price of beef (pesos m$n of 1960 per 1/10 kg. dressed weight).

Y_{47} = volume of exports (thousand tons dressed weight).

Predetermined Variables

X_3 = population (thousand inhabitants).

X_{15} = net change in the balance of loans granted to the cattle sector (in hundred million pesos of 1960).

X_{19} = rainfall during the quarter expressed as percentage of the mean rainfall of the corresponding quarter.

X_{28} = trend factor ($X_{28} = 1000 + 10.\ t$; $t = 1$ for I/1958 and $t = 52$ for IV/1970).

X_{29} = seasonal dummy assuming the value 100 in quarter I (summer), otherwise zero.

X_{30} = seasonal dummy assuming the value 100 in quarter IV (fall), otherwise zero.

X_{31} = seasonal dummy assuming the value 100 in quarter IV (spring), otherwise zero.

X_{38} = beefless days dummy.

X_{40} = net effective exchange rate (pesos of 1960 per dollar).

X_{44} = average price of Danish export type of steer (dollars per ton).

X_{56} = average wholesale price of fish (pesos of 1960 per 1/10 kgs).

X_{75} = average official settlement wage rate (cents of 1960 per hour).

X_{90} = three quarters moving average of stock of steers (thousand head) at the beginning of the period.

X_{88} = beginning of the period total stock of animals excluding steers (thousand head).

X_{106} = exports on foot (thousand tons dressed weight).

X_{00} = hoof and mouth disease in England (0-100) dummy.

$Y_{18,t-2}$ = farm price of beef lagged two quarters.

$Y_{47,t-1}$ = volume of exports lagged one quarter.

In as much as price expectations are assumed to be influenced by previous prices as well as by current price, farm price is introduced in the model without lag (endogenous) and with two quarters lag (predetermined). It is lagged two quarter instead of only one because high collinearity between current and one quarter lag farm price precluded disentangling their separate effects. Stock variables

are lagged because of the following reasons: (a) quarterly stocks per category were estimated under the assumption that animals shift from one category to another on the basis of age[7/] and thus, the fact that an animal was registered as entering a given category does not mean that it actually belongs to that category according to its weight, and (b) it takes a certain amount of time to finish animals to slaughter weight. For example, a calf just born would not be slaughtered until he is at least seven or eight months old. Pregnant cows and heifers cannot be sold for slaughter[8/], and one has to wait until the calf is born and can feed itself. For these reasons stock of steers is lagged two quarters and stock of other animals five quarters.

In the case of steers, a three quarter moving average centered on quarter t-2 is considered because (a) the assumptions adopted in estimating quarterly stocks resulted in a series for steers which had a strong seasonal pattern[9/], and (b) given the variety of breeds (and climate in different regions of the country), steers of different breeds (or raised in different regions) will take different amounts of time to reach optimum slaughter weight[10/].

7/ See Appendix A.

8/ Slaughter of pregnant animals is forbidden by law.

9/ This is due to the combined effect of two assumptions: (i) that animals shift from one category to the next on the basis of age, and (ii) that births have a strong seasonal pattern. The resultant of these two assumptions is that the seasonal pattern of birth is transferred to the quarterly estimates of the stocks of the three final categories: steers, cows, and bulls.

10/ It must be pointed out that these problems do not arise in models where the observational unit is a year.

On the demand side, average official settlement wage rate was used to represent the purchasing power of consumers because of lack of data on per-capita disposable income. Price of fish is included to represent price of a beef substitute. Prices of other meats such as pork, lamb and poultry are excluded. The reason is that they cannot be assumed to be truly exogenous and thus, their inclusion would invalidate the statistical assumption of independence between predetermined variables and the disturbance term. The supply of fish, however, can be increased in the short-run and hence its price is not as highly correlated with beef price as are the prices of pork, lamb and poultry.[11/]

In the demand for export function, a trend factor is included as proxy for income of importing countries because of simplicity considerations given that, three alternative indices computed for the latter under different weighting schemes shows strong correlation of this income variable with time.[12/]

Price of Danish export type of steers is used to represent the price of substitutes of Argentine beef in the International

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[11/] The zero order correlation coefficients for the period I/1960-IV/1970 are:

	Farm Price of Beef	Retail Price of Beef
Index of retail price of pork, lamb and poultry	.514	.637
Wholesale price of fish	-.498	-.365

[12/] In all cases the zero order correlation coefficients were higher than .99.

Market because it was the only homogeneous series available for the whole period and because Denmark is one of the principal net exporters of beef to other countries of Europe, which are the principal markets for Argentine beef.

Since slaughter equations are expressed in number of animals (thousand head), while domestic consumption and exports are expressed in terms of volume of beef (thousand tons), sample mean dressed weights (ADW's, in tons) are included in the market clearing conditions as known parameters of the corresponding slaughter variables.

Statistical Estimates

The stochastic equations of the model were estimated by two stage least squares procedure[13/] and the resulting estimates of the parameters are reported in Table 1. With forty-four observations there are twenty-five degrees of freedom in the first stage[14/] at least thirty-four in the second stage of estimation. Following convention, coefficients of multiple correlation corrected by degrees of freedom (R^2's, computed in the second stage of estimation) and t ratios are presented for each stochastic equation. However, caution should be exercized in interpreting these statistics because of their limited value in evaluating the goodness of fit and in testing hypotheses about structural parameters in simultaneous systems of equations.[15/]

13/ Ordinary least squares estimates of stochastic equations corresponding to the four alternative versions of the model are reported in Appendix D.

14/ The only variable excluded from the set of instruments in the first stage of estimation is exports on foot (X_{106}). The reason being that the nature of this variable as strictly exogenous can be questioned; see footnote 13/, Chapter II.

15/ See Christ, Carl F., Econometric Models and Methods, John Wiley Press, New York, 1967, pp. 437,441,446,515, and 519.

Table 1. Model 1, Two Stage Least Squares Estimates for the Period I/1960-IV/1970.*

	Y_1	Y_{21}	Y_{15}	Y_{18}	Y_{47}	Y_{18} t-2	X_{29}	X_{30}	X_{31}	X_{19} t-1	X_{19} t-2	X_{15}	X_{90} t-2	X_{88} t-5
(1.1)	1.0			1.3511			1.822	.449	1.505	-.270	.052		.369	
				(3.095)			(2.976)	(.847)	(2.845)	(.367)	(.072)		(6.125)	
(1.2)		1.0		2.6473		-3.217	.913	2.137	-1.128	.064	.893	-4.923		.050
				(3.316)		(4.226)	(1.391)	(3.609)	(1.848)	(.073)	(1.037)	(2.284)		(6.449)
(1.3)			1.0	.7783										
				(9.659)										
(1.4)				.5633	1.0									
				(3.836)										
(1.5)	.2524	.1792	-1.0		-1.0									

Table 1. (continued).

	X_{75}	X_3	X_{56}	X_{38}	X_{28}	X_{00}	X_{40}	X_{44}	Y_{47} t-1	X_{106}	α	R^2
(1.1)											204.28	.570
											(1.006)	
(1.2)											323.28	.928
											(.648)	
(1.3)	.052	.030	.353	-.290							-221.39	.893
	(2.230)	(5.632)	(1.635)	(2.316)							(2.470)	
(1.4)					.084	-.038	1.980	.374	.529		-192.20	.701
					(1.068)	(.230)	(2.438)	(2.591)	(3.662)		(1.400)	
(1.5)										1.0		

*Sign of B estimates correspond to the left hand side of the equality. Sign of γ estimates correspond to the right hand side; t ratios in absolute value in parenthesis below the coefficients.

The estimates obtained for the coefficient of farm price (Y_{18}) indicate, as was hypothesized, that slaughter decreases (investment increases) as price rises, with the effect being smaller in absolute and relative magnitudes for steers (animals closer to the optimum slaughter age) than for other (breeding and younger) animals. The results are also consistent in these terms when disaggregation is taken to the extreme of fitting separate slaughter functions for each category of animals.[16/] Furthermore, the price slopes of the aggregate slaughter supply functions expressed in terms of volume of beef (weighted by ADW's of the corresponding categories) are about the same in both aggregate (Model 1) and disaggregated (Model 3) specifications of the model; they are (-.815) and (-.823) respectively.

With regard to the seasonal pattern of slaughter the statistical estimates of the coefficients of the seasonal dummies (variables X_{29}, X_{30}, and X_{31}) are consistent with a priori information about seasonality of rainfall and births. In the first (summer) and fourth (spring) quarters, when rainfall and pastures are more abundant, there is an increase in sales of steers. Animals that could not be finished during the winter (quarter III) because of lack of availability of pastures, are finished and sold during the spring and summer. Sales of animals other than steers are increased in the

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16/ See Table 1, Appendix B. It must be pointed out that when in prior estimations current and one quarter lagged prices were introduced in the steers slaughter equation, the former had a negative sign while the latter a positive one. This tends to support the hypothesis that as beef prices rise steers are kept for at least one additional quarter. However, as it was indicated earlier one quarter lagged price was excluded because of multicollinearity reasons.

fall (quarter II) and decreased in the spring (quarter IV). This is due to two reasons: (1) the calving season is at its peak at the end of the winter and beginning of the spring and this results in a noticeable decrease of slaughter of both cows and calves, and (2) during the fall there is an increase in slaughter of all animals[17/], mainly cows being culled and calves, to match the feeding requirements with the availability of pastures during the winter.

The above analysis refers to "normal weather" effects. Turning now to "abnormal weather" effects (variables $X_{19,t-1}$ and $X_{19,t-2}$), it appears that as previous rainfall relative to the mean of the quarter increases, current slaughter increases, i.e., animals are finished sooner. It should be noted that as the lag increases, the magnitude of the coefficient also increases in the positive direction. This is consistent with the investment model developed in Chapter II. As weather conditions improve so do pasture conditions and thus, feed prices tend to go down. A decline in price of feeds results in an increase of the capital price of all animals and of the optimum slaughter age. Hence, the incentives to decrease short-run slaughter results in an increase of future slaughter.

The estimates indicate that availability of credit (X_{15}) has a strong effect on slaughter, particularly on slaughter cows, young steers and calves.[18/] As hypothesized, given the particular capital

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[17/] See Table 10, Appendix B.
[18/] Ibid.

market conditions existing in Argentina[19], an increase in the net flow of loans granted to cattle producers will result in a decrease of slaughter. The evidence found here tends to support this hypothesis.

The estimates of the coefficients of the stock variables ($X_{90,t-2}$ and $X_{88,t-5}$) have the hypothesized sign and the "unadjusted" elasticities[20] of slaughter supply with respect to (w.r.t.) stocks is 1.03 in the case of steers and 1.51 in the case of other animals.

Turning now to the domestic demand equation (1.3) the "unadjusted" elasticities measured at mean values are presented in Table 2.

Table 2. Short-Run Unadjusted Elasticities of Domestic Demand.

With Respect To			Elasticity
(a) farm price	(Y_{18})	:	- .426
(b) population	(X_3)	:	1.510
(c) wages	(X_{75})	:	.346
(d) price of fish	(X_{56})	:	.067

These elasticities are estimates of "desired" adjustment in quantity demanded if the other variables in the system remained constant. In the case of the first, (a) indicates the adjustment in consumption as resultant of shifts coming from the supply side. The other estimates (a), (b) and (c), indicate the adjustment in consumption

[19] See Chapter II.

[20] Unadjusted by change in price and measured at mean values. Unadjusted elasticities are computed from structural estimates. Adjusted elasticities are computed from reduced form estimates also called impact multipliers. See Theil and Boot [37,pp. 139-143].

resulting from changes in the corresponding variables provided that supply is prefectly elastic with respect to price. They do not measure and hence cannot be interpreted as changes that will actually occur in consumption as a consequence of changes in the respective exogenous variables. Estimates of this last concept, which is the one of interest to policymakers may be obtained from the reduced forms. However, the above elasticities are useful in evaluating consumers behavior. Furthermore, in as much as the "equilibrium or adjusted elasticities" computed from the reduced forms depend on and are functions of the structural parameters, no interpretation of the former can be done in isolations from the latter ones.

The elasticity of domestic demand with respect to price (Y_{18}) is similar in magnitude to the estimates obtained in previous studies on the basis of annual data. This would indicate that consumers do adjust to price within the short-run. The elasticity with respect to population (X_3) is larger than the hypothesized value of one. This may be due to two reasons: (1) the rate of population growth has been declining through the same period[21/], which implies that as the composition of the population changed toward a higher percentage of adults, beef consumption may increase - ceteris paribus - faster than population; and (2) this variable may be picking up part of the effect of increase in per-capita income. As was pointed out earlier,

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[21/] The estimated annual growth rate of population of the period 1955-1960 was about 1.7 percent while the one for the period 1965-1970 was slightly under 1.4 percent.

no information was available on this last variable and when an estimate of per-capita GDP was introduced in the model, strong multicollinearity precluded disentangling its effect from that of the population variable. A series measuring the average official settlement wage rate (X_{75}) was introduced to represent per-capita income, and it must be recognized that this variable may well underestimate the true changes in consumer's real income.

The estimates of the coefficient of the dummy variable (X_{38}) representing rationing (beefless days) indicates that such a policy tended to reduce consumption. This does not mean that it actually reduces consumption. The final effect on consumption, after the price adjustment has taken place, should be inferred on the basis of the reduced forms. For whatever it is worth, the estimated reduction in consumption as a result of two beefless days a week enforced in the whole country, is about 29 thousand tons per quarter or 6.64 percent. However, analysis of the residuals of the slaughter equations indicate that slaughter also tended to decrease in the short-run under such policy. Beefless days are an extremely controversial issue in Argentina and enforced only for short period of time. Hence, producers expectations about its withdrawal may have induced them to withhold cattle from slaughter in which case this would have been a sterile policy to achieve the objective of an increase in exports in the short-run. Only if the beefless days are enforced for long periods of time will exports increase in the long run. Again, this analysis is not complete and is not sufficient to evaluate such a policy unless the price effects are considered. This is to be done on the basis of the reduced form estimates.

Turning now to the demand for exports, short and long run "unadjusted" elasticities measured at mean values are presented in Table 3.[22/]

Table 3. Short and Long Run Unadjusted Elasticities of Demand for Exports.

With Respect To		Short-Run	Long-Run
(a) farm price	(Y_{18})	- .888	-1.886
(b) income of importing countries approximated by trend factor	(X_{28})	.723	1.535
(c) real net effective exchange rate	(X_{40})	.812	1.724
(d) price of substitutes of Argentine beef (Danish export type steer)	(X_{44})	1.099	2.333

These estimates agree with the effect one could expect a priori in terms of both sign and magnitude and indeed reflect the sensitivity of demand for exports to external forces. In as much as these estimates are only useful in explaining why things occur as they do, and not sufficient to explain how much do exports change as a consequence of external forces after allowance has been made for the interaction of supply and demand, we now turn to the analysis of the reduced forms.

[22/] Long run "unadjusted" elasticities were obtained by adjusting the respective short-run elasticities by the coefficient of lagged exports ($Y_{47,t-1}$). They are still unadjusted by price effect.

Reduced Form Estimates

The estimates obtained by solving the above subsystem of equations for each endogenous variable in terms of all predetermined variable present in the subsystem are reproduced in Table 4. They correspond to the expression $\hat{Y}_t = \hat{B}_{11}^{-1} \hat{\Gamma}_{11} X_t = \tilde{\Pi}_{11} X_t$ and represent single (current)period impacts on the endogenous variables caused by changes in predetermined variables. These impacts are "current" equilibrium solutions or resultants reflecting joint and adjusted behavior. Unfortunately, due to the exclusion of the higher-numbered block(s) corresponding to the equations explaining the number of calves born and ending stocks, the reduced form estimates $[\hat{\Pi}_{21}, \hat{\Pi}_{22}]$ cannot be obtained, and hence "interim and total multipliers" (thus, "interim and long run equilibrium elasticities") cannot be calculated. Evaluation of single (current) period impacts however, provide useful short-run information.

First, note that shifts in demand (either domestic or foreign) are overcompensated by the price effect due to the negative price slope of supply. In the long run as stocks increase so does slaughter, thus the sign would be reversed resulting in the expected direction of adjustment.

Secondly, the allocation of beef between domestic demand and exports favors, as one would expect, the one which shifted upward and vice versa. That is, if domestic demand shifted upward, although the supply price effect forces a reduction in actual consumption, the reduction in actual volume of exports is larger. The converse also holds.

Table 4. Model 1, Reduced Form Coefficients.

	Y_{18} t-2	X_{29}	X_{30}	X_{31}	X_{19} t-1	X_{19} t-2	X_{15}	X_{90} t-2	X_{88} t-5	X_{75}
Y_1	-1.4802	3.4321	1.7233	1.9613	-.4155	.4966	-2.2652	.6081	.0234	-.1335
Y_{21}	-6.1173	4.0878	4.6338	- .2338	-.2211	1.7641	-9.3614	.4686	.0970	-.2616
Y_{15}	- .8527	.9275	.7340	.2629	-.0838	.2561	-1.3049	.1377	.0135	-.0249
Y_{18}	1.0956	-1.1917	-.9432	- .3377	.1077	-.3291	1.6766	-.1770	-.0173	.0988
Y_{47}	- .6171	.6713	.5313	.1902	-.0607	.1853	- .9444	.0997	.0098	-.0556

Table . Continued.

	X_3	X_{56}	X_{38}	X_{28}	X_{00}	X_{40}	X_{44}	Y_{47} t-1	X_{106}	π*
Y_1	-.0770	- .9064	.7446	-.2157	.0976	-5.0840	- .9603	-1.3583	-2.5677	1547.40
Y_{21}	-.1509	-1.7760	1.4590	-.4226	.1912	-9.9616	-1.8816	-2.6614	-5.0311	2954.96
Y_{15}	-.0144	- .1691	.1389	-.1242	.0562	-2.9287	- .5532	- .7824	-1.4791	552.32
Y_{18}	.0570	.6709	-.5511	.1596	-.0722	3.7629	.7108	1.0053	1.9004	-994.10
Y_{47}	-.0321	- .3778	.3104	-.0059	-.0027	- .1396	- .0264	- .0373	-1.0705	367.77

*Intercept.

Thirdly, due to the negative price slope of supply and demand, a shift of supply (along the aggregate demand curve) results in larger impacts in the short-run than otherwise. This is the reason why reduced form coefficient in the supply side are larger than the corresponding structural ones.

Single (current) period equilibrium elasticities of farm price[23/] with respect to non-lagged exogenous variables obtained in the four alternative specifications of the model are presented in Table 5. Some elasticities appear to be reasonably stable to level of aggregation and model specification. Some, as the ones with respect to income of importing countries (X_{28}) and exchange rate (X_{40}), are not. In order to identify the reasons why this is so, one must analyze the corresponding structural estimates. Both final retail domestic and FOB demand for exports corresponding to Model 3 are derived to the farm level in order to compare them with the ones obtained in Model 1 and detect the source of discrepancy. The resulting derived demands, domestic (DDD3) and for exports (DDX3)[24/] are reproduced below

$$(1.3) \quad Y_{15} = -.7783\, Y_{18} + .052\, X_{75} + .030\, X_3 + .353\, X_{56} - .290\, X_{38} - 221.39$$

$$(DDD3) \quad Y_{15} = -.7222\, Y_{18} + .063\, X_{75} + .034\, X_3 + .515\, X_{56} - .082\, X_{38} - 374.01 - .160\, X_{49}$$

23/ Only elasticities of farm price will be considered here in as much as this variable (a) is the most important from the policy standpoint, (b) is the only variable on which no equation was normalized in, and (c) is the most sensitive one given the price slopes of supply and demand.

24/ DDD3 correspond to the solution of (3.3') and (3.15), while DDX3 corresponds to the solution of (3.4'), (3.16) and (3.17) of Table 10, Appendix B.

Table 5. Single (current) Period Equilibrium Elasticities of Farm Price With Respect to Non-Lagged Exogenous Variables.[1]

With Respect to		Model 1	Model 2	Model 3	Model 4
(a) Credit availability[2]: flow	(X_{15})	.020	.019	.021	.025
balance	(B)	1.375	1.297	1.493	1.742
(b) Wage rate (income)	(X_{75})	1.201	1.126	1.377	1.522
(c) Population	(X_3)	5.257	4.962	5.662	6.363
(d) Price of substitutes (fish)	(X_{56})	.231	.216	.314	.349
(e) Income of importing countries approximated by trend factor	(X_{28})	.869	.806	2.198	2.392
(f) Net effective exchange rate	(X_{40})	.979	.919	1.978	2.141
(g) Price of substitutes in the international market (Danish export type of steer)	(X_{44})	.132	.125	.132	.141

[1] Evaluated at mean values.

[2] The elasticity with respect to "credit flow" is defined as

$$E_f = \frac{\partial Y_{18}}{\partial X_{15}} \cdot \frac{\bar{X}_{15}}{\bar{Y}_{18}}$$

where X_{15} is the net change $(B_t - B_{t-1})$ in the balance (B) of credit granted to the cattle sector. The elasticity with respect to "credit balance" is

$$E_b = \frac{\partial Y_{18}}{\partial X_{15}} \cdot \frac{\bar{B}_t}{\bar{Y}_{18}} = \frac{\partial Y_{18}}{\partial (B_t - B_{t-1})} \cdot \frac{\bar{B}_t}{\bar{Y}_{18}}$$

since it is defined as

$$E_b = \frac{\partial Y_{18}}{\partial B_t} \cdot \frac{\bar{B}_t}{\bar{Y}_{18}} = \frac{\partial (B_t - B_{t-1})}{\partial B_t} \cdot \frac{\bar{B}_t}{(B_t - B_{t-1})} \cdot \frac{\partial Y_{18}}{\partial (B_t - B_{t-1})} \cdot \frac{(B_t - B_{t-1})}{\bar{Y}_{18}}$$

where $\frac{\partial (B_t - B_{t-1})}{\partial B_t} = 1$

$$(1.4)\quad Y_{47} = -\ .5633\ Y_{18} + .084\ X_{28} - .038\ X_{00} + 1.980\ X_{40} + .374\ X_{44} + .529\ Y_{47,t-1} - 192.20$$

$$(DDX3)\quad Y_{47} = -\ .5347\ Y_{18} + .245\ X_{28} - .373\ X_{00} + 4.285\ X_{40} + .398\ X_{44} + .162\ Y_{47,t-1} - 28.70$$

The price slopes (coefficients of Y_{18}) in both derived demands are close to the ones obtained in the direct fittings (1.3) and (1.4) of demands at the farm level. This is the reason why only some reduced form estimates differ substantially in magnitude among the alternative specifications of the model. The one that differs most and is of special interest is the coefficient of net effective exchange rate (X_{40}). It is half smaller in the directly fitted farm level demand (1.4) of the derived demand one (DDX3). This is due to the fact that the linearization[25/] of the net export price - FOB price transformation identity

$$Y_{70} = Y'_{59} \cdot X_{40}$$

forced the coefficient of X_{40} to be larger than what it would have been if inferred from the sample. In this sense, the elasticity estimates obtained in Models 3 and 4 with respect to this variable should be considered as an upper bound. In spite of this, the conclusion that farm price is sensitive to exchange rate appears

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25/ See Appendix C. For the definition of net export price (Y_{70}) and FOB price (Y'_{59}) see Appendix B.

valid. This differs with the finding of Yver based on annual data, which is a smaller single (current) period elasticity of .130[26/]. However, these results are not necessarily in contradiction. A devaluation would result in an increase in price which would lead to withholding animals from slaughter. But animals close to the optimum slaughter age (or weight), even in the case of no pasture restriction, cannot be held for a long period of time. As these animals enter the marketing channels price would increase less than otherwise and thus, the annual elasticity of farm price with respect to exchange rate would be smaller than the quarterly elasticity[27/].

Furthermore, devaluations were in most cases accompanied by modifications in the export surcharge and subsidy rates so as to soften the immediate impact of such drastic policy actions. The exchange rate variable used in this study was adjusted by export duties, subsidies and taxes; thus, it has a smaller variance than "unadjusted" exchange rate used by Yver. This explains why the single (current) period elasticities of farm price with respect to exchange rate obtained here are substantially larger than the one obtained by Yver.

In light of these results, the conclusion that farm price is sensitive to the level of the net effective exchange rate appears

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[26/] Yver [44, Table 25, pg. 96].

[27/] It must be pointed out that this statement can only be validated on the basis of the full reduced form matrix which includes ending stocks and number of calves born as endogenous variables.

valid. This has strong policy implications in as much as, under the present system, the level of the nominal exchange rate as well as that of export surcharge and subsidy rates is set by the government. Moreover, since slaughter supply reacts inversely to price, modifications in the level of the net effective exchange rate constitute shocks introduced in the system which are capable of generating the observed cyclical path of slaughter and price. That is, explicit or implicit devaluations (or revaluations) directed toward stabilizing beef exports result in a destablization of farm prices. As beef prices go up relative to FOB prices, an implicit or explicit devaluation is induced by the need for maintaining the volume of exports. This forces the quantity adjustment into domestic consumption. Since domestic demand is rather inelastic with respect to price, the required quantity adjustment cannot be fulfilled by a reduction of consumption unless price increases sufficiently. Obviously, under the postulated market behavior price will increase until short-run equilibrium is reached. At the new price level a further implicit or explicit devaluation is needed to maintain the level of exports. This process continues until the new output from an increased herd is channeled to slaughter. In summary, exchange rate policies directed toward stabilizing beef exports result in a destabilization of price by feeding the cyclical process.

CHAPTER IV

EVALUATION OF THE MODEL

The evaluation of hypotheses about behavior of the different groups of decision units should be done on the basis of sign and magnitude of the structural estimates ($\hat{\beta}$'s and $\hat{\gamma}$'s). However, such an evaluation - done in the previous chapter - is not adequate or enough unless the model is validated by the reproduction of the observed phenomenon. That is, unless the observed pattern of the endogenous variables within the sample is reproduced on the basis of the reduced form estimates ($\tilde{\pi}$'s).[1/]

Actual and predicted[2/] values of consumption (Y_{15}) and exports (Y_{47}) are plotted in Figure 7. In general, the cyclical pattern of both series is well reproduced. However, there appears to be (a) some overshooting of the cycle, and (b) considering this overshooting, the predicted values of consumption and exports corresponding to the first and second quarters are always higher than the observed values. The same can be said about farm price (Y_{18}) for which predicted and observed values are plotted in Figure 8. In this case the

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[1/] Reduced form estimates ($\tilde{\pi}$'s) are obtained from the structural estimates ($\hat{\beta}$'s and $\hat{\gamma}$'s).

[2/] Predicted on the basis of the reduced form coefficients corresponding to Model 1.

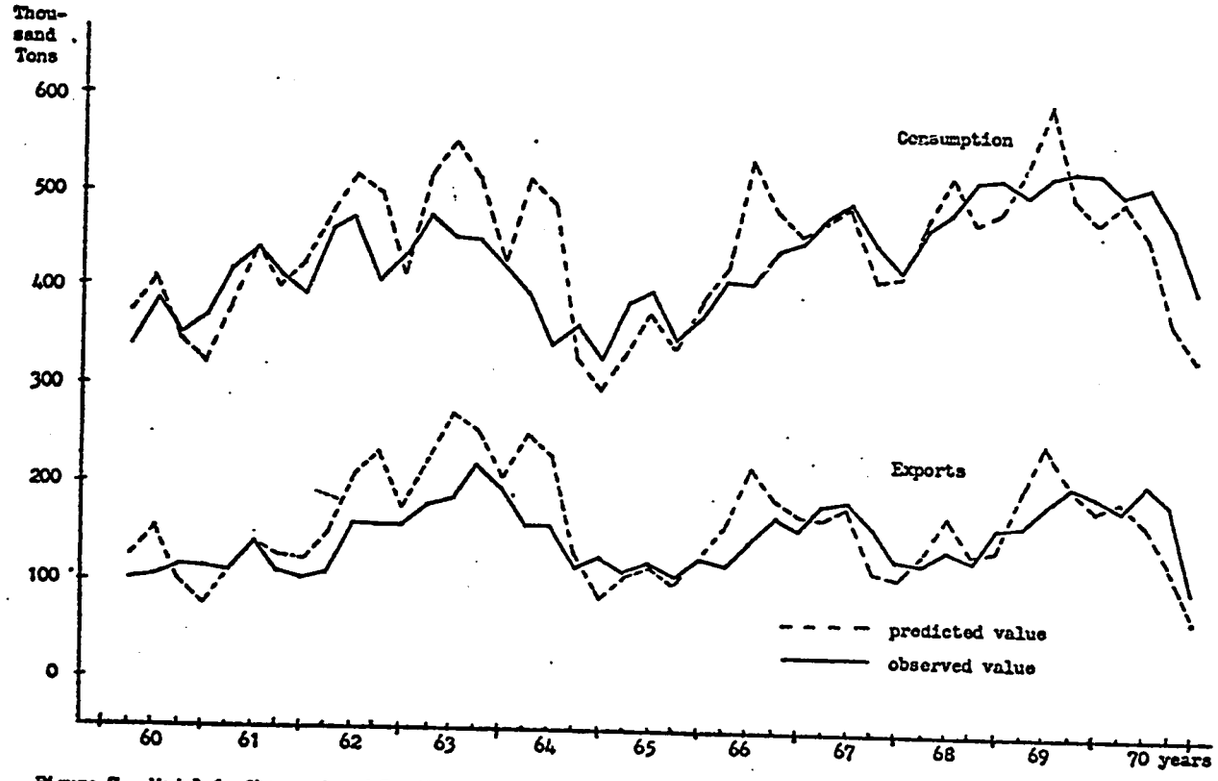

Figure 7. Model 1, Observed and Predicted Values of Consumption (Y_{15}) and Exports (Y_{47}), I/1960-IV/1970.

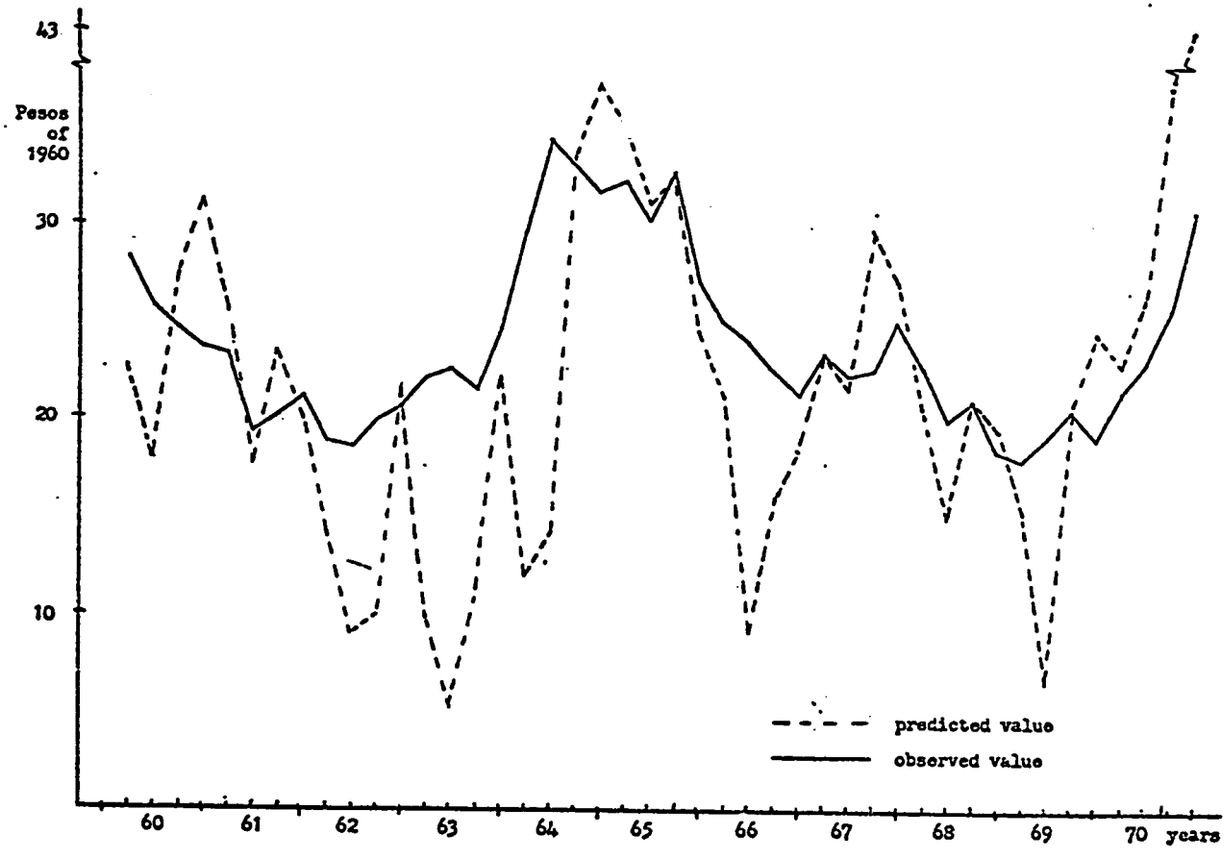

Figure 8. Model 1. Observed and Predicted Real Price of Beef Cattle at the Farm Level (Y_{18}), I/1960-IV/1970.

overshooting of the cycle is more evident[3/] and the predicted values for the first and second quarters are, given this overshooting smaller than the observed values. This is what one would expect given the relationship between price and quantity: both aggregate short-run slaughter supply and demand are negative sloping with respect to price.

Among the possible causes of this over-shooting of the cycle two appear evident: (1) the linear specification of the model, and (2) numerical inaccuracies in the estimates of the price slope parameters.

Linearity in the Variables

Linear form specification implies restricting the hypersurfaces describing the behavior of each group in the system to have constant slopes in all dimensions; i.e., with respect to each endogenous and predetermined variable irrespective of its magnitude. This is certainly a strong restriction to impose on the structure. The reaction of consumers, export packers and producers to price changes might well be different when prices are at high levels than when prices are at low levels.

Consider the case of producers. As price increases stocks are being built up and thus there is an increase in the use of factors of

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[3/] Since price varies more than quantities, one could expect larger discrepancies. In addition, since none of the equations were normalized on price, it is highly likely that the prediction of price would be less accurate than the prediction of quantities.

production: land, labor, management and capital (investment in animals, pastures and other variable inputs). If the aggregate supply functions of these factors (and/or inputs) are not infinitely elastic with respect to their own prices, as one would postulate a priori, the marginal cost of investment will increase for the individual firm as stocks are being built up. Moreover, marginal cost may increase at an increasing rate. Consider for example, the use of capital as a factor of production. In the aggregate the observed phenomenon is that the price cycle is the opposite from the slaughter cycle and that price fluctuations are wider than quantity fluctuations. That is, as slaughter decreases price increases in a larger proportion and vice-versa. This implies that the marginal cost of investment for the individual firm[4/] increases at an increasing rate if all producers behave in similar fashion, in as much as the use of capital (investment in animals) as a factor of production increases with beef prices which increase in a larger proportion than the reduction of slaughter. Furthermore, marginal cost will increase at a higher rate if supply of capital is not perfectly elastic with respect to interest rate. As a result of this, the true aggregate slaughter supply function(s) might be non-linear in the variables and thus, the use of linear functions will result in overshooting of the cycle.

[4/] In the theory of investment behavior described in Chapter II beef prices were considered as given for the individual firm.

Numerical Errors in the Estimates

Overshooting the cycle may also be due to numerical inaccuraties in the estimates of the price slope parameters. Slaughter supply of all categories of animals were postulated and inferred as negative sloping with respect to price. The resulting aggregate slaughter supply curve cuts from above the corresponding aggregate demand curve in the price-quantity dimension. The closer the estimated price slope of aggregate slaughter supply is to the estimated price slope of aggregate demand, the wider will be price fluctuations resulting from shifts of these curves which originated from exogenous shocks and thus, the larger will be the possibility of overshooting the cycle. That is, the price slope estimates obtained for the slaughter supply equations may overestimate the true slope parameters.

In order to verify the above assertion a standard deviation is subtracted from the estimated price slopes of the slaughter equations of Model 1. The resulting values for the structural estimates of the coefficients of current price (Y_{18}) are .901 (instead of 1.351) in the equation explaining the number of steers slaughtered (1.1), and 1.845 (instead of 2.647) in the equation explaining the number of other animals slaughtered (1.2).[5/] To these new structural estimates corresponds a new set of reduced form estimates which are presented in Table 6. Actual and predicted values of consumption (Y_{15}) and

[5/] The corresponding new values for the intercepts are: 96.73 in equation (1.1) and 132.88 in equation (1.2).

Table 6. Modified Model 1, Reduced Form Coefficients.

	Y_{18} t-2	X_{29}	X_{30}	X_{31}	X_{19} t-1	X_{19} t-2	X_{15}	X_{90} t-3	X_{88} t-5	X_{75}
Y_1	- .6029	2.5431	1.0197	1.7093	- .3351	.2511	-1.0145	.4761	.0105	- .0598
Y_{21}	-4.5747	2.4098	3.3058	- .7094	- .0694	1.3008	-7.0007	.2194	.0725	- .1225
Y_{15}	- .5726	.6229	.4929	.1765	- .0563	.1720	- .6763	.0925	.0091	.0003
Y_{18}	.7357	- .8003	- .6334	- .2268	.0723	- .2210	1.1259	- .1188	- .0116	.0664
Y_{47}	- .4145	.4508	.3568	.1278	- .0407	.1245	- .6343	.0670	.0066	- .0374

Table 6. (continued)

	X_3	X_{56}	X_{38}	X_{28}	X_{00}	X_{40}	X_{44}	X_{47} t-1	X_{106}	σ*
Y_1	- .0345	- .4059	.3335	- .0966	.0467	-2.2769	- .4301	- .6083	-1.1499	627.79
Y_{21}	- .0707	- .8314	.6830	- .1978	.0895	-4.6632	- .8808	-1.2458	-2.3552	1220.54
Y_{15}	.0002	.0023	- .0020	- .0834	.0377	-1.9669	- .3715	- .5255	- .9933	235.35
Y_{18}	.0383	.4505	- .3701	.1072	- .0485	2.5271	.4773	.6752	1.2763	-589.42
Y_{47}	- .0216	- .2538	.2085	.0236	- .0107	.5565	.1051	.1487	- .7189	130.82

* Intercept

of exports (Y_{47}) obtained on the basis of these new reduced forms are plotted in Figure 9. Note that prediction is substantially improved relative to direct prediction on the basis of Model 1 (Figure 7), and that the cycle is well reproduced. The same can be said about prediction of farm price (Y_{18}) - plotted in Figure 10 - relative to the one obtained on the basis of Model 1 (Figure 8). This suggests that supply price slopes were in fact overestimated - in absolute values - in Model 1.[6/] However, the conclusions reached in Chapter III are still valid in as much as no change of sign of the structural coefficients were involved. Furthermore, note that there are still systematic seasonal discrepancies between predicted and observed values but that such discrepancies are smaller in magnitude than in the case of Model 1.

Seasonal Pattern of Slaughter

Before attempting to explain the cause of the above mentioned systematic seasonal discrepancies, consider the procedure utilized to generate quarterly observations of slaughter and consumption from annual data.[7/] Annual data on slaughter per category of animals is available for the whole country. Monthly data on "recorded sales to slaughter" corresponding to the principal central markets and

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[6/] It must be pointed out that further reduction of the absolute magnitude of the price slope coefficients in the slaughter supply equations resulted in undershooting of the cycle.

[7/] The procedure is explained in detail in Appendix E.

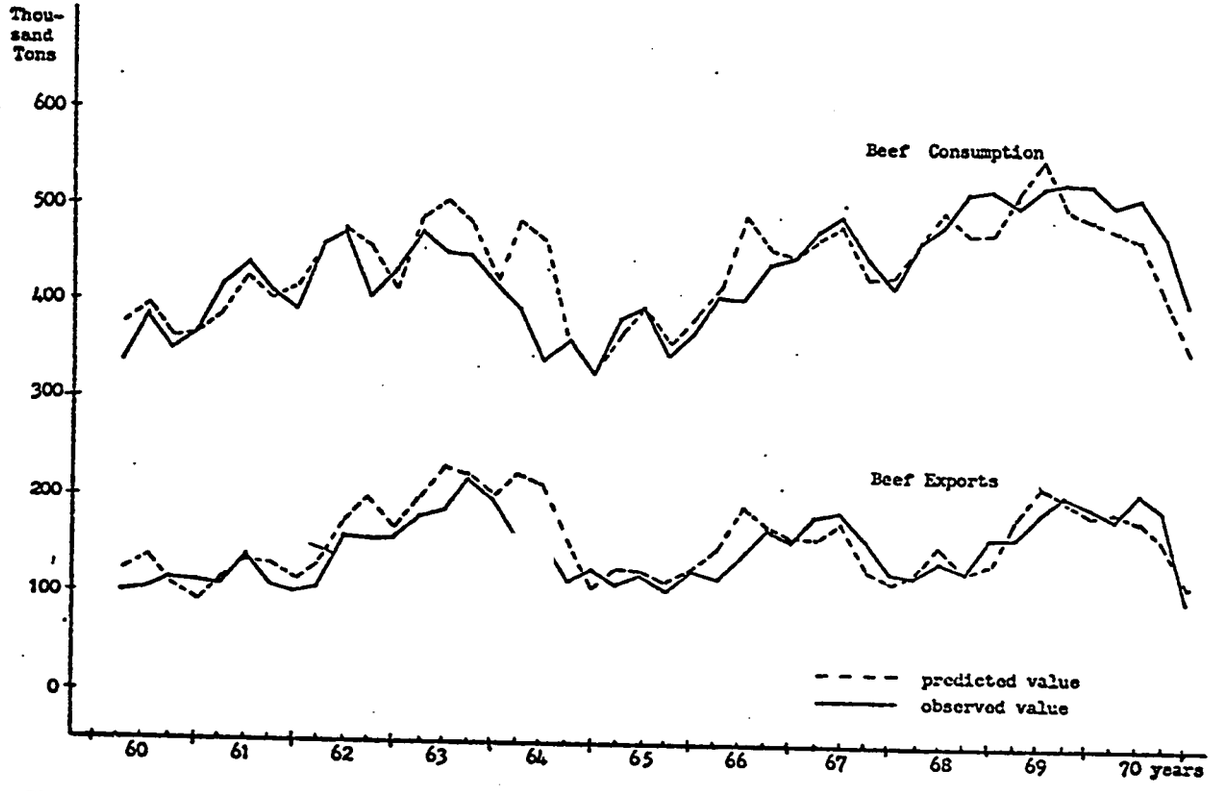

Figure 9. Modified Model 1, Observed and Predicted Values of Beef Consumption (Y_{15}) and Exports (Y_{47}'). I/1960-IV/1970.

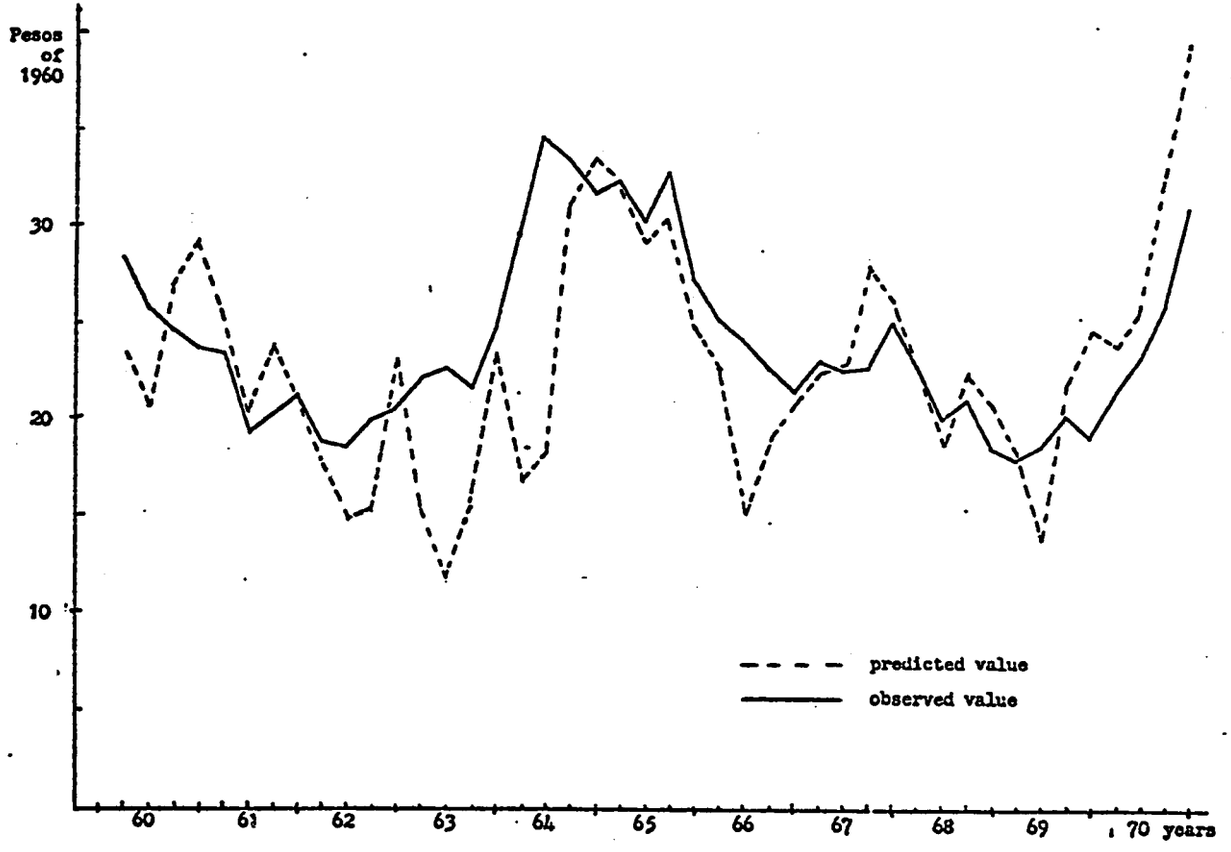

Figure 10. Modified Model 1, Observed and Predicted Real Price of Beef Cattle at the Farm Level (Y_{18}), I/1960-IV/1970.

direct purchases on farms by large packing plants is also available. Since only sixty to eighty percent of total sales for slaughter are "recorded," the procedure adopted here to obtain quarterly observations of total slaughter per category rested on the assumption that "unrecorded sales to slaughter" had the same seasonal pattern as "recorded sales to slaughter". That is, annual "unrecorded sales to slaughter" were distributed among quarters according to the quarterly distribution of "recorded sales to slaughter". This procedure may result in an overestimation of the seasonal pattern of slaughter since it is possible that much of the seasonal variation of sales is channeled through the central markets and other outlets in which sales are recorded. The fact that "unrecorded sales to slaughter" are mostly sales to small slaughter plants and butchers in the interior of the country (sales which are probably more seasonally stable) tends to support the above argument.

The volume of meat obtained from slaughter was estimated by multiplying the number of animals slaughtered per category times their corresponding average dressed weight. Consumption was calculated by subtracting from this variable the equivalent dressed weight of all beef products exported during the quarter. Thus, consumption data inherits the overestimation of the seasonal pattern of slaughter. This may be observed in Figures 7 and 9. Since there is no a priori reason to believe that the seasonal pattern of consumption is as pronounced as obtained in this case, one might conclude that the seasonal pattern of slaughter was overestimated by assuming that

"unrecorded sales to slaughter" had the same seasonal pattern as "recorded sales to slaughter". This however, does not invalidate the conclusions reached in Chapter III in as much as it only refers to magnitude of coefficients and not to sign. Furthermore, the above reasoning shows the potential that a model of this nature has as a tool of analysis in the evaluation of alternative policy actions, and as a basis for simulation as well as forecasting instrument.

Implications for Further Research

It seems appropriate to conclude with a summary of the potential avenues that might be profitably pursued in future research. These suggestions originate from the limitations of the present study, which were implicitly or explicitly stated in the preceding discussion.

First, the procedure utilized here to estimate quarterly slaughter data from annual data should be revised with regard to the "seasonality of unrecorded sales to slaughter". The assumption adopted here resulted in an apparent overestimation of the seasonal pattern of slaughter.

Secondly, the procedure used to generate quarterly data on stock per category[8/] could be substantially improved with knowledge of the weight and age distribution of animals slaughtered, information which would allow reducing the probability of assigning the wrong year of

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8/ See Appendix A.

birth to an animal. Knowledge about the composition of slaughter by breeds could also be used to improve the estimates of the number of calves born in as much as animals of different breeds take different amounts of time to reach the same weight. Census information could be used to check the accuracy of the model and to make the necessary corrections in the parameters.

Thirdly, in order to be able to obtain interim and long-run impacts and equilibrium elasticities, an equation explaining the number of calves born and the stock accounting equations should be added to the model to complete the system. No attempt was made in this study to incorporate these equations in the system because of the extreme complexities involved and the strong assumptions required to generate quarterly estimates of stocks per category.[9/] However, there exists alternative criteria of aggregation of stocks and flows (slaughter) which would make it feasible to incorporate these equations in the model. One of them is to consider only two categories of animals: males and females.[10/] In this way the accounting model is simplified considerably since the intercategory shifts (within stocks of males and females) are by-passed. Although there would be some loss of information when this criterion of aggregation is adopted, the interrelationships among the large components of the Argentine beef cattle

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9/ Ibid.

10/ Yver [44] uses this aggregation criteria.

economy could still be analyzed in terms of long-run equilibrium elasticities and their policy implications. Moreover, the analysis of the equilibrium path of the endogenous variables until they reach final equilibrium, complemented with the results obtained on the basis of annual models, would provide a solid basis for the evaluation of alternative policies with regard to their immediate, intermediate and long-run effects.

CHAPTER V

SUMMARY AND CONCLUSIONS

The major differences between this and previous studies of the Argentine beef cattle economy lie in (a) the emphasis given here to the analysis of the industry's short-run structure in an effort to understand its dynamic characteristics and to explain the observed price fluctuations, (b) the sample period utilized to estimate the structure, and (c) the emphasis given here to the explicit evaluation of specific policies implemented during the last decade, such as exchange rate policy, beefless days rationing, maximum retail prices and credit policy.

To understand the short-run structure and price formation mechanism of the beef cattle economy is extremely important in Argentina. The large fluctuations which, characterized by a strong cyclical path, have been observed in the real price of beef cattle in the short-run, constitute an important source of disturbance in the overall economy. This is so because beef cattle production is the most important single enterprise in the agricultural sector, beef exports have been and still are one of the main sources of critical export earnings, and because beef is a basic consumption good for the Argentines and consequently changes in its price substantially affect their real income and the overall price stability.

While previous studies focus on the long run and make inferences about the structure of the beef cattle economy on the basis of annual data for the period 1935-1966 - a period which was characterized by a number of institutional and market changes that might have affected the underlying structure - in this study the focus is on the short-run and the inferences about the structure are based on quarterly data for a more recent sample period (I/1960-IV/1970) which is freer of direct government interference in the market.

In this chapter, the procedure adopted to provide a basis for the short-run analysis is first briefly described. Then, an attempt is made to summarize the central points of this study and to assemble the conclusions in terms of their most important policy implications. Finally, the feasibility of policy objectives which have been accepted in Argentina is briefly analyzed on the basis of the conclusions and findings of this and previous studies.

Methodology

In order to analyze the structure of the beef cattle economy, its short-run dynamics and its problems, a quarterly model was developed and estimates of its parameters, based on the period I/1960-IV/1970, were obtained. The economic model is based on a theory of investment behavior of producers and on traditional demand theory. Four statistical models were specified and estimated. These differ in (a) the level of aggregation of slaughter supply equations, (b) whether or not average slaughter weights are regarded as variables

or assumed to be constant at mean sample values, and (c) whether or not domestic demand and demand for exports are specified directly at the farm level or specified at the final retail and FOB levels taking explicitly into consideration the behavior of the marketing group and of export packers. The interdependency among the large components of the beef cattle economy were analyzed on the basis of the most aggregated model (Model 1). The other three models were designed to allow for a more complete evaluation of the hypotheses about behavior of producers, consumers, intermediaries and export packers; and to provide a basis for analysis of consistency among alternative specifications of the statistical model.

All four models were specified as simultaneous systems of equations in which slaughter volume and quantities demanded and exported react to and determine price. That is, it is hypothesized that in the aggregate, not only consumers and export packers but also producers react to price within the quarter. This hypothesis is based on the assumption that expectations about future prices are affected by current prices as well as by previous prices. These models correspond to simultaneous equations blocks of more complete block recursive systems, in which the other block(s) are made out of an equation explaining the inflow of animals to the herd (the number of calves born during the quarter) and of stock accounting equations connecting stocks and flows.

The estimation of the model required quarterly information on slaughter and stocks for each category of animals, average slaughter weights, consumption and exports as well as data on the variables affecting them. Since the data published on the relevant variables is either on an annual basis or in incomplete form, a considerable amount of computational work was required to generate consistent quarterly time series for each of the variables involved. A model was designed to generate quarterly stocks per category of animals. The procedure adopted makes use of information and assumptions about mortality rates, seasonality of calving and male-female distribution of calves born, to determine the stock series which were capable of generating the observed slaughter flow.

The stochastic equations of the four alternative models were estimated by two stage least squares procedures. The resulting estimates given support to the implicit or explicit hypotheses formulated on the basis of the economic model. Only the ones considered most relevant are briefly summarized here.

Summary and Conclusions

The empirical evidence indicates that slaughter of all categories of animals is characterized by a seasonal pattern reflecting the seasonality in births and pasture availability. Animals that could not be finished during the winter because of lack of pasture availability are finished and sold during the spring and summer when pastures are more abundant because of higher rainfall. Consequently, sales

for slaughter of finished animals (steers) increase during these quarters. Sales of animals other than steers increase in the fall and decrease in the spring. This is due to two reasons: (1) the calving season is at its peak at the end of the winter and beginning of the spring and results in a noticeable decrease in slaughter of both cows and calves, and (2) during the fall there is an increase in slaughter of all animals (mainly cows being culled and calves) that is necessary to match the feeding requirements with the availability of pastures during the winter. This seasonality of slaughter is important in as much as it implies that, as a constraint, availability of pastures varies with the season and consequently the response of slaughter (or investment) to price changes.

In the short-run and in the absence of an effective pasture constraint, the slaughter of all categories of animals decreases as beef prices go up or input prices go down. The decrease in slaughter of female and younger animals is greater than the decrease in slaughter of animals closer to the optimum slaughter age (weight). This is what one would expect given that, if individual producers maximize the present net discounted value of the animals in the hred over the animals' remaining lifetime, the elasticity of capital price (value as capital goods) of female and younger animals is larger than that of animals closer to the optimum slaughter age as steers. The important point, however, is that in the short-run and in the absence of a pasture constraint, even slaughter of steers - animals whose capital prices increase less - decreases as beef prices go up, because the optimum slaughter age

(weight) increases with beef prices. This constitutes new and solid evidence that, not only do cattle producers respond to price changes in the expected direction but also that they respond promptly (within the quarter) and in significant magnitude.

The evidence indicates that availability of credit has a strong effect on slaughter, particularly on slaughter of cows, young steers and calves. As was hypothesized, given the particular capital market conditions existing in Argentina[1/], an increase in the net flow of loans granted to cattle producers will result in a decrease of slaughter, i.e., increase of investment. The evidence found here gives empirical support to this hypothesis.

The inverse response of slaughter to current price contributes to the explanation of the short-run instability of prices. An upward shift in market demand originating in exogenous shocks results in an increase in price which is larger than the one which would have been obtained if slaughter supply had not reacted at all, or had reacted positively to current price. This accelerates the price cycle in its upward swing and thus, only in the long run as the new animals from an increased herd enter the marketing outlets and slaughter increases, do beef prices (in real terms) start the downward swing. Ex post, the observed peakness and amplitude of the cycle also depends on exogenous factors such as droughts, consumers' income, population increase,

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[1/] See Chapter II.

prices of beef substitutes, net effective exchange rate, and restriction of access to foreign markets, which either affect slaughter supply or market demand.

Another element that contributes to explaining price fluctuations is the inelasticity of domestic demand.[2/] Shifts of slaughter supply originating in exogenous shocks (as droughts) or in lagged reaction of slaughter to price (as an increased production from a larger herd) result in large price fluctuations partially because of the inelasticity of domestic demand.[3/] That is, domestic demand is not fully able to absorb quantity fluctuations without relatively large adjustment forced onto price. In other words, if domestic demand were substantially elastic such wide price fluctuations would not exist; consumption and not price would operate as the principal adjustment mechanism.

Beefless days as a policy directed to increase or maintain exports when cattle prices are going up is an extremely controversial issue in Argentina and therefore merited special attention. In this study, the estimated - ceteris paribus - reduction in consumption as a result of two beefless days a week enforced in the whole country is about 6.64 percent. However, analysis of the residuals of the slaughter equations indicates that slaughter also tended to decrease in the short run under such a policy. Producers expectations about its withdrawal

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[2/] In this study the value of -.426 was obtained for the price elasticity of domestic demand measured at mean values.

[3/] This assertion contrasts with the one made by Jarvis [24, p. 463] which, in his own words, reads "Although some people contend that beef demand in Argentina is very price inelastic, there is no empirical evidence to support this, quite the contrary. A price elasticity of -.5 is quite substantial."

may have induced them to withhold from slaughter. In as much as animals close to optimum slaughter weight cannot be held for a long period of time, a beefless day policy would be effective in the longer run. The empirical evidence found in this study points in this direction.

Another interesting result is that as far as the evidence goes, maximum retail price policies seem to affect more the recorded retail prices than the true retail prices. That is, recorded retail prices appear substantially distorted during the period in which maximum retail price policies were adopted.

From the demand side, among the principal sources of exogenous factors affecting price are some such as population and income of importing countries which have only long-run implications in as much as they have a definite and steady trend. Others such as real wage rate and net effective exchange rate are more subject to variation in the short run and thus merit special attention.

The empirical evidence in this study indicates that farm prices are, in the short run, highly sensitive to both real wage rate and net effective exchange rate. This has strong policy implications since, under the present system, the levels of these variables are in the short run either set or highly influenced by government decisions. As beef prices go up relative to FOB prices exports, which are more price elastic than domestic demand, start declining. This induces the government to devalue[4/] in an attempt to maintain

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[4/] Devaluation is made by either increasing the nominal exchange rate (pesos per dollar) applicable to beef exports, or by reducing export surcharges and/or increasing export subsidies.

the level of exports. The quantity adjustment is thus forced into domestic consumption. Since domestic demand is rather inelastic with respect to price and slaughter reacts inversely to price, the required adjustment in price to clear the market is larger than the initial increase. At the new price level a further implicit or explicit devaluation is needed to maintain the level of exports. This process continues until the new output from an increased herd reaches the market. In summary, exchange rate policy directed toward stabilizing beef exports results in a destabilization of price by forcing the quantity adjustment to be absorbed by the more inelastic demand.

Feasibility of Policy Objectives

In Argentina price stability is widely accepted today as a policy objective, with the qualification that the level around which price is stabilized:[5/]

(a) provides enough incentives to increase production in the long run, so as to allow for the maintenance of per capita consumption at an acceptable level, and for a level of exports which provides for an import capacity consistent with the development plans;

(b) allows export packers to compete in the international market; and

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5/ See Pineiro and Bordelois [34].

(c) is consistent with the policy objectives of overall price stability and maintenance of the real wage levels.

The first of these qualifications call for a minimum price level while the other two call for a maximum price level for beef. All of them imply a certain degree of price stability and are objectives of both short-run and long-run nature. The underlying assumption is that the world market would absorb, at the given price, the surplus of slaughter over domestic consumption.

In contrast to many other commodities, prospects for beef and veal in the world market are encouraging. A recent study[6/] had as its main conclusion that "Argentina faces favorable prospects for increasing her beef exports to the E.E.C. by 1975. Her main limitations may be the capability to increase slaughtering substantially." The author also concluded that "Argentina would be displaced to a second position as a world exporter by Australia no matter when alternative assumptions are made[7/]." Although these assertions are very much dependent on the assumption adopted and on the projections of slaughter for 1975 in each of the regions considered, the optimism about the world trade possibilities is consistent with most other studies and projections.[8/] This means that the world excess demand for

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[6/] Liboreiro [27, p. 204]. In this research use is made of a quadratic spatial equilibrium model, in which 15 regions are considered: Argentina, the countries member of the EEC, U.K., U.S.A., Australia, New Zealand, Ireland, Denmakr, Rest of Latin America, Canada and the Rest of the World. The model operates with excess demand functions for each region, and other parameters such as level of income, prices of substitutes and trasnfer costs.

[7/] Liboreiro [27, p. 192].

[8/] See Dieter [11, pp. 1-22].

Argentine beef not only would be increasing over time, but it might also become more elastic - at certain price levels - because of new countries entering the market as net importers.

Assuming that in fact the international market would absorb, at the given price, the surplus of slaughter over domestic consumption, consider the question of how to increase production. In the long run, increase in production might be induced by (a) maintenance of a high output price,[9/] (b) decrease in input prices, and (c) shifts of the production function.

Evidence found here and in previous studies indicates that, as expected, increase in beef prices induces substantial increases in production. The problem is how to keep prices at profitable levels when the increased production arrives in the market, so as to avoid depletion of the herd. Before attempting to answer this question consider the relative beef-grain price. The evidence found by Yver indicates that in the long run "the quantity of beef supplied can be increased by increasing both beef prices and crop prices simultaneously.[10/] That is, the increase in beef production does

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[9/] Beef prices are apparently at their cyclical peak right now and thus the damage to consumers' purchasing power has already been done. Once nominal wages have been adjusted to the new price situation, as they have, less pressure can be expected from the consumer side to have prices back to lower levels. Hence, a policy of stabilizing farm prices at a relatively high level might be politically feasible in the short run (this depends on the position of the cycle). However, economic forces would tend to dominate the picture in the long run, and unless the structure of the economy is modified, programs designed to stabilize price at a relatively high level - as a price support program - could be extremely costly.

[10/] Yver, [44, p. 50].

not have to come necessarily at the expense of grain production with the consequent reduction in export earnings. Both could be increased if the appropriate policies are implemented.

Theoretically, as far as the evidence goes, an increase in output price and/or a decrease in input price will induce a larger output but adoption of new technology may not necessarily take place. The question is how to provide stimulus for the adoption of new technology. This will depend first on its availability, second on its profitability, and third on extension. Profitability of new technology could be affected by new input prices. Apparently this is the case of the use of fertilizer on pastures. Very little fertilizer is used in Argentina and its high price is usually blamed on it.[11/] Producers could also be induced to adopt new technology in a treadmill fashion by a land-income taxation schemme in which fixed cost (land tax rate) is increased and income tax rate reduced. All these possibilities appear promising and merit further research.[12/]

If prospects in the international market look favorable and if production can be increased in the long run by an "incentive" level of beef price and/or input prices, the next question is how to keep

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[11/] Fertilizer prices are well above world prices, because imports are heavily taxed. An evaluation of social costs and benefits of reducing import taxes is suggested as relevant.

[12/] Experimental research done at the National Research and Extension Institute (INTA) (see, for example "Reserva 6", Estacion Experimental, INTA-Balcarce) shows that carrying capacity can be substantially increased by just adopting new management practices and fertilizing pastures.

prices at a profitable level when the increased production arrives in the market, or how to avoid or place bounds on the cycle.

As was argued before, short-run exchange rate policies directed toward stabilizing beef exports result in a destabilization of price by feeding the cyclical process; that is by forcing the adjustment into domestic consumption and thus onto price. A consumption tax scheme[13/] could be implemented as an alternative to exchange rate policy directed toward stabilizing exports. In the short run retail prices will increase more as a result of a consumption tax and hence consumers' real income will be hurt. However, in as much as the tax-induced reduction in consumption slows down the increase in farm price, not only will exports be favored but the negative reaction of slaughter will be reduced and thus price cycles will be less strong in the long run. As a consequence of this, in the long run, consumers' real income may be affected by a consumption tax as much as by exchange rate policy. Before such changes are made, the effects of such policy should be evaluated[14/] to determine their social costs and benefits and the feasibility of its implementation.

Short-run policies designed to increase slaughter (such as tax exemptions) and decrease consumption (such as beefless days) when price goes up (and vice versa when price goes down) seem appropriate in achieving a certain degree of stability in both the short and

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[13/] See Reca, L.G., "Efectos de un Impuesto a la Faena de Carne con Destino al Mercado Interno," unpublished mimeo, Direccion Nacional de Economia y Sociologia Rural, S.E.A.G., 1971.

[14/] The short run effects of such policy could be evaluated on the basis of Model 3.

medium run. However, this only tends to reduce or absorb the supply price effect but does not prevent price fluctuations originating in exogenous forces like long droughts or shifts of foreign demand.[15/] In the long run, unless domestic demand becomes more elastic, sharp fluctuations might occur as a consequence of these forces.

A price support program would make demand more elastic below the given price level. However, a program of this nature could at times be extremely costly (if price is set close or above the equilibrium price) in terms of both consumer surplus and export subsidy. The volume of beef acquired by the government could be used in welfare programs or dumped in non-commercial outlets in the international market. Social and treasury cost of alternative ways of implementing a price support program should be evaluated before changes are made. A priori, it can only be said that the reduction of consumer surplus may be of significant magnitude given the inelasticity of demand, which reflects consumers' preference for beef, and that as shown,[16/] the benefits of price support programs (above equilibrium price) will tend to be capitalized by the owners of fixed assets (land, marketing certificates, etc.) during the time the program is in effect.

To change tastes and preferences of the consumer might well be a difficult and very costly task. One might attempt to make domestic

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[15/] Unless the government is willing and able to adopt appropriate short run policy action in a continuous, sustained and dynamic fashion. Many times it is either politically unfeasible to enforce them or they are adopted too late.

[16/] See Floyd [14, pp. 148-158].

demand more elastic through a long run promotional campaign for beef substitutes. This would tend to reduce price fluctuations arising from exogenous forces. Empirical studies[17/] show some but little evidence of substitution of pork, lamb and poultry for beef. A promotional campaign creating an "image of close substitutes" might not only shift downward domestic demand for beef but also make it more price elastic. An increase of the price elasticity of domestic demand would certainly result in reduction of price fluctuations by allowing for a larger domestic absorbtion of the slaughter cycle. Since the length of the production period of hogs, lamb, poultry and fish are shorter than that of beef, a package of policies directed toward increasing production of these beef substitutes could be successfully instrumented in the short run. The timing of such policies must be appropriate so as not to generate cyclical processes in the economies of these substitutes.

In summary, the evidence obtained in this and previous studies indicate that:

(a) given the nature of domestic demand exports can be increased in the long run only through increase in production;

(b) increase in production can be induced by stable high beef prices and low input prices;

(c) lower input prices (such as price of fertilizer) combined with a land-income taxation scheme and appropriate credit plans, by inducing

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17/ See Guadagni [18 and 19], Martinez [28] and Nores [31, pp. 64-66]

the adoption of new technology might be more desirable than higher output prices in as much as the latter hurts consumers' real income, endangers exports and results in inflationary pressure;

(d) price fluctuations (cycles) will exist as long as there exist external forces which domestic consumption is not fully able to absorb without drastically affecting price; price acts as the principal adjustment mechanism;

(e) price fluctuations can be bounded through alternative policy schemes, such as price support programs and the like, but social and treasury costs of these programs should be evaluated before changes are made;

(f) given the balance of payment problems and the need to insure regularity of supplies to foreign countries, the objective of increasing and stabilizing beef exports should remain one of high priority, which means that the slaughter cycle cannot be exported and must be absorbed domestically;

(g) implicit or explicit devaluations (revaluations) do allow for the maintenance of the level of exports in the short run, but result in destabilization of price by forcing the adjustment into domestic consumption and thus on price;

(h) domestic absorbtion of the cycle, in the absence of direct government intervention through price support and other programs, could only be obtained in the long run through an increase in the price elasticity of domestic demand; the larger the price elasticity of domestic demand the smaller will be the price fluctuations caused by exogenous forces and shocks originating in the production and external sector;

(i) a long run promotional campaign creating the "image of close substitutes" will not only shift downward domestic demand for beef (allowing for an increase in exports) but will also make it more price elastic. This implies changing tastes and preferences of consumers and thus might well be a difficult and extremely costly task. However, it must be accompanied by and appropriately timed package of policies directed to increase production of beef substitutes.

LIST OF REFERENCES

LIST OF REFERENCES

[1] Argentina, Banco Central de la Republica Argentina, Boletin Estadistico, Buenos Aires, several issues.

[2] Argentina, Banco Central de la Republica Argentina, Boletin Estadistico - Suplemento Marzo de 1971.

[3] Argentina, Banco Ganadero Argentino, Mercados y Precios del Ganado Vacuno, Buenos Aires, 1966.

[4] Argentina, Banco Nacion Argentina, Memoria Anual, Buenos Aires, several issues.

[5] Argentina, Bolsa de Cereales, Revista Anual de la Bolsa de Cereales, several issues.

[6] Argentina, Junta Nacional de Carnes, Resena Anual, Buenos Aires, issues of 1958 to 1970.

[7] Argentina, Instituto National de Estadisticas y Censos, Boletin de Estadisticas, Buenos Aires, several issues.

[8] Argentina, Instituto Nacional de Estadisticas y Censos, Censo National de Poblacion Familias y Viviendas - 1970 - Resultados Provisionales.

[9] Argentina, Servicio Meteorologico Nacional, Registros Mensuales de Precipitacion Pluvial, January 1958 to December 1970.

[10] Díaz Alejandro, Carlos,F., Exchange Rate Devaluation in a Semi-Industrialized Country - The Experience of Argentina, 1955-1961, The M.I.T. Press, U.S.A., 1965.

[11] Dieter, Elz, "Survey of the World Beef and Veal Economy," World Bank, Economics Department, mimeo, February 27, 1970.

[12] Fienup, Darrel F., Brannon, R. M. and F. A. Fender, The Agricultural Development of Argentina, Praeger, New York, 1968.

[13] Fisher, Franklin M., The Identification Problem in Econometrics, McGraw-Hill Book Co., New York, 1966.

[14] Floyd, John E., "The Effects of Price Supports on the Returns to Land and Labor in Agriculture," Journal of Political Economy, Vol. LXXIII - No. 2, April 1965, pp. 148-158.

[15] Fox, K.A., J. K. Sengupta, E. Thorbecke, The Theory of Quantitative Economic Policy, Rand McNally & Co., Chicago, 1966.

[16] Fromm, Gary and Paul Taubam, Policy Simulation with an Econometric Model, The Brookings Institution, Washington, 1968.

[17] Fox, Karl A., Econometric Analysis for Public Policy, Iowa State University Press, Ames, Iowa, 1958.

[18] Guadagni Alieto A., "Estudio Econometrico del Consumo de Carne Vacuna en la Argentina en elPeriodo 1914-1959," Desarrollo Economico, Vol. 3, No. 4, January-March 1964.

[19] Guadagni, Alieto A. and A. Petrecolla, "La Funcion de Demanda de la Carne Vacuna en la Argentina en el Perido 1935-1961," El Trimestre Economico, April-June 1965.

[20] Hart, A. G., "Anticipations, Business Planning and the Cycle," Quarterly Journal of Economics, Vol. LI, pp. 273-297.

[21] Hart, A. G., "Inputation and Demand for Productive Resources in Disequilibrium," in Explorations in Economics, Notes and Essays Contributed in Honor of F. W. Taussig, McGraw-Hill Book Co., 1936, p. 264.

[22] Hart, A. G., "Risk, Uncertainty, and the Unprofitability of Compounding Probabilities," in Studies in Mathematical Economics and Econometrics, Edited in Memory of Henry Schultz by Lange, McIntyre and Yntema, The University of Chicago Press, 1942, pp. 110-131.

[23] Herrmann, L.F. and R. E. Branson, "A Program for Stabilizing Argentine Beef Exports," A Special Report to CAFADE and to USAID/Argentina, mimeo, Buenos Aires, Argentina, 1962.

[24] Jarvis, Lovell, "Supply Response in the Cattle Industry, The Argentine Case 1937-38 to 1966-67," unpublished Ph.D. dissertation, M.I.T., August 1969.

[25] Kohout, Jose Carlos, "A Price and Allocation Decision Model for the Beef Economy in Argentina," unpublished Ph.D. dissertation, University of Illinois, Urbana, 1969.

[26] Liboreiro, Ernesto S., "The Possible Effects of Price Uncertainty on Argentine Beef Production," unpublished research paper submitted to the College of Agriculture, Michigan State University, June 1968.

[27] Liboreiro, E.S., "Effects of the European Economic Community Agricultural Policies on Argentine Exports of Beef," unpublished Ph.D. dissertation, Michigan State University, 1970.

[28] Martinez, Miguel E., "Interrelaciones de Demanda en el Mercado Argentino de Carnes," Cuadernos de Economia No. 79, Facultad de Ciencias Economicas Universidad Nacional de Cuyo, 1970.

[29] Marschak J., "Money and the Theory of Assets," Econometrica, Vol. 6, No. 4, 1938, pp. 311-325.

[30] Mincer, Jacob, Economic Forecasts and Expectation, National Bureau of Economic Research, New York, 1969.

[31] Nores, Gustavo A., "An Econometric Model of the Argentine Beef Cattle Economy," unpublished M.S. dissertation, Purdue University, June 1969.

[32] Peffer, E. Louise, "The Argentine Cattle Industry Under Peron," Food Research Institute Studies, Vol. I, No. 2, May 1960.

[33] Peffer, E. Louise, "State Intervention in the Argentine Meat Packing Industry, 1946-1958," Stanford Food Research Institute Studies, Vol. 2, No. 1, February 1961.

[34] Pineiro M. and G. Bordelois, "Politica de Carnes, Problemas y Alternativas," unpublished paper, mimeo, Buenos Aires, 1970.

[35] Stigler, G.J., "Production and Distribution in the Short Run," Journal of Political Economy, Vol. XLVII, February-December 1939, pp. 305-327.

[36] Theil, Henri, Applied Economic Forecasting, Rand McNally & Co., 1966.

[37] Theil, H. and J.C.G. Boot, "The Final Form of Econometric Equation Systems," Review of the International Statistical Institute, Vol. 30:2, 1962.

[38] Tinbergen, J., On the Theory of Economic Policy, North Holland, Amsterdam, 1966.

[39] Tintner, Gerhard, "A Contribution to the Nonstatic Theory of Production," in Studies in Mathematical Economics and Econometrics, The University of Chicago Press, 1942, pp. 92-109.

[40] Tintner, Gerhard, "The Theory of Production under Nonstatic Conditions," The Journal of Political Economy, Vol. L, No. 5, October 1942, pp. 645-667.

[41] Tintner, Gerhard, "The Pure Theory of Production Under Technological Risk and Uncertainty," Econometrica, Vol. 9, No. 3-4, July-October 1941.

[42] United Nations, Food and Agriculture Organization of the United Nations(FAO), Monthly Bulletin of Agricultural Economics and Statistics, several issues.

[43] Winsberg, Morton D., "Modern Cattle Breeds in Argentina: Origins, Diffusion, and Change," Occasional Publication No. 13, Center for Latin American Studies, University of Kansas, September 1968.

[44] Yver, Raul E., "The Investment Behavior and the Supply Response of the Cattle Industry of Argentina," unpublished Ph.D. dissertation, University of Chicago, August 1971.

APPENDIX A

CONSTRUCTION OF QUARTERLY STOCK SERIES

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CONSTRUCTION OF QUARTERLY STOCK SERIES

Empirical testing of the supply and demand model requires quarterly data of both slaughter flow and stock of animals. While the existing annual data on slaughter is considered fairly reliable, quarterlydata had to be generated on the basis of monthly registered sales to slaughter. The procedure utilized to estimate quarterly slaughter per category is described in Appendix D. The procedure utilized to generate quarterly per category stocks is described in detail below.

The official information available on per category stocks correspond to the censuses of 1937, 1947, 1952, 1960 and 1969,[1/] and to sample surveys, some of which are not considered reliable given their large discrepancies.[2/] Thus, consistent quarterly time series of stock per category of animals must be developed before the quarterly model of the beef cattle economy can be estimated. The approach followed is to utilize information about mortality rates, calving seasonality and male-female distribution of calves born to determine the stock which would have been capable of generating the observed

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[1/] The information on this last census is not available at the moment.

[2/] For an analysis of the consistencies and discrepancies among the census and surveys data, see Jarvis [24, pp. 144-258] and Yver [44, pp. 64-65].

slaughter flow. The procedure adopted is divided into two steps. First a series is developed for the number of calves born during the year and then, quarterly estimates of stocks per category are obtained considering the inflow of calves born and the outflows of slaughter and mortality, given certain assumptions about the seasonal distribution of births and shift of animals from category to category on the basis of age.

Construction of the Annual Series of Calves Born

The procedure utilized to generate the number of calves born is the one developed by Yver[3/] which consists of inferring the number of male calves born in any given year (CMB_T) from the slaughter of male animals in the next three consecutive years. To wit, the number of male calves born in year T equals the number of male calves slaughtered (CMS) during year T+1 adjusted by mortality, plus the number of young steers slaughtered (YSS) during year T+2 adjusted by mortality, plus the number of steers slaughtered (SS) during year T+3 adjusted by mortality, plus the number of calves born during year T going to the bull herd ($CMBH_T$).[4/]

Mortality rates are assumed to decline exponentially over time and to depend on a climatic index which considers both rainfall and

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3/ Yver [44, pp. 68-75]. This procedure is similar to the one used by Jarvis [24, pp. 182-185].

4/ The number of calves born during year T going to the bull herd was determined, quoting Yver "by bull sales and change in stocks of bulls according to the census. Since this outlet for male calves is very small, errors in estimating this component should not affect much of the estimate of total male calves born." [44, p. 70].

temperature.[5] Starting from mortality rates for 1937[6] (m_{i0}) four mortality indices (m_{iT}, $i = 1,\ldots,4$) are developed by means of the following relation:

$$m_{iT} = m_{i0} \cdot e^{-.01\,T - \Delta C_T} \quad ; i = 1,\ldots,4$$

where ΔC_T is the percentage change in the "de Martonne" climate index, and $i = 1$ in the case of calves, $i = 2$ for young steers and heifers, $i = 3$ for steers, and $i = 4$ for cows.

The number of male calves born in year T is given by[7]

$$CMB_T = M_{1T} \cdot CMS_{T+1} + M_{2T} \cdot YSS_{T+2} + M_{3T} \cdot SS_{T+3} + CMBH_T$$

where $M_{1T} = 1/(1 - m_{1T+1})$

$M_{2T} = M_{1T}/(1-m_{2T+2})$

$M_{3T} = M_{2T}/(1-m_{3T+3})$

CMS = male calves slaughtered,

YSS = young steers slaughtered,

SS = steers slaughtered, and

CMBH = male calves going to the bull herd.

This procedure appears fairly accurate in as much as (a) births are heavily concentrated at the end of the year with about 60 to 75 percent

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5/ See Yver [44, pp. 69-70] and Jarvis [24, pp. 176-179].

6/ These are annual rates of: .06 for calves, .04 for heifers and young steers, .03 for steers and .075 for cows.

7/ So as not to confuse the reader, the notation used here is the same as that of Yver [44, pp. 69-72], with the only difference being that years are represented by the subscript T, saving the subscript t for quarters.

of them occurring between August and November, and (b) the age limits (corresponding to mean weights) for the male categories are: 9-12 months for calves, 20-26 months of young steers and 32-40 months for steers. If all male animals slaughtered fell between these limits, the possibility of assigning the wrong year of bith to an animal would exist but its probability of occurrence would be small. Certainly, not every animal slaughtered falls between the weight limits[8/] corresponding to these age limits. However, the only information available on distribution of slaughter by weights indicates that the concentration around the mean values is high enough so one can have reasonable confidence in the resulting estimates.

The series of male calves born generated by Yver for the period 1937-1967 using this model is updated here to January 1971, on the basis of information on male slaughter up to the year 1971 and by assuming that the number of calves born during 1969 and 1970 were a given percentage (the mean for the last five years) of the breeding herd.[9/] Mortality rates since 1966 were assumed equal to the mean values for the period 1958-1966.[10/]

Once the number of male animals born during year T (CMB_T) was estimated, the number of female calves born (CFB_T) was obtained according

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[8/] See Yver [44, pp. 68-69].

[9/] To this mean, Yver's annual stock accounting model [44, p. 71]was solved in an interactive fashion up to January 1971.

[10/] Lack of temperature data since 1967 enabled the computation of the "de Martonne" climate index.

to a generally accepted male-female birth ratio.[11] These two series were used to generate quarterly stocks per category.

Quarterly Stock Model

In developing the quarterly stock model the following assumptions were made:

(a) the seasonal pattern of births is:[12]

quarter I (summer)	= .12
quarter II (fall)	= .12
quarterIII (winter)	= .38
quarter IV (spring)	= .38

(b) mortality rates are distributed evenly through the year;

(c) animals are transfered from one category to the next on the basis of age:[13]

(i) calves become young steers or heifers at the age of twelve months, or are incorporated into the bull herd at the same age;

(ii) young steers become steers at the age of twenty-four months and heifers become cows at the same age;

(d) 51.4 percent of the calves born are male and 48.6 percent are female.

Assumption (b) appears unrealistic since one might presume mortality is higher during the winter and during the calving season than during the rest of the year. However, in as much as this assumption does

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[11] Out of the total number of calves born it is assumed that .514 are male and .486 are females.

[12] This seasonal pattern appears reasonable a priori; see Jarvis [24, Chapter IV].

[13] When transferring animals from one category to the next in order, it is assumed that animals of the younger category slaughtered during quarter t were of the age of transfer.

not affect significantly the results, it was adopted to allow for the checking of the resulting quarterly series with the annual series obtained by Yver. By assuming that mortality rates are distributed evenly through the year, quarterly rates (a_{it}) corresponding to Yver's annual rates (m_{iT}) could be computed from

$$(1 - m_{iT}) = (1 - a_{it})^4 \; ; \text{ for } i = 1,\ldots,4 \text{ and } t \in T$$

and thus, other things equal, the generated stocks for the beginning of the first quarter of any year should equal the corresponding figures obtained by Yver. Starting from January 1, 1958 stocks per category of animals for subsequent quarters were obtained from the following relations:

1. <u>Male Calves</u>

$$CM_{t+1} = (1 - a_{1t})\, CM_t + .514\, b_t\, TCB_T - CMS_t - O_t - b_t\, CMBH_{T-1}$$

$$O_t = .514\, b_t\, (1 - m_{1T})\, TCB_{T-1} - CMS_t - b_t\, CMBH_{T-1}$$

2. <u>Young Steers</u>

$$YS_{t+1} = (1 - a_{2t})\, YS_t + O_t - YSS_t - Q_t$$

$$Q_t = (1 - m_{2T})\, [.514\, b_t\, (1 - m_{1T-1})\, TCB_{T-2} - CMS_{t-4} - b_t\, CMB_{T-2}] - YSS_t$$

$$= (1 - m_{2T})\, O_{t-4} - YSS_t$$

3. <u>Steers</u>

$$S_{t+1} = (1 - a_{3t})\, S_t + Q_t - SS_t$$

4. Bulls

$$BO_{t+1} = BO_t + b_t\ CMBH_{t-1} - BOS_t$$

5. Female calves

$$CF_{t+1} = (1 - a_{1t})\ CF_t + .486\ b_t\ TCB_T - CFS_t - P_t$$

$$P_t = .486\ b_t\ (1 - m_{1T})\ TCB_{T-1} - CFS_t$$

6. Heifers

$$H_{t+1} = (1 - a_{2t})\ H_t + P_t - HS_t - R_t$$

$$R_t = (1 - m_{2T})\ [.486\ b_t\ (1 - m_{1T-1})\ TCB_{T-2} - CFS_{t-4}] - HS_t$$

$$= (1 - m_{2T})\ P_{t-4} - HS_t$$

7. Cows

$$C_{t+1} = (1 - a_{4t})\ C_t + R_t - CS_t$$

8. Total Herd

$$TH_{t+1} = CM_{t+1} + CF_{t+1} + YS_{t+1} + H_{t+1} + S_{t+1} + BO_{t+1} + C_{t+1}$$

$$= (1 - a_{1t})(CM_t + CF_t) + (1 - a_{2t})(YS_t + H_t) + (1 - a_{3t})\ S_t$$

$$+ (1 - a_{4t})\ C_t + BO_t + b_t\ TCB_T - CMS_t - CFS_t - YSS_t$$

$$- HS_t - SS_t - CS_t - BOS_t$$

where CM_t = stock of male calves at the beginning of quarter t,

TCB_t = total number of calves born during year T,

CMS_t = male calves slaughtered during quarter t,

$CMBH_T$ = male calves joining the bull herd during year T,

O_t = number of male calves joining the young steer category during quarter t,

YS_t = stock of young steers at the beginning of quarter t,

YSS_t = young steers slaughtered during quarter t,

Q_t = number of young steers joining the steer category during the quarter t,

S_t = stock of steers at the beginning of quarter t,

SS_t = steers slaughtered during quarter t,

BO_t = stock of bulls at the beginning of quarter t,

BOS_t = slaughter of bulls during quarter t,

CF_t = stock of female calves at the beginning of quarter t,

CFS_t = slaughter of female calves during quarter t,

P_t = number of female calves joining the heifer category during quarter t,

H_t = stock of heifers at the beginning of quarter t,

HS_t = slaughter of heifers during quarter t,

R_t = number of heifers joining the cow herd during quarter t,

C_t = stock of cows at the beginning of quarter t,

CS_t = slaughter of cows during quarter t,

TH_t = total herd at the beginning of quarter t,

b_t = proportion of births occurred during quarter t,

a_{it} = quarterly death rate, for $i = 1,\ldots,4$

m_{iT} = annual death rate, for $i = 1,\ldots,4$

$i=1$ = for calves,

$i=2$ = for young steers and heifers,

$i=3$ = for steers,

$i=4$ = for cows,

$t \varepsilon T$ = where t = quarter and T = calendar year.

The resulting series of stock per category are reproduced in Table 7. It must be pointed out that the values corresponding to the first quarter of the year are, for all practical purposes, the same as those obtained by Yver.[14/] This is due to the similarity of the computational procedures which only differ in the length of the unit of observation (quarter vs. year) and the assumptions mentioned above. Both models are after all only accounting models and hence, as long as they use the same data and similar assumptions, there is no reason why they should differ in results.

Summarizing, first a series of number of calves born during the year was developed and then, quarterly estimates of stock per category were obtained considering the inflow of calves born and the outflows of slaughter and mortality, under assumptions about seasonal distribution of births and that animals shift from category to category on the basis of age. One could have used this last assumption and others about the slaughter age of animals in developing directly a quarterly series of calves born. However, in such a case, the possibility of

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[14/] With the exception of those corresponding to the years 1966 and 1967. This is due to the fact that revised data on slaughter was used here for those years.

Table 7. Estimated Quarterly Cattle Stock Per Category, Period II-1958/I-1971.*

	Male Calves	Young Steers	Steers	Bulls	Female Calves	Heifers	Cows	Total Calves	Total Stock
1958.2	6129.14	5515.67	3375.48	1967.70	5794.70	5451.52	20896.39	11923.84	49130.63
3	6037.93	5430.70	2413.81	1902.05	5708.47	5436.63	19407.39	11746.40	46337.00
4	5928.01	5355.46	3133.93	1855.53	5604.54	5388.77	19943.20	11532.56	47209.48
1959.1	5819.56	5287.91	3769.90	1816.53	5502.01	5333.23	20716.65	11321.57	48245.82
2	5910.58	5284.14	3202.94	1789.33	5588.07	5301.59	20113.87	11498.66	47190.56
3	6000.53	5273.72	2314.75	1755.30	5673.13	5267.34	19267.47	11673.67	45552.28
4	6433.91	5177.45	3057.58	1768.14	6082.91	5184.31	20087.27	12516.83	47791.69
1960.1	6862.23	5072.17	3737.38	1786.51	6487.90	5097.75	21131.80	13350.14	50173.77
2	6971.74	5149.41	3127.18	1776.21	6591.45	5179.46	20539.93	13563.18	49335.44
3	7079.70	5215.73	2374.02	1761.89	6693.54	5256.03	19369.75	13773.24	48140.69
4	7632.45	5553.92	2952.67	1805.61	7216.18	5612.58	20589.01	14848.63	51352.45
1961.1	8177.46	5871.85	3495.30	1841.96	7731.48	5958.42	21342.93	15908.99	54419.39
2	8060.61	5971.45	2748.85	1812.37	7621.03	6069.20	20684.86	15681.64	52968.40
3	7945.16	6043.77	1918.76	1776.48	7511.87	6169.97	19837.58	15457.03	51198.61
4	7784.18	6547.24	2856.76	1792.63	7359.67	6655.59	20788.62	15143.86	53784.73
1962.1	7625.08	7071.67	3795.63	1807.65	7209.25	7147.39	21833.99	14834.33	56490.88
2	7480.01	6872.01	3064.53	1766.54	7072.09	6992.76	21011.03	14552.11	54259.00
3	7337.31	6659.90	2331.74	1706.13	6937.17	6831.41	19783.05	14274.48	51566.74
4	7151.92	6432.45	3708.42	1692.23	6761.88	6616.08	20912.00	13913.80	53275.01
1963.1	6969.55	6194.06	4772.41	1678.67	6589.45	6398.04	22081.86	13559.60	54954.07
2	6892.99	5971.05	3850.85	1646.42	6517.07	6302.56	20852.83	13410.07	52033.82
3	6817.43	5807.45	3000.87	1606.98	6445.63	6240.72	19610.00	13263.06	49529.10
4	6771.76	5529.77	3706.86	1640.01	6402.46	6092.11	20434.42	13174.22	50577.41
1964.1	6726.69	5340.51	4396.14	1681.03	6459.84	5966.69	21559.14	13086.53	52030.06
2	6755.02	5466.59	3394.83	1641.47	6386.63	5976.36	20821.50	13141.65	50442.42
3	6783.04	5599.48	2539.62	1602.96	6413.14	5990.09	20195.42	13196.18	49123.77
4	7026.93	5744.17	3318.01	1638.47	6643.74	6003.09	21407.76	13670.68	51782.20

Table 7. Continued.

	Male Calves	Young Steers	Steers	Bulls	Female Calves	Heifers	Cows	Total Calves	Total Stock
1965.1	7268.23	5812.07	4179.65	1680.53	6871.90	5993.04	22818.68	14140.13	54624.14
2	7232.37	5875.96	3337.96	1646.42	6838.00	6023.78	22313.67	14070.38	53268.19
3	7197.04	5929.32	2501.98	1612.57	6804.60	6053.49	21682.27	14001.64	51785.29
4	7312.71	6103.81	3497.88	1645.91	6913.98	6231.61	22704.48	14226.69	54470.41
1966.1	7426.71	6255.27	4288.29	1680.46	7021.77	6402.53	23840.27	14448.48	56915.32
2	7543.03	6242.80	3298.16	1698.60	7131.76	6380.50	23324.87	14674.79	55579.75
3	7658.03	6201.40	2479.15	1631.45	7240.50	6334.62	22508.09	14898.54	54113.29
4	8205.60	6257.66	3168.85	1648.20	7758.24	6405.08	23500.26	15963.84	56943.31
1967.1	8746.97	6300.75	3760.57	1668.42	8270.13	6471.22	24504.91	17017.10	59723.01
2	8567.92	6334.75	2834.15	1618.78	8100.84	6520.74	23529.50	16668.77	57506.71
3	8391.25	6337.71	1901.87	1568.02	7933.79	6542.71	22352.55	16325.03	55027.92
4	8076.93	6786.19	2720.35	1590.46	7638.50	6964.92	23245.03	15717.44	57624.41
1968.1	7770.75	7266.86	3652.71	1602.01	7347.10	7402.71	24202.34	15117.85	59244.50
2	7662.17	7090.62	3090.45	1547.55	7244.44	7211.81	23163.44	14906.61	56970.50
3	7555.01	6922.60	2417.01	1495.94	7143.13	7010.94	22054.09	14698.15	54598.76
4	7436.10	6632.83	3633.18	1498.25	7030.70	6696.98	23071.07	14466.80	56199.14
1969.1	7318.75	6351.99	4664.82	1501.50	6919.74	6394.68	24567.23	14238.50	57718.74
2	7233.23	6313.68	3682.15	1448.21	6838.89	6308.84	23502.82	14072.12	55327.85
3	7148.84	6292.40	2558.76	1388.13	6759.10	6221.42	22294.04	13907.95	52662.73
4	7089.43	6196.22	3203.63	1347.54	6702.94	6067.95	23023.67	13792.37	53625.41
1970.1	7030.81	6078.71	3786.08	1313.51	6647.51	5912.81	23901.88	13678.32	54671.33
2	7027.44	5960.67	2825.08	1264.08	6644.32	5862.69	22735.37	13671.77	52319.68
3	7024.11	5803.69	1701.67	1202.73	6641.18	5802.85	21319.43	13665.29	49495.69
4	7214.45	5667.68	2373.65	1208.90	6821.15	5757.74	22069.28	14035.60	51112.90
1971.1	7402.28	5587.23	3465.80	1230.30	6998.75	5744.36	23136.41	14401.03	53565.16

*beginning of the quarter.

assigning to an animal the wrong quarter of birth would be larger than in the case of first developing an annual series of calves born and then assigning them to quarters on the basis of knowledge about the seasonal distribution of births. That is, it is argued that the probability of assigned to an animal the wrong year of birth is smaller than the probability of assigning him the wrong quarter of birth.

The above model could be improved with knowledge about the weight and age distribution of animals slaughtered; information which would allow reducing the probability of assigning the wrong year of birth to an animal. Knowledge about the composition of slaughter by breeds could also be used to improve the estimate of the number of calves born, in as much as animals of different breeds take different amounts of time to reach the same weight. Finally, census information could be used to check the accuracy of the model and to make the necessary corrections in its parameters.

APPENDIX B

ALTERNATIVE SPECIFICATIONS OF THE MODEL

APPENDIX B

ALTERNATIVE SPECIFICATIONS OF THE MODEL

The model was specified in four alternative versions which differ in (a) the level of aggregation of the slaughter supply equations, (b) whether or not average dressed weights (ADW) of animals slaughtered are regarded as variables or assumed to be constant at mean sample values, and (c) whether or not domestic demand and demand for exports are postulated and fitted directly at the farm level or postulated and fitted at the final retail and FOB levels taking explicitly into consideration the behavior of the marketing group and export packers.

Model 1 (presented in Chapter III) was specified in aggregate form so as to reflect the interdependency among the large components of the beef cattle economy; that is, the interdependency among slaughter supply, domestic demand and demand for exports at the farm level. Slaughter was divided into two main categories: (1) steers and (2) other animals. This disaggregation was based on the assumption that while steers could only be held for a short period of time, all other animals except those culled, could be kept for a longer time span given their larger maturity or productive horizon. Because of simplicity considerations ADW's of animals slaughtered were assumed to be constant (at mean sample values). In Model 2, this assumption is relaxed and functions explaining the ADW's of steers and other animals are specified in accordance with the reasoning developed in Chapter II.

Model 2

Average dressed weights per category were relatively stable during the sample period. The coefficients of variation for the individual categories ranged from .026 to .058.[1/] However, ADW's constitute a second dimension of slaughter defining the volume of beef to be allocated between consumption and exports. Although stable, they have not been constant. Furthermore, the theory of investment behavior analyzed in Chapter II indicates that the optimum slaughter age (thus weight) changes with beef prices. Hence, as prices approach their cyclical peak the number of animals slaughtered will approach its cyclical low value - because of withholdings - but these animals will be heavier, and vice versa. That is, as far as the price effect is concerned, changes in weight would tend, in the long run, to partially compensate changes in the number of animals slaughtered. The specification of equations explaining ADW's would, in such a case, yield a more efficient and complete model in terms of prediction.

In Model 2 four equations are added to the system; two explaining ADW's of animals slaughtered (steers and others) and two defining the volume of meat obtained from slaughter. The latter which are non-linear identified of the form

$$\text{Volume of Meat}_{jt} = (\text{number of animals}_{jt}) \times (ADW_{jt})/1000$$

$$j = \text{steers, and other animals.}$$

[1/] See Appendix C, Table 15. The procedure used to obtain estimates of the national ADW's per category is described in Appendix E.

were linearized by means of Taylor's expansion series evaluated at mean values.[2/] The resulting 2SLS estimates are presented in Table 8; the meaning of each empirical variable being defined on page 134. Since two predetermined variables (lagged ADW's: $Y_{7,t-1}$ and $Y_{13,t-1}$) were added to the system the number of instrumental variables is now twenty one, leaving - with forty four observations - twenty three degrees of freedom in the first stage of estimation. Note that, as a result of this, little change occurred in the estimates of the coefficients corresponding to the equations present in Model 1.

The interpretation of the estimates of the coefficients of the stochastic equations explaining ADW's is not unambiguous. There are two reasons for this ambiguity. First, the explained variables[3/] (ADW's) were obtained by multiplying average live weights times corresponding dressing percentages. Since both of these components are variables which depend on the breed composition of slaughter as well as on age, the empirical results may not necessarily coincide with what one could expect in the case of homogeneous slaughter in terms of breeds. Take, for example, the case of steers - equation (2.1) -. As beef prices go up slaughter of steers declines in the short run. Given that as a consequence of the increase in price optimum slaughter age increases, one could expect ADW of steers slaughtered to go also up. However, when the breed composition of slaughter is brought into the analysis, things change.

[2/] See Appendix C.

[3/] For the computational procedure utilized to obtain these variables see Appendix E.

Table 8. Model 2, Two Stage Least Squares Estimates of Structural Parameter for the Period, I/1960-IV/1970.*

	Y_1	Y_{21}	Y_7	Y_{13}	Y_1^1	Y_{21}^1	Y_{15}	Y_{18}	Y_{47}	Y_{18} t-2	X_{29}	X_{30}	31	X_{19} t-1	X_{19} t-2	X_{15}
(2.1)	1.0							1.3649 (3.127)			1.826 (2.981)	.450 (.849)	1.507 (2.848)	-.270 (.366)	.051 (.071)	
(2.2)		1.0						2.6165 (3.282)		-3.237 (4.256)	.910 (1.387)	2.136 (3.611)	-1.131 (1.654)	.063 (.072)	.897 (1.043)	-4.956
(2.6)			1.0					.0300 (1.091)		.011 (.432)	-.073 (3.294)	-.040 (1.902)	-.032 (1.490)	-.035 (1.160)	-.065 (2.170)	
(2.7)				1.0				-.0357 (1.184)		.067 (2.077)	-.085 (3.022)	-.088 (3.596)	-.0004 (.015)	.012 (.363)	-.042 (1.293)	
(2.8)	-.2524		-1.1457		1.0											
(2.9)		-.1792		-1.7449		1.0										
(2.3)							1.0	.7800 (9.680)								
(2.4)								.5670 (3.861)	1.0							
(2.5)					1.0	1.0	-1.0		-1.0							

Table 8. Continued.

	X_{90} t-2	X_{88} t-5	Y_7 t-1	Y_{13} t-1	X_{75}	X_3	X_{56}	X_{38}	X_{28}	X_{00}	X_{40}	X_{44}	Y_{47} t-1	X_{106}	α	R^2
(2.1)	.370 (6.135)														205.66 (1.013)	.570
(2.2)		.051 (6.450)													322.13 (.646)	.929
(2.6)			.602 (4.751)												118.41 (3.303)	.654
(2.7)				.372 (2.705)											95.2 (4.641)	.734
(2.8)															-289.60	
(2.9)															-309.22	
(2.3)					.052 (2.230)	.030 (5.360)	.352 (1.632)	- .289 (2.310)							-220.84 (2.463)	.893
(2.4)									.083 (1.058)	- .036 (2.187)	1.983 (2.439)	.377 (2.613)	.530 (3.663)		-192.01 (1.398)	.701
(2.5)														1.0		

*Signs of β estimates correspond to the left hand side of the equality. Sign of γ estimates correspond to the right hand side; t ratios in absolute value between parehthesis below the coefficients.

Certain traditional breeds, such as Aberdeen Angus, Shorthorn and Hereford, have a rather stable optimum weight in terms of quality given that premiums are paid on the basis of degree of finishing, percentage and distribution of fat, etc. It does not pay the firm to withhold these animals from slaughter for long periods of time because of premium losses. Other breeds such as Holstein-Friesian,[4/] Santa Gertrudis and domestic cross breeds, may be slower but are more steady weight gainers within the same age range. As a result of this their optimum slaughter weight (say, of Holstein-Friesian steers) is more sensitive to beef prices than that of traditional breeds (say, of Aberdeen Angus steers). Since the former are, in general slaughtered at heavier weights than the latter, the observable phenomenon brought by an increase in price in the short run could be a decrease (rather than expected increase) in the average weight of steers slaughtered. This would explain the negative sign of the coefficient of current price (Y_{18}) in equation (2.6). The positive sign of the coefficient of lagged price ($Y_{18,t-2}$) tends to support this hypothesis.[5/]

Furthermore, the estimates of the coefficients of the seasonal dummies (X_{29}, X_{30} and X_{31}) and of the rainfall indices ($X_{19,t-1}$ and $X_{19,t-2}$) indicate that as pasture conditions improve the average weight of steers - Y_7 in equation (2.6) - decreases. Since under improved

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[4/] According with the census of 1960, around twenty percent of the total stock of cattle was Holstein-Friesian.

[5/] Unfortunately, no information on slaughter classified by breeds is available, so this reasoning remains as hypothesis for the moment.

pasture conditions animals are finished sooner, a decrease in average dressed weight could only come about from a larger decrease in sales of steers of heavier breeds such as Holstein-Friesian relative to sales of steers of lighter breeds such as Angus. That is, as beef prices go up (or feed prices go down) less steers are sold for slaughter, but such a decrease in sales is larger in the case of breeds which are more steady weight gainers (heavier breeds) resulting in a decrease of the observable average dressed weight.[6/] In the long run, however, the movement would be reversed and as prices reach their cyclical peak, animals slaughtered will be heavier. The evidence found by Jarvis[7/] on the basis of annual data points in this direction, as does the sign of the coefficient of farm price ($Y_{18,t-2}$) in equation (2.6).

Secondly, interpretation of the estimates obtained for the coefficients of the equation expalining ADW of animals other than steers - equation (2.7) - is not unambiguous in as much as the explained variable (Y_{13}) is an average which includes animals of different weights such as calves, young steers, heifers, cows and bulls. That is, while the average weight corresponding to each of these categories is a function of price, previous pasture conditions, etc.,the average weight for the aggregate of all five categories is also a function of the composition of slaughter in terms of the number of animals slaughtered

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6/ Ibid.

7/ Jarvis, [24, pp. 405-407].

in each category.[8] The observable phenomenon at this level of aggregation would be an increase in weight as the result of an increase in price and vice versa. This is due to the combination of two forces operating in the same direction; (1) as beef prices go up it pays to sell the heaviest animals within each category relative to light animals and (2) as beef prices go up it pays to sell fewer animals from those categories whose capital prices increased most, i.e., calves and heifers, which happen to be the lighter ones within the aggregate of all other animals except steers. The estimated coefficients of current (Y_{18}) and lagged price ($Y_{18,t-2}$) in equation (2.7) both being positive, support this reasoning.

Reduced form estimates corresponding to Model 2 are presented in Table 9. Note that in general current period impacts are smaller than those corresponding to Model 1 (Table 4). This comes about because of the partial compensation of the price effect in number of animals slaughtered by the price effect of their average weight, and results in better prediction and less overshooting of the cycle than in the case of Model 1 which assumes constant average slaughter weights.[9]

Model 3

In Model 3 (a) separate slaughter functions are specified for each individual category, (b) average dressed weights are assumed constant

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[8] This problem does not appear when separate slaughter and ADW functions are specified for each category on animals.

[9] See Chapter IV.

Table 9. Model 2, Reduced Form Coefficients.

	Y_{18} t-2	X_{29}	X_{30}	X_{31}	X_{19} t-1	X_{19} t-2	X_{15}	X_{90} t-2	X_{88} t-5	Y_{7} t-1	Y_{13} t-1	X_{75}	X_{3}
Y_1	-1.0951	2.7771	1.1718	1.8497	- .4547	.1138	-2.1586	.5970	.0222	1.6764	1.5777	- .1264	- .0729
Y_{21}	-5.3363	2.7353	3.5197	- .4739	- .2912	1.0175	-9.0941	.4351	.0936	3.2137	3.0244	- .2423	- .1397
Y_7	- .0131	- .0521	-.0241	- .0245	- .0391	- .0636	- .0474	.0050	.0005	.6388	.0347	- .0028	- .0016
Y_{13}	.0956	- .1099	-.1069	- .0089	.0168	- .0436	.0564	- .0059	- .0006	- .0438	.3307	.0033	.0019
Y_1'	- .2914	.6413	.2681	.4388	- .1595	- .0441	- .5992	.1564	.0062	1.1550	.4379	- .0351	- .0202
Y_{21}'	- .7894	.2984	.4442	- .1005	- .0228	.1062	-1.5311	.0676	.0157	.4994	1.1190	- .0376	- .0217
Y_{15}	- .6258	.5441	.4125	.1959	- .1056	.0359	-1.2336	.1297	.0127	.9580	.9016	- .0202	- .0117
Y_{18}	.8023	- .6976	-.5288	- .2511	.1353	- .0460	1.5815	- .1663	- .0163	-1.2282	-1.1559	.0926	.0538
Y_{47}	- .4549	.3955	.2998	.1424	- .0767	.0261	- .8967	.0943	.0092	.6964	.6554	- .0525	- .0303

Table 9. continued.

	X_{56}	X_{38}	X_{28}	X_{00}	X_{40}	X_{44}	Y_{47} t-1	X_{106}	$*_a$
Y_1	- .8556	.7024	- .2017	.0875	-4.8199	- .9163	-1.2882	-2.4306	753.62
Y_{21}	-1.6401	1.3465	- .3867	.1677	-9.2397	-1.7566	-2.4695	-4.6594	1372.56
Y_7	- .0188	.0154	- .0044	.0019	- .1059	- .0201	- .0283	- .0534	130.45
Y_{13}	.0224	- .0184	.0053	- .0023	.1261	- .0239	.0337	.0636	80.87
Y_1'	- .2375	.1949	- .0560	.0243	-1.3379	- .2544	- .3576	- .6747	50.07
Y_{21}'	- .2548	.2092	- .0601	.0261	-1.4358	- .2729	- .3837	- .7240	77.85
Y_{15}	- .1369	.1124	- .1153	.0500	-2.7544	- .5237	- .7362	-1.3890	92.30
Y_{18}	.6268	- .5146	.1478	- .0641	3.5313	.6713	.9438	1.7808	-401.46
Y_{47}	- .3554	.2918	- .0008	.0003	- .0193	- .0036	- .0051	-1.0097	35.62

*Intercept.

(at mean sample values) for each category and are introduced as known parameters in the market clearing condition, and (c) domestic demand and demand for exports are postulated and fitted directly at the final retail and FOB levels considering explicitly the behavior of the marketing group and export packers.

Model 3 consists of twelve equations in twelve endogenous variables. Six stochastic behavioral relations explain slaughter of each category of animals: steers (3.1), young steers (3.10), cows (3.11), heifers (3.12), calves (3.13) and bulls (3.14). Consumers behavior at the retail level is explained by equation (3.3') and the behavior of the marketing group is explained by a price spread equation (3.15). World's excess demand for Argentine beef at the FOB level is represented by equation (3.4') and export packers' behavior is explained in a price spread equation, (3.16). A market clearing condition (3.5) and a linearized[10/] net export price - FOB price transformation identify (3.17) close the system.

The identities and two stage least squares estimates of the stochastic equations are presented in Table 10. With twenty-three predetermined variables and fourty-four observations there are twenty-one degrees of freedom in the first stage of estimation.

As was mentioned in Chapter III, the price slopes of the aggregate (total) slaughter supply functions expressed in terms of volume of beef

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[10/] The linearization was done by means of Taylor's expansion series evaluated at mean values. The errors of linearization introduced by applying this procedure are analyzed in Appendix C.

Table 10. Model 3. Two Stage Least Squares Estimates of Structural Parameters for the Period I/1960-IV/1970.*

	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Y_{15}	Y_{17}	Y_{18}	Y_{70}	Y^1_{59}	Y_{47}	$Y_{18\,t-2}$	X_{29}	X_{30}	X_{31}
(3.1)	1.0								1.2821 (2.978)					1.807 (2.949)	.447 (.838)	1.498 (2.829)
(3.10)		1.0							.6400 (2.761)				- .935 (4.032)	- .140 (.076)	- .390 (2.201)	- .016 (.073)
(3.11)			1.0						.1861 (.401)				-1.283 (3.032)	- .007 (.018)	1.267 (3.523)	-1.303 (3.543)
(3.12)				1.0					1.2568 (5.336)				- .914 (4.079)	.859 (4.268)	.197 (2.770)	.007 (.041)
(3.13)					1.0				.2030 (.571)				-1.098 (3.603)	- .045 (.156)	1.280 (4.982)	- .687 (2.669)
(3.14)						1.0			- .0560 (1.578)				- .146 (4.614)	- .020 (.679)	.024 (.922)	- .042 (1.592)
(3.3)							1.0	.6674 (8.793)								
(3.15)							.1134 (1.288)	1.0	- .9998 (8.308)							
(3.16)									- .5414 (8.391)	1.0		.1683 (2.018)				
(3.17)										1.0	- .6219					
(3.4)											.5267 (4.078)	1.0				
(3.5)	.2524	.1838	.2011	.1651	.1104	.2718	-1.0					-1.0				

Table 10. Continued.

	X_{19} t-1	X_{19} t-2	X_{15}	X_{90} t-2	X_{81} t-3	X_{86} t-5	X_{85} t-3	$\dot{X}_{87}$ t-4	X_{75}	X_{3}	X_{56}	X_{49}	X_{38}
(3.1)	-.270 (.366)	.055 (.076)		.369 (6.080)									
(3.10)	-.039 (.150)	-.061 (.236)	-1.451 (2.225)		-.029 (1.878)								
(3.11)	.336 (.638)	.754 (1.455)	-2.998 (2.314)			.028 (2.641)							
(3.12)	.219 (.824)	.401 (1.544)	.110 (.167)				.060 (4.504)						
(3.13)	.061 (.160)	.407 (1.088)	-1.197 (1.268)					.029 (3.112)					
(3.14)	.016 (.411)	.058 (1.499)	-.156 (1.605)										
(3.3)									.059 (2.600)	.032 (5.982)	.476 (2.232)	-.374 (4.981)	-.075 (.598)
(3.15)												-.338 (4.106)	
(3.16)													
(3.17)													
(3.4)													
(3.5)													

Table 10. continued.

	X_{28}	X_{00}	X_{40}	X_{44}	Y_{47} t-1	X_{106}	α	R^2
(3.1)							197.35 (.972)	.569
(3.10)							889.94 (6.606)	.778
(3.11)							341.96 (1.243)	.817
(3.12)							474.62 (4.064)	.908
(3.13)							94.53 (.482)	.833
(3.14)	.065 (8.587)						- 5.39 (.401)	.827
(3.3)							-250.24 (2.719)	.907
(3.15)							142.78 (2.274)	.859
(3.16)							162.07 (6.889)	.705
(3.17)			4.339				-264.27	
(3.4)	.210 (4.213)	- .320 (2.193)		.342 (2.434)	.139 (.879)		-64.82 (1.565)	.704
(3.5)						1.0		

*Signs of β estimates correspond to the left hand side of the equality. Signs of γ estimates correspond to right hand side; t ratios in absolute values between parentheses below the coefficients.

(weighted by ADW's of the corresponding categories) are about the same in both Model 3 and Model 1; they are -.815 and -.823 respectively. When the demand equations obtained in Model 3 are derived at the farm level and compared to those obtained in Model 1, little difference is found between the corresponding price slopes coefficients.[11/] On this account alone, the exercise in disaggregation proved to be successful. However, given that in terms of data quality retail and FOB prices are considered less reliable than farm prices, one is willing to place more confidence in the aggregate version of the model. This also holds for the supply side. Evidently, given the method and the rigid assumptions used to generate quarterly stocks per category, the possibility of assigning animals on the basis of age to one category which weightwise corresponds to another category, does exist. The negative coefficient of stock of young steers ($X_{81,t-3}$) in the equation explaining the number of young steers slaughtered (3.10) indicates that this might have been the case.

Current period price elasticities and "unadjusted" cummulative price elasticities of slaughter supply of individual categories of animals are given in Table 11. Note that, in accordance with the theory of investment behavior described in Chapter II, the short-run elasticity for steers (-.363) is smaller than for young steers (-.668) and that this latter one is smaller than the one for heifers (-.962). This is so because as prices go up, younger and female animals become more valuable as capital goods do older and male animals respectively.

[11/] See Chapter III,

Table 11. Short-Run and Unadjusted Cummulative Price Elasticity of Slaughter Supply per Category of Animals.1/

Category of Animals	Short Run Elasticity (period t)	Unadjusted 2/ Cummulative Elasticity (periods t and t-2)
1. Steers	- .363	- .363
2. Young Steers	- .668	-1.644
3. Cows	- .088	- .691
4. Heifers	- .962	-1.661
5. Calves	- .258	-1.649
6. Bulls	.282	- .454

1/ Measured at mean values.

2/ These elasticities are unadjusted by changes in stocks and computed as follows

$$UCE_i = \left(\frac{\partial Y_i}{\partial Y_{18,t}} + \frac{\partial Y_i}{\partial Y_{18,t-2}} \right) \frac{\bar{Y}_{18}}{\bar{Y}_i} ; \quad \text{where } i = \text{category of animals.}$$

Slaughter supply of cows, however, is not inferred as very sensitive to current price. Its short-run price elasticity is -.088. The reason is that in the short run the slaughter of cows is bounded, on one side by a minimum culling rate, and on the other side (positive direction) by the fact that cows are, during most of the year, either pregnant, feeding their calves or producing milk. As time goes by this elasticity increases resulting in "unadjusted" cummulative elasticity of cow slaughter of -.691.[12/]

Turning now to retail domestic demand - equation (3.3) - , a dummy variable (X_{49}) representing periods for which maximum retail prices were established was introduced as an explanatory variable. Theoretically, such variables should not be present in the demand equation in as much as, if such a policy were effective, it is already present in the retail price variable (Y_{17}). However, residuals in prior estimates of this demand equation were consistently negative and large in magnitude for the period in which maximum retail price policies were adopted. This suggests that such a policy was effective on the statistical information collected on retail prices but not on the true prices paid by consumers. In fact, when this dummy variable (X_{49}) was incorporated in the demand equation (3.3) all estimates improved from the statistical point of view. The negative sign obtained for the coefficient of this variable would indicate compensation

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12/ The interpretation of these cummulative elasticities as interim price elasticities is not valid in as much as they were not adjusted by changes in stocks; such adjustment was not made here given that stock equations were excluded from the model. They do, however, indicate the direction of adjustment.

of the artifi .ial (not real) increase in consumption which would come about of a recorded (not real) decrease in retail price. That is, as far as the evidence goes, maximum retail price policies affected the recorded retail prices more than the true prices.[13/]

With regard to price spreads - equations (3.15) and (3.16) - the inferred behavior for both domestic intermediaries and export packers is that as the quantity marketed increases, price spread or margin per unit of product decreases. That is, both groups seems to attempt to maintain total gross returns in the face of changes in the marketed volume. These findings are consistent with those of previous studies[14/] based on annual data.

Reduced form estimates corresponding to Model 3 are presented in Table 12. Note that, as in the case of the first two models, shifts in demand are overcompensated[15/] by the price effect due to the negative price slope of supply. In the longer run, however, as stocks

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13/ It must be pointed out, however, that since maximum retail price policies were usually adopted when prices were either increasing fast or at high levels, the negative residuals found in previous estimations of the retail demand function could be partially due to the linearity imposed on this function. If the true function were in fact concave from below, a linear function would yield negative residuals at high and low price levels. Since the true form of the demand function is unknown, no final conclusion can be reached at this point. However, the possibility of these type of convexity is very uncommon and theory as well as empirical studies tend to indicate that demand functions for non-inferior goods are if anything, convex rather than concave from below.

14/ See Nores [31, pp. 68-74].

15/ Except in the case of shifts of demand for exports caused by changes of the net effective exchange rate (X_{40}) and income of importing countries (X_{28}).

Table 12 Model 3. Reduced Form Coefficients.

	Y_{18} t-2	X_{29}	X_{30}	X_{31}	X_{19} t-1	X_{19} t-2	X_{15}	X_{90} t-2	X_{81} t-3	X_{86} t-5	X_{85} t-3	X_{87} t-4	X_{75}	X_{3}	X_{56}
Y_1	-1.6880	3.0824	1.6438	1.5594	- .1801	.6950	-2.3352	.5010	- .0121	.0128	.0225	.0073	- .1452	- .0788	-1.1721
Y_2	-1.7776	.4966	.2074	.0147	.0059	.2585	-2.6166	.1058	- .0350	.0064	.0112	.0036	- .0725	- .0393	- .5851
Y_3	-1.5280	.1781	1.4407	-1.2940	.3490	.8469	-3.3369	.0307	- .0017	.0299	.0033	.0010	- .0211	- .0143	- .1701
Y_4	-2.5687	2.1092	1.6701	.0672	.3071	1.0284	-2.1791	.2078	- .0118	.0125	.0821	.0071	- .1424	- .0772	-1.1489
Y_5	-1.3652	.1569	1.4694	- .6772	.0752	.5083	-1.5667	.0335	-.0019	.0020	.0036	.0301	- .0230	- .0124	- .1855
Y_6	- .0722	- .0757	- .0282	- .0446	.0120	.0300	- .0540	- .0092	.0005	- .0006	- .0010	- .0003	.0063	.0034	.0512
Y_{15}	- .9504	.7181	.6739	.0346	.0506	.3603	-1.3148	.1193	- .0068	.0072	.0127	.0041	- .0179	- .0097	- .1450
Y_{17}	1.4241	-1.0760	-1.0097	- .0518	- .0758	- .5599	1.9701	- .1788	.0102	- .0108	- .0190	- .0061	.1153	.0625	.9304
Y_{18}	1.3166	- .9947	- .9334	- .0479	- .0701	- .4992	1.8213	- .1653	.0094	- .0100	- .0175	- .0057	.1133	.0614	.9142
Y_{70}	.8313	- .6281	- .5893	- .0302	- .0442	- .3151	1.1500	- .1043	.0059	- .0063	- .0111	- .0036	.0715	.0388	.5772
Y_{59}	1.3367	-1.0099	- .9477	- .0486	- .0711	- .5068	1.8491	- .1678	.0096	- .0101	- .0178	- .0057	.1150	.0624	.9281
Y_{47}	- .7040	.5319	.4991	.0256	.0374	.2669	- .9739	.0884	- .0050	.0052	.0094	.0030	- .0606	- .0328	- .4888

Table 12. Continued.

	X_{49}	X_{38}	X_{28}	X_{00}	X_{40}	X_{44}	$Y_{47\,t-1}$	X_{106}	*a
Y_1	.3654	.1847	- .5172	.8494	-9.7543	- .9078	- .3689	-2.2760	3019.65
Y_2	.1824	.0922	- .2582	.4240	-4.8692	- .4531	- .1841	-1.1362	2298.78
Y_3	.0530	.0268	- .0750	.1232	-1.4158	- .1318	- .0535	- .3303	751.62
Y_4	.3582	.1810	- .5070	.8326	-9.5618	- .8898	- .3616	-2.2311	3241.23
Y_5	.0578	.0292	- .0818	.1344	-1.5444	- .1437	- .0584	- .3603	541.39
Y_6	- .0159	- .0080	.0876	- .0371	.4260	.0396	.0161	.0994	-128.66
Y_{15}	.0452	.0228	- .2912	.4782	-5.4923	- .5111	- .2077	-1.2815	1215.31
Y_{17}	- .6281	- .1466	.4363	- .7166	8.2294	.7658	.3112	1.9202	-2195.90
Y_{18}	- .2850	- .1440	.4034	- .6625	7.6080	.7080	.2877	1.7752	-2201.31
Y_{70}	- .1799	- .0909	.2134	- .3555	4.0824	.3799	.1544	1.1208	-1144.24
Y'_{59}	- .2894	- .1462	.3432	- .5716	- .4124	.6109	.2483	1.8023	-1414.97
Y_{47}	.1524	.0770	.0291	- .0189	.2172	.0202	.0082	- .9493	680.44

*intercept.

increase so does slaughter, thus the sign would be reversed resulting in the expected direction of adjustment. But, again, the allocation of beef between domestic consumption and exports favors the one which shifted upward and vice versa.

Model 4

The assumption of constant average dressed weight of the animals slaughtered, adopted in Model 3 is dropped in this last model. By doing so, twelve new equations are added to the system. Six of them explain the ADW of each of the six categories of animals and six define the corresponding volumes of meat obtained from slaughter. Two stage least squares estimates are presented in Table 13. With twenty-nine predetermined variables and forty-four observations, there are fifteen degrees of freedom in the first stage of estimation. Note that the estimates of the coefficients corresponding to the equations present in Model 3 did not change much as a result of this.

As in the case of Model 2 the interpretation of the estimates of the coefficients of the stochastic equations explaining ADW's is not unambiguous. The negative effect of current price (Y_{18}) on the ADW of male animals slaughtered - in equations (4.6), (4.18), (4.21) and (4.22) - could be interpreted as in Model 2 by bringing the breed composition of the slaughter into the analysis. Reduced form estimates corresponding to Model 4 are presented in Table 14.

Table 13. Model 4 Two Stage Least Squares Estimates for the Period I/1964-70*.

	Y_{18}	X_{18} t-2	X_{29}	X_{30}	X_{31}	X_{19} t-1	X_{19} t-2	X_{15}	X_{90} t-2	X_{81} t-3	X_{86} t-5	X_{85} t-3	X_{87} t-4	X_{28}	X_7 t-1	X_8 t-1	X_9 t-1	X_{10} t-1	X_{11} t-1	X_{12} t-1	a	R^2
(4.1) Y_1	-1.3634		1.825	.450	1.507	- .270	.051		.370												205.51	.570
	(3.243)		(2.983)	(.849)	(2.848)	(.367)	(.071)		(6.154)												(1.014)	
(4.10) Y_2	- .6372	-.937	- .140	-.390	- .016	- .039	- .060	-1.454		- .028											889.66	.778
	(2.699)	(4.113)	(.708)	(2.202)	(.094)	(.151)	(.236)	(2.245)		(1.878)											(6.616)	
(4.11) Y_3	- .0984	-1.336	- .015	1.264	-1.309	.330	.763	-3.091			.028										332.65	.818
	(.224)	(3.235)	(.394)	(3.524)	(3.568)	(.629)	(1.478)	(2.409)			(2.653)										(1.214)	
(4.12) Y_4	-1.1504	-.980	.848	.494	.009	.213	.414	- .003				.060									467.03	.910
	(5.200)	(4.517)	(4.261)	(2.779)	(.001)	(.808)	(1.606)	(.004)				(4.528)									(4.042)	
(4.13) Y_5	- .1799	-1.110	-.048	1.280	- .689	.059	.409	-1.220					.030								89.04	.633
	(.536)	(3.705)	(1.651)	(4.982)	(2.677)	(.156)	(1.095)	(1.303)					(3.150)								(.459)	
(4.14) Y_6	.054	-.145	-.020	.025	- .042	-.016	.058	- .155						.065							- 5.32	.827
	(1.615)	(4.702)	(.674)	(.924)	(1.568)	(.413)	(1.495)	(1.599)						(8.606)							(.396)	
(4.6) Y_7	-.0459	.021	-.073	-.040	- .031	-.032	-.032								.585						123.96	.665
	(1.842)	(.868)	(3.352)	(1.952)	(1.475)	(1.091)	(2.224)								(4.712)						(3.535)	
(4.18) Y_8	- .0191	.027	-.049	-.057	- .352	-.040	-.056									.439					114.27	.533
	(1.014)	(1.469)	(2.899)	(3.546)	(2.015)	(1.724)	(2.454)									(3.255)					(4.460)	
(4.19) Y_9	.0083	.093	-.023	-.035	.105	-.008	-.003										.515				116.27	.492
	(.191)	(2.079)	(.536)	(.929)	(2.838)	(.154)	(.055)										(.938)				(4.964)	
(4.20) Y_{10}	.0186	.019	-.014	.027	-.056	-.029	-.027											.647			55.63	.780
	(1.081)	(1.028)	(.935)	(1.798)	(3.880)	(1.382)	(1.308)											(5.909)			(3.262)	
(4.21) Y_{11}	-.0198	.024	-.076	-.064	-.033	.031	-.059												.371		75.57	.423
	(.790)	(1.005)	(3.403)	(3.070)	(1.424)	(1.011)	(1.960)												(2.388)		(4.339)	
(4.22) Y_{12}	-.0449	-.057	-.169	-.168	.029	.091	-.021													.410	186.34	.585
	(.766)	(.937)	(3.075)	(3.394)	(.544)	(1.286)	(.306)													(2.749)	(4.286)	

Table 13 Continued.

	Y_{15}	Y_{17}	Y_{18}	Y'_{59}	Y_{47}	X_{75}	X_3	X_{56}	X_{49}	X_{38}	X_{28}	X_{00}	X_{44}	X_{47} t-1	a	R^2
(4.3')Y_{15}		-.6771 (9.155)				.058 (2.587)	.032 (5.972)	.470 (2.207)	-.373 (4.966)	-.069 (.549)					-245.17 (2.675)	.907
(4.15)Y_{17}	- .1134 (1.312)		.9949 (8.496)						-.336 (4.109)						143.88 (2.344)	.859
(4.16)Y_{70}			.5261 (8.3264)		- .1629 (1.973)										164.91 (7.105)	.707
(4.4')Y_{47}				- .5127 (4.005)							.206 (4.194)	- .320 (2.192)	.329 (2.392)	.151 (.966)	- 62.29 (1.518)	.705

The following non-stochastic equations complete the system:

$$(4.8)\quad Y'_1 = -289.60 + .2524\,Y_1 + 1.1457\,Y_7$$

$$(4.23)\quad Y'_2 = -57.25 + .1838\,Y_2 + .3108\,Y_8$$

$$(4.24)\quad Y'_3 = -137.45 + .2011\,Y_3 + .6895\,Y_9$$

$$(4.25)\quad Y'_4 = -69.47 + .1651\,Y_4 + .4241\,Y_{10}$$

$$(4.26)\quad Y'_5 = -28.04 + .1104\,Y_5 + .2560\,Y_{11}$$

$$(4.27)\quad Y'_6 = -17.15 + .2718\,Y_6 + .0643\,Y_{12}$$

$$(4.17)\quad Y_{70} = -264.27 + .6219\,Y'_{59} + 4.339\,X_{40}$$

$$(4.5)\quad Y'_1 + Y'_2 + Y'_3 + Y'_4 + Y'_5 + Y'_6 = Y_{15} + Y_{47} + X_{106}$$

Table 14. Model 4, Reduced Form Coefficients.*

	Y_{18} t-2	X_{29}	X_{30}	X_{31}	X_{19} t-1	X_{19} t-2	X_{15}	X_{90} t-2	X_{81} t-3	X_{86} t-5
Y_1	-1.8050	2.9362	1.5978	.4251	- .3136	.4932	-2.8975	.6238	- .0140	.0153
Y_2	-1.8165	.3793	.1464	- .5216	- .0594	.1467	-2.8082	.1186	- .0345	.0071
Y_3	-1.4662	.0652	1.3468	-1.3870	.3268	.7949	-3.3001	.0183	- .0010	.0291
Y_4	-2.5030	1.7856	1.4625	- .9129	.1762	.7871	-2.4478	- .2141	- .0113	.0129
Y_5	-1.3481	.0986	1.4314	- .8317	.0532	.4673	-1.6023	.0335	- .0018	.0020
Y_6	- .0735	- .0640	- .0205	.0009	.0177	.0405	- .0402	- .0100	.0006	- .0006
Y_7	- .0397	- .0356	- .0014	- .3484	- .0335	- .0501	- .0975	.0085	- .0005	.0005
Y_8	.0017	- .0334	- .0409	- .3671	- .0406	- .0498	- .0406	.0036	- .0002	.0002
Y_9	.1040	- .0297	- .0419	.1116	- .0078	- .0057	.0176	- .0015	.0001	- .0001
Y_{10}	.0436	- .0291	.0113	- .0412	- .0284	- .0330	.0395	- .0035	.0002	- .0002
Y_{11}	- .0022	- .0598	- .0473	- .0487	- .0304	- .0526	- .0421	.0037	- .0002	.0002
Y_{12}	- .1164	- .1524	- .1302	- .0066	.0897	- .0064	- .0954	.0083	- .0005	.0005
Y_1'	- .0511	.7003	.4017	.2919	- .1775	.0671	- .8431	.1672	- .0041	.0044
Y_2'	- .3333	.0593	.0141	- .2099	- .0235	.0115	- .5287	.0229	- .0064	.0014
Y_3'	- .2231	- .0074	.2419	- .2020	.0604	.1559	- .6515	.0026	- .0001	.0057
Y_4'	- .3947	.2824	.2562	- .1682	.0170	.1159	- .3873	.0339	- .0019	.0020
Y_5'	- .1494	- .0044	.1459	- .1043	.0136	.0381	- .1876	.0046	- .0003	.0003
Y_6'	- .0275	- .0272	- .0139	- .0002	.0106	.0106	- .0171	- .0022	.0001	- .0001
Y_{15}	- .9660	.5947	.6142	- .5790	.0233	.2366	-1.5507	.1358	- .0075	.0082
Y_{17}	1.4267	- .8783	- .9072	.8551	.0345	.3495	2.2902	- .2006	.0110	.0121
Y_{18}	1.3239	- .8150	- .8419	.7935	.0320	- .3243	2.1252	- .1861	.0102	- .0112
Y_{70}	.8045	- .4953	- .5116	.4822	.0194	- .1971	1.2915	- .1131	.0062	- .0068
Y_{59}	1.2936	- .7964	- .8226	.7754	.0312	- .3169	2.0767	- .1819	.0100	- .0109
Y_{47}	- .6632	.4083	.4218	- .3975	- .0160	.1625	-1.0647	.0932	- .0051	.0056

Table 14. Continued.

	X_{85} t-3	X_{87} t-4	Y_7 t-1	Y_8 t-1	Y_9 t-1	Y_{10} t-1	Y_{11} t-1	Y_{12} t-1	X_{75}	X_3
Y_1	.0269	.0090	1.8215	.3708	.2829	.7457	.2581	.0716	- .1707	- .0942
Y_2	.0126	.0042	.8513	.1733	.1322	.3485	.1206	.0335	- .0798	- .0440
Y_3	.0019	.0006	.1315	.0267	.0204	.0538	.0186	.0052	- .0123	- .0068
Y_4	.0827	.0075	1.5369	.3128	.2387	.6292	.2178	.0604	- .1441	- .0795
Y_5	.0035	.0312	.2403	.0489	.0373	.0984	.0341	.0094	- .0225	- .0124
Y_6	- .0011	- .0004	- .0721	- .0146	- .0112	- .0295	- .0102	- .0028	.0067	.0037
Y_7	.0009	.0003	.6463	.0124	.0095	.0251	.0087	.0024	- .0057	- .0032
Y_8	.0004	.0001	.0255	.4442	.0040	.0104	.0004	.0010	- .0024	- .0013
Y_9	- .0001	- .0001	- .0111	- .0022	.1492	- .0045	- .0016	- .0004	.0010	.0006
Y_{10}	- .0004	- .0001	- .0248	- .0050	- .0039	.6368	- .0035	- .0010	.0023	.0013
Y_{11}	.0004	.0001	.0264	.0054	.0041	.0108	.3747	.0010	- .0025	- .0014
Y_{12}	.0009	.0003	.0600	.0122	.0093	.0245	.0085	.4123	- .0056	- .0031
Y_1^1	.0078	.0026	1.2002	.1079	.0823	.2169	.0751	.0208	- .0497	- .0274
Y_2^1	.0024	.0008	.1644	.1699	.0255	.0673	.0233	.0065	- .0154	- .0085
Y_3^1	.0003	.0001	.0188	.0038	.1070	.0077	.0027	.0007	- .0017	- .0010
Y_4^1	.0135	.0012	.2432	.0495	.0378	.3740	.0344	.0096	- .0228	- .0126
Y_5^1	.0005	.0035	.0333	.0068	.0052	.0136	.0997	.0013	- .0031	- .0017
Y_6^1	- .0002	- .0001	- .0157	- .0032	- .0025	- .0064	- .0022	.0257	.0015	.0008
Y_{15}	.0144	.0048	.9748	.1948	.1514	.3991	.1381	.0383	- .0285	- .0157
Y_{17}	- .0213	- .0071	-1.4397	- .2931	- .2236	- .5894	- .2040	- .0566	.1278	.0705
Y_{18}	- .0197	- .0066	-1.3360	- .2719	- .2075	- .5469	- .1893	- .0525	.1252	.0690
Y_{70}	- .0120	- .0040	- .8119	- .1653	- .1261	- .3324	- .1150	- .0319	.0761	.0420
Y_{59}	- .0193	- .0064	-1.3055	- .2658	- .2028	- .5345	- .1850	- .0513	.1223	.0675
Y_{47}	.0098	.0033	.6693	.1362	.1040	.2740	.0948	.0263	- .0627	- .0346

Table 14. Continued.

	X_{56}	X_{49}	X_{38}	X_{28}	X_{00}	X_{40}	X_{44}	Y_{47} t-1	X_{106}	Π^*
Y_1	-1.3836	.4283	.2031	- .5987	1.0046	-11.2297	-1.0328	- .4740	-2.7177	2796.56
Y_2	- .6466	.2001	.0949	- .2798	.4695	- 5.2483	- .4827	- .2215	-1.2701	2100.73
Y_3	- .0998	.0309	.0146	- .0432	.0725	- .8105	- .0745	- .0342	- .1961	519.67
Y_4	-1.1674	.3614	.1714	- .5051	.8476	- 9.4753	- .8715	- .4000	-2.2931	2653.50
Y_5	- .1825	.0565	.0268	- .0790	.1326	- 1.4817	- .1363	- .0625	- .3586	430.96
Y_6	.0547	- .0170	- .0080	.0887	- .0398	.4447	.0409	.0188	.1076	-107.86
Y_7	- .0466	.0144	.0068	- .0201	.0338	- .3780	- .0347	- .0159	- .0915	211.20
Y_8	- .0194	.0060	.0028	- .0084	.0141	- .1573	- .0145	- .0066	- .0381	150.57
Y_9	.0084	- .0026	- .0012	.0036	- .0061	.0684	.0063	.0029	.0165	130.49
Y_{10}	.0189	- .0058	- .0028	.0082	- .0137	.1532	.0141	.0065	.0370	20.28
Y_{11}	- .0201	.0062	.0029	- .0087	.0145	- .1631	- .0150	- .0069	- .0395	113.20
Y_{12}	- .0456	.0141	.0067	- .0197	.0331	- .3698	- .0340	- .0156	- .0895	271.68
Y_1	- .4026	.1246	.0591	- .1742	.2923	-3.2675	- .3005	- .1379	- .7907	658.22
Y_2	- .1249	.0386	.0183	- .0540	.0907	-1.0135	- .0932	- .0428	- .2453	375.66
Y_3	- .0143	.0044	.0021	- .0062	.0104	- .1158	- .0106	- .0049	- .0280	57.03
Y_4	- .1847	.0572	.0271	- .0799	.1341	-1.4994	- .1379	- .0633	- .3628	377.22
Y_5	- .0253	.0078	.0037	- .0109	.0184	- .2053	- .0189	- .0087	- .0497	48.52
Y_6	.0120	- .0037	- .0017	.0228	- .0087	.0971	.0089	.0041	.0235	29.35
Y_{15}	- .2314	.0716	.0339	- .3204	.5376	-6.0100	- .5527	- .2537	-1.4545	1015.75
Y_{17}	1.0358	- .6567	- .1520	.4732	- .7940	8.8761	.8163	.3747	2.1481	-1862.23
Y_{18}	1.0147	- .3141	- .1489	.4391	- .7368	8.2365	.7575	.3477	1.9933	-1900.62
Y_{70}	.6167	- .1909	- .0905	.2281	- .3875	4.3323	.3984	.1829	1.2114	- 911.82
Y_{59}	.9916	- .3070	- .1456	.3667	- .6232	- .0106	.6407	.2941	1.9478	-1041.25
Y_{47}	- .5084	.1574	.0746	.0179	- .0005	.0054	.0005	.0002	- .9987	471.56

*Intercept.

The meaning of each variable used in the estimation of the four models is as follows:

Endogenous Variables:

Y_1' = volume of beef obtained from slaughter of steers (thousand tons)

Y_2' = volume of beef obtained from slaughter of young steers (thousand tons)

Y_3' = volume of beef obtained from slaughter of cows (thousand tons)

Y_4' = volume of beef obtained from slaughter of heifers (thousand tons)

Y_5' = volume of beef obtained from slaughter of calves (thousand tons)

Y_6' = volume of beef obtained from slaughter of bulls (thousand tons)

Y_1 = number of steers slaughtered (thousand head)

Y_2 = number of young steers slaughtered (thousand head)

Y_3 = number of cows slaughtered (thousand head)

Y_4 = number of heifers slaughtered (thousand head)

Y_5 = number of calves slaughtered (thousand head)

Y_6 = number of bulls slaughtered (thousand head)

Y_7 = ADW of steers slaughtered (kilograms)

Y_8 = ADW of young steers slaughtered (kilograms)

Y_9 = ADW of cows slaughtered (kilograms)

Y_{10} = ADW of heifers slaughtered (kilograms)

Y_{11} = ADW of calves slaughtered (kilograms)

Y_{12} = ADW of bulls slaughtered (kilograms)

Y_{13} = ADW of all animals slaughtered but steers (kilograms)

Y_{15} = domestic consumption (thousand tons)

Y_{17} = retail price of beef (pesos of 1960 per 1/10 kilogram equivalent carcass weight)

Y_{18} = farm price of beef (pesos of 1960 per 1/10 kilogram equivalent carcass weight)

Y_{21} = slaughter of all animals but steers (thousand head)

Y_{47} = volume of exports (thousand tons equivalent carcass weight)

Y'_{59} = average FOB price obtained for exports (dollars per ton equivalent carcass weight)

Y_{70} = average net export price (pesos of 1960 per 1/10 kilogram equivalent carcass weight)

Predetermined Variables

X_3 = population (thousand inhabitants)

X_{15} = net change in the balance of loans granted to the cattle sector (in hundred million pesos of 1960).

X_{19} = rainfall during the quarter expressed as a percentage of the mean rainfall of the corresponding quarter.

X_{28} = trend factor ($X_{28} = 1000 + 10.t$; $t = 1$ for I/1958 and $t = 52$ for IV/1970)

X_{29} = seasonal dummy assuming the value of 100 in quarter I (summer), zero otherwise.

X_{30} = seasonal dummy assuming the value of 100 in quarter II (fall), zero otherwise.

X_{31} = seasonal dummy assuming the value of 100 in quarter IV (spring), zero otherwise.

X_{38} = beefless days dummy.

X_{40} = net effective exchange rate (pesos of 1960 per dollar)

X_{44} = average price of Danish export type of steer (dollars per ton)

X_{49} = dummy variable assuming the value of 100 when maximum retail prices for beef were established, zero otherwise.

X_{56} = average wholesale price of fish (pesos of 1960 per 1/10 kilogram)

X_{75} = average official settlement wage rate (cents of 1960 per hour)

X_{81} = stock of young steers at the beginning of the period (thousand heads).

X_{85} = stock of heifers at the beginning of the period (thousand heads)

X_{86} = stock of cows at the beginning of the period (thousand heads)

X_{87} = stock of calves at the beginning of the period (thousand heads)

X_{88} = stock of all animals but steers at the beginning of the period (thousand heads).

X_{90} = three quarters moving average of stock of steers at the beginning of the period (thousand heads).

X_{106} = exports on foot (thousand tons equivalent carcass weight)

X_{00} = dummy variable assuming the value of 100 for the period in which shipments to England were supressed because of the hoof and mouth disease, zero otherwise.

APPENDIX C

LINEARIZATION OF NON-LINEAR EQUATIONS

APPENDIX C

LINEARIZATION OF NON-LINEAR EQUATIONS

The last three models - presented in Appendix B - contain equations non-linear in the variables. They are non-stochastic equations defining the volume of meat (Y'_j) obtained from the slaughter of each category (j) of animals as the product of the number of animals (Y_j) times their corresponding average dressed weight (Y_k); or defining the net export price (Y_{70}) as the product of FOB price (Y'_{59}) times the net effective exchange rate (X_{40}). That is:

(1) $Y'_{jt} = Y_{jt} \cdot Y_{kt} / 1000$ where $j = 1,\ldots,6,21$

(2) $Y_{70t} = Y'_{59t} \cdot X_{40t} / 100$ and $k = 7,\ldots,13$

In order to expand these equations by means of Taylor's series, they are denoted - neglecting subscripts - as follows:

$$Z = X \cdot Y = f(a+x,b+y) = (a+x)\cdot(b+y) = a\cdot b + a\cdot y + b\cdot x + x\cdot y$$

where $a = \bar{X}$; $b = \bar{Y}$; $x = (X-\bar{X})$ and $y = (Y-\bar{Y})$

The successive partial derivatives evaluated at mean values ($x = 0$ and $y = 0$) are:

$$f'_x = b + y = b$$

$$f'_y = a + x = a$$

$$f''_x = 0$$

$$f''_y = 0$$

$$f''_{xy} = 1$$

Expanding $Z = (a+x)\cdot(b+y)$ by Taylor's series the following relation is obtained:

$$\begin{aligned} Z &= a\cdot b + b\cdot x + a\cdot y + (1/2!)\cdot 2\cdot x\cdot y + 0 + \ldots + 0 \\ &= a\cdot b + b\cdot x + a\cdot y + x\cdot y \\ &= \bar{X}\cdot\bar{Y} + \bar{Y}\cdot(X-\bar{X}) + \bar{X}\cdot(Y-\bar{Y}) + (X-\bar{X})\cdot(Y-\bar{Y}) \\ &= \bar{Y}\cdot X + \bar{X}\cdot Y - \bar{X}\cdot\bar{Y} + (X-\bar{X})\cdot(Y-\bar{Y}) \end{aligned}$$

When the last term - the non-linear term - is neglected, the error of linearization for every observation is the cross-product of the deviations about the means. It is defined as

$$e_t = Z_t - \tilde{Z}_t = \cdot\, x_t \cdot Y_t$$

$\tilde{Z}_t$ being the approximated value of Z_t obtained on the basis of the linearization equation

$$\tilde{Z}_t = \bar{Y}\cdot X + \bar{X}\cdot Y - \bar{X}.\bar{Y}$$

In general, the error of linearization will be smaller the smaller are the coefficients of variation of the variables X and Y. Means, standard deviations and coefficients of variation of the respective variables are presented in Table 15. Note that while the number of animals slaughtered (Y_j; $j = 1,\ldots,6,21$) vary sub-

Table 15. Means, Standard Deviations and Coefficients of Variation of the Variables Present in Non-Linear Equations, Period I/1960-IV/1970.

Variable (*)	Mean	Standard Deviation	Coefficient of Variation
Y_1	1145.7	160.4	.1400
Y_2	310.8	75.3	.2422
Y_3	689.5	166.2	.2410
Y_4	424.1	118.9	.2803
Y_5	256.0	126.6	.4945
Y_6	64.3	12.8	.1990
Y_7	252.4	7.4	.0293
Y_8	183.8	4.8	.0261
Y_9	201.1	10.7	.0532
Y_{10}	165.1	6.4	.0387
Y_{11}	110.4	5.7	.0516
Y_{12}	271.8	15.8	.0583
Y_{13}	179.2	9.4	.0526
Y_{21}	1744.9	438.7	.2514
Y'_{59}	433.9	73.2	.1686
Y_{70}	266.0	30.2	.1134
X_{40}	62.2	10.3	.1651

*The meaning of each variable is explained in Appendix B.

stantially, their average dressed weight (Y_k; k = 7,...,13) are relatively constant. The coefficients of variation of the latter ones range from .026 to .058. Thus, one could expect small errors of linearization in the corresponding equations (1). Note, however, that such is not the case for the net export price - FOB price transformation identity (2); hence, larger errors of linearization can be expected given that the coefficient of variation of FOB price (Y'_{59}) is .169 and that of net effective exchange rate (X_{40}) is .165.

Although in the extreme case, when one of the variables is constant, the error is equal to zero for every observation, it is not enough for one of the variables to be relatively constant for the error to be small. The reason is that the average error ($\bar{e}$) tends to approach the covariance (X,Y) as the sample size increases.

$$\bar{e} = \frac{\sum_n x \cdot y}{n} \rightarrow \frac{\sum_n x \cdot y}{n-1} = \text{cov}\ (X,Y)$$

$$\text{as } n \rightarrow \infty$$

That is, the average error depends on how the variables X and Y vary together. Errors may be large in the case of some observations. So one should consider in this case other dimensions of the error such as the coefficient of variation of the error about the true mean ($\bar{Z}$), which gives more weight to large errors. Mean errors, mean absolute errors and coefficients of variation of the errors,

Table 16. Mean Errors of Linearization, Mean Absolute Errors and Coefficients of Variation of the Errors Relatives to the True Means, I/1960-IV/1970.

Equation defining	Mean Error about the true mean 1/	Mean absolute error about the true mean 2/	Coefficient of variation about the true mean 3/
Y'_1 : Volume of meat obtained from steers	.00126	.00262	.00448
Y'_2 : Volume of meat obtained from young steers	.00188	.00440	.00709
Y'_3 : Volume of meat obtained from cows	-.00890	.01026	.01716
Y'_4 : Volume of meat obtained from heifers	-.00779	.00887	.01402
Y'_5 : Volume of meat obtained from calves	.00750	.01614	.02286
Y'_6 : Volume of meat obtained from bulls	.00138	.00717	.03057
Y'_{21}: Volume of meat obtained from animals other than steers	-.01140	.01165	.02155
Y_{70}: Net export price	-.02112	.02184	.03380

1/ Mean error about the true mean is defined as $\frac{\sum_n x.y}{\sum_n Z}$

2/ Mean absolute error about the true mean is defined as $\frac{\sum_n |x.y|}{\sum_n Z}$

3/ Coefficient of variation of the error about the true mean is defined as

$$\frac{n \cdot \sqrt{\sum_n [x \cdot y]^2}}{\sqrt{n-1}\,[\sum_n Z]}$$

the notation is explained in the text.

all relatives to the true means ($\bar{Z}$'s) are presented in Table 16 for each of the linearized equations. Note that in general the errors appear to be small. However, given the relative magnitude of the variables, the errors are not negligible in the case of Y_3', Y_4', Y_5', Y_{21}' and Y_{70}. That is, although the linearization procedure utilized allows for the solution of the model, the approximation is not as close as one might desire.

APPENDIX D

ORDINARY LEAST SQUARES ESTIMATES

APPENDIX D

ORDINARY LEAST SQUARES ESTIMATES

Ordinary least squares estimates of the stochastic equations present in the four alternative models are presented below. The equations are numbered according to the second digit of the code used in the presentation of the two stage least squares estimates. Figure in parentheses below the coefficients are t ratios in absolute values. The meaning of each variable is described in Appendix B.

(1) slaughter supply of steers: $R^2 = .570$

$$Y_1 = \underset{(1.029)}{208.39} - \underset{(3.418)}{1.392}\, Y_{18} + \underset{(2.996)}{1.831}\, X_{29} + \underset{(.853)}{.451}\, X_{30} + \underset{(2.855)}{1.509}\, X_{31}$$

$$- \underset{(.366)t-1}{.269}\, X_{19} + \underset{(.686)t-2}{.496}\, X_{19} + \underset{(6.190)t-2}{.371}\, X_{90}$$

(2) slaughter supply of all animals other than steers: $R^2 = .779$

$$Y_{21} = \underset{(.623)}{309.05} - \underset{(3.348)}{2.267}\, Y_{18} - \underset{(4.882)t-2}{3.462}\, Y_{18} + \underset{(1.341)}{.875}\, X_{29} + \underset{(3.615)}{2.130}\, X_{30}$$

$$+ \underset{(1.915)}{1.161}\, X_{31} + \underset{(.053)t-1}{.046}\, X_{19} + \underset{(1.101)t-2}{.942}\, X_{19} - \underset{(2.536)}{5.327}\, X_{15} + \underset{(6.442)t-5}{.051}\, X_{88}$$

(3) domestic demand at the farm level: $R^2 = .893$

$$Y_{15} = \underset{(2.570)}{-228.65} - \underset{(10.174)}{.756}\, Y_{18} + \underset{(2.232)}{.052}\, X_{75} + \underset{(5.384)}{.030}\, X_3 + \underset{(1.665)}{.359}\, X_{56}$$

$$- \underset{(2.409)}{.300}\, X_{38}$$

(3') domestic demand at the retail level: $R^2 = .893$

$$Y_{15} = \underset{(2.809)}{-254.99} - \underset{(9.379)}{.658}\, Y_{17} + \underset{(2.615)}{.059}\, X_{75} + \underset{(5.991)}{.032}\, X_{3} + \underset{(2.264)}{.481}\, X_{56}$$

$$- \underset{(.653)}{.081}\, X_{38} - \underset{(4.997)}{.375}\, X_{49}$$

(4) demand for exports at the farm level: $R^2 = .712$

$$Y_{47} = \underset{(1.478)}{-199.28} - \underset{(3.683)}{.429}\, Y_{18} + \underset{(1.477)}{.110}\, X_{28} + \underset{(2.356)}{1.873}\, X_{40} + \underset{(2.139)}{.263}\, X_{44}$$

$$- \underset{(.668)}{.105}\, X_{00} + \underset{(3.578)}{.505}\, Y_{47}$$

(4') demand for exports at the FOB level: $R^2 = .705$

$$Y_{47} = - \underset{(1.426)}{.57.70} - \underset{(4.070)}{.487}\, Y'_{59} + \underset{(4.142)}{.200}\, X_{28} + \underset{(2.295)}{.305}\, X_{44} - \underset{(2.189)}{.319}\, X_{00}$$

$$+ \underset{(1.124)t-1}{.171}\, Y_{47}$$

(6) average weight of steers slaughtered: $R^2 = .668$

$$Y_{7} = \underset{(3.685)}{128.26} - \underset{(2.499)}{.05}\, Y_{18} + \underset{(1.222)t-2}{.029}\, Y_{18} - \underset{(3.368)}{.073}\, X_{29} - \underset{(1.974)}{.041}\, X_{30}$$

$$- \underset{(1.449)}{.031}\, X_{31} - \underset{(1.027)\ t-1}{.031}\, X_{19} - \underset{(2.246)\ t-2}{.066}\, X_{19} + \underset{(4.636)\ t-1}{.571}\, Y_{7}$$

(7) average weight of all animals slaughtered excluding steers: $R^2 = .733$

$$Y_{13} = \underset{(4.641)}{95.18} + \underset{(1.333)}{.035}\, Y_{18} + \underset{(2.188)_{t-2}}{.067}\, Y_{18} - \underset{(3.031)}{.085}\, X_{29} - \underset{(3.599)}{.088}\, X_{30}$$

$$- \underset{(.016)}{.0004}\, X_{31} + \underset{(.369)t-1}{.012}\, X_{19} - \underset{(1.293)_{t-2}}{.043}\, X_{19} + \underset{(2.712)_{t-1}}{.373}\, Y_{13}$$

(10) slaughter supply of young steers: $R^2 = .779$

$$Y_{2} = \underset{(6.579)}{880.78} - \underset{(2.703)}{.553}\, Y_{18} - \underset{(4.439)_{t-2}}{.987}\, Y_{15} - \underset{(.750)}{.148}\, X_{29} - \underset{(2.221)}{.392}\, X_{30}$$

$$- \underset{(.127)}{.223}\, X_{31} - \underset{(.172)_{t-1}}{.045}\, X_{19} - \underset{(.199)t-2}{.051}\, X_{19} - \underset{(2.406)}{1.542}\, X_{15} - \underset{(1.872)t-3}{.028}\, X_{81}$$

(11) slaughter supply of cows: $R^2 = .819$

$$Y_3 = \underset{(1.171)}{320.00} + \underset{(.050)}{.021}\, Y_{18} - \underset{(3.506)}{1.407}\, Y_{18_{t-2}} - \underset{(.068)}{.027}\, X_{29} + \underset{(3.518)}{1.260}\, X_{30}$$

$$- \underset{(3.593)}{1.316}\, X_{31} + \underset{(.615)}{.322}\, X_{19_{t-1}} + \underset{(1.505)}{.776}\, X_{19_{t-2}} - \underset{(2.531)}{3.216}\, X_{15} + \underset{(2.665)}{.028}\, X_{86_{t-5}}$$

(12) slaughter supply of heifers: $R^2 = .910$

$$Y_4 = \underset{(4.006)}{461.27} - \underset{(5.193)}{1.069}\, Y_{18} - \underset{(4.891)}{1.031}\, Y_{18_{t-2}} + \underset{(4.235)}{.841}\, X_{29} + \underset{(2.771)}{.491}\, X_{30}$$

$$- \underset{(.030)}{.005}\, X_{31} + \underset{(.792)}{.208}\, X_{19_{t-1}} + \underset{(1.646)}{.423}\, X_{19_{t-2}} - \underset{(.138)}{.088}\, X_{15} + \underset{(4.524)}{.060}\, X_{86_{t-3}}$$

(13) slaughter supply of calves: $R^2 = .833$

$$Y_5 = \underset{(.438)}{84.02} - \underset{(.510)}{.159}\, Y_{18} - \underset{(3.817)}{1.120}\, Y_{18_{t-2}} - \underset{(.173)}{.050}\, X_{29} + \underset{(4.980)}{1.279}\, X_{30}$$

$$- \underset{(2.685)}{.691}\, X_{31} + \underset{(.152)}{.058}\, X_{19_{t-1}} + \underset{(1.101)}{.411}\, X_{19_{t-2}} - \underset{(1.337)}{1.241}\, X_{15} + \underset{(3.169)}{.030}\, X_{87_{t-4}}$$

(14) slaughter supply of bulls: $R^2 = .827$

$$Y_6 = - \underset{(.394)}{5.29} + \underset{(1.712)}{.053}\, Y_{18} - \underset{(4.841)}{.144}\, Y_{18_{t-2}} - \underset{(.672)}{.020}\, X_{29} + \underset{(.925)}{.025}\, X_{30}$$

$$- \underset{(1.587)}{.042}\, X_{31} + \underset{(.414)}{.016}\, X_{19_{t-1}} + \underset{(1.494)}{.058}\, X_{19_{t-2}} - \underset{(1.606)}{.154}\, X_{15} + \underset{(8.621)}{.066}\, X_{28}$$

(15) domestic price spread: $R^2 = .859$

$$Y_{17} = \underset{(2.417)}{139.51} - \underset{(1.316)}{.108}\, Y_{15} + \underset{(9.124)}{1.003}\, Y_{18} - \underset{(4.196)}{.339}\, X_{49}$$

(16) price spread of exports: $R^2 = .709$

$$Y_{70} = \underset{(7.756)}{171.65} - \underset{(2.143)}{.169}\, Y_{47} + \underset{(8.257)}{.502}\, Y_{18}$$

(18) average weight of young steers slaughtered: $R^2 = .537$

$$Y_8 = \underset{(4.452)}{113.60} - \underset{(.561)}{.010}\, Y_{18} + \underset{(1.153)_{t-2}}{.020}\, Y_{18} - \underset{(2.879)}{.049}\, X_{29} - \underset{(3.550)}{.057}\, X_{30}$$

$$- \underset{(2.030)}{.035}\, X_{31} - \underset{(1.818)_{t-1}}{.042}\, X_{19} - \underset{(2.467)_{t-2}}{.057}\, X_{19} + \underset{(3.275)_{t-1}}{.440}\, Y_8$$

(19) average weight of cows slaughtered: $R^2 = .492$

$$Y_9 = \underset{(4.970)}{146.40} + \underset{(.100)}{.004}\, Y_{18} + \underset{(2.202)_{t-2}}{.096}\, Y_{18} - \underset{(.544)}{.024}\, X_{29} - \underset{(.932)}{.035}\, X_{30}$$

$$+ \underset{(2.840)}{.106}\, X_{31} - \underset{(.138)_{t-1}}{.007}\, X_{19} - \underset{(.054)_{t-2}}{.003}\, X_{19} + \underset{(.942)_{t-1}}{.152}\, Y_9$$

(20) average weight of heifers slaughtered: $R^2 = .781$

$$Y_{10} = \underset{(3.260)}{55.49} + \underset{(.799)}{.013}\, Y_{18} + \underset{(1.264)_{t-2}}{.023}\, Y_{18} - \underset{(.953)}{.015}\, X_{29} + \underset{(1.799)}{.027}\, X_{30}$$

$$- \underset{(3.885)}{.056}\, X_{31} - \underset{(1.328)_{t-1}}{.028}\, X_{19} - \underset{(1.301)_{t-2}}{.027}\, X_{19} + \underset{(5.947)_{t-1}}{.650}\, Y_{10}$$

(21) average weight of calves slaughtered: $R^2 = .424$

$$Y_{11} = \underset{(4.318)}{74.91} - \underset{(.679)}{.016}\, Y_{18} + \underset{(.923)_{t-2}}{.021}\, Y_{18} - \underset{(3.404)}{.076}\, X_{29} - \underset{(3.069)}{.064}\, X_{30}$$

$$- \underset{(1.439)}{.033}\, X_{31} + \underset{(.984)_{t-1}}{.030}\, X_{19} - \underset{(1.970)_{t-2}}{.059}\, X_{19} + \underset{(2.424)_{t-1}}{.376}\, Y_{11}$$

(22) average weight of bulls slaughtered: $R^2 = .585$

$$Y_{12} = \underset{(4.297)}{186.68} - \underset{(.646)}{.036}\, Y_{18} - \underset{(1.084)_{t-2}}{.064}\, Y_{18} - \underset{(3.058)}{.188}\, X_{29} - \underset{(3.389)}{.168}\, X_{30}$$

$$+ \underset{(.550)}{.029}\, X_{31} + \underset{(1.262)_{t-1}}{.089}\, X_{19} - \underset{(.303)_{t-2}}{.022}\, X_{19} + \underset{(2.733)_{t-1}}{.047}\, Y_{12}$$

APPENDIX E

DATA USED IN THE ESTIMATION

APPENDIX E

DATA USED IN THE ESTIMATION

The estimation of the model required quarterly information on slaughter per category of animals, average slaughter weights, consumption, exports, and prices as well as on the variables affecting them. Since the data on the relevant variables is either published on annual or in incomplete form, a considerable amount of computational work was required to generate a consistent quarterly time series for each of the variables involved. The series were chosen and elaborated so as to approximate as closely as possible the economic variables. The source of each series and the computational procedure utilized to obtain each empirical variable is described below.

Data on Slaughter per Category of Animals

Annual data on "recorded slaughter" per category of animals is available for the whole country. Total slaughter per category is defined as the sum of "recorded slaughter" plus "exports on foot" plus "on-farm slaughter." Out of these three components of total slaughter supply "exports on foot" are only available on monthly basis. However, monthly information is also available on "recorded sales for slaughter and exports on foot." This latter includes sales for

slaughter at the principal central markets,[1] local auctions, direct purchases on farms by central packers,[2] recorded private sales,[3] and other recorded sales.[4] The total of "recorded sales to slaughter and exports on foot" represents from sixty to eighty five percent of total slaughter. The procedure adopted here to obtain quarterly series of slaughter per category is as follows:

1. quarterly series of "recorded sales for slaughter and exports on foot" were obtained for each category of animals from monthly data for each of the marketing outlets,
2. quarterly series of "recorded sales for slaughter" were obtained by subtracting exports on foot,
3. annual "unrecorded sales for slaughter" were obtained as the difference between "recorded sales for slaughter" and "recorded slaughter,"[5]
4. annual "unrecorded sales for slaughter" were distributed among quarters according to the quarterly distribution of "recorded sales for slaughter,"
5. official annual estimates of "slaughter on farm" were first distributed among categories of animals according to the following

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[1] Central Markets of Liniers, Rosario, Cordoba, Santa Fe, and Tucuman.

[2] Includes Frigorificos Centrales y Grandes Fabricas Regionales.

[3] Ventas Particulares.

[4] Ventas en Consignacion.

[5] Official statistics of "recorded sales to slaughter" are identical to those of "recorded slaughter" in the case of young steers and heifers. This implies assuming that every sale of young steers and heifers for slaughter is recorded. Although this assumption is difficult to justify, it was adopted here in as much as any other assumption would yield annual slaughter series different from the official ones.

percentages:[6] 20 percent steers, 5 percent young steers, 20 percent heifers and 55 percent cows; and then were evenly distributed among quarters; and finally,

6. total quarterly slaughter per category of animals was obtained as the sum of quarterly "recorded sales for slaughter," plus quarterly "unrecorded sales for slaughter," plus quarterly "exports on foot," plus quarterly "on-farm slaughter." The resulting series are reproduced in Table 17.

It must be pointed out that this procedure may result in an overestimation of the seasonal pattern of slaughter since it is possible that much of the seasonal variation of sales is channelled through the central markets and other outlets in which sales are recorded. The fact that "unrecorded sales for slaughter" are mostly sales to small slaughter plants and butchers in the interior of the country (sales which are probably more seasonally stable) tends to support this argument. However, lack of evidence enabled the adoption of any other assumption about seasonal pattern of "unrecorded sales to slaughter."

Data on Average Dressed Weight of Animals Slaughtered

Average Live Weights (ALW_j) of each category (j) of animals are published monthly for each of the marketing outlets in which sales are "reported." Monthly dressing percentage (DP_j) of each category (j) of animals slaughtered in Central Packing Plants and Slaughter Houses[7] are also published monthly. The procedure used to generate

[6] Official estimates of on-farm slaughter represent from 2 to 3 percent of total slaughter and it is argued that more than 75 percent of it is slaughter of cows. Since this implies that more than 15 percent of the total number of cows slaughtered is slaughtered on farms, something that is difficult to believe, a smaller percentage (55 percent) is adopted here.

Table 17. Quarterly Slaughter per Category Plus Exports on Foot, I/1958 - IV/1970.*

Quarter	Male Calves (1)	Steers (2)	Young Steers (3)	Bulls (4)	Female Calves (5)	Heifers (6)	Cows (7)	Total (8)
1958-1	132,619	1,411,666	261,019	61,294	56,837	665,077	745,477	3,333,959
2	207,164	1,185,749	283,419	71,656	88,784	642,911	1,037,315	3,516,998
3	129,921	1,059,873	321,312	65,512	55,681	471,220	724,352	2,827,871
4	88,699	1,160,407	334,300	58,004	38,014	425,880	548,714	2,654,018
1959-1	59,370	884,125	210,790	43,878	25,444	340,025	538,259	2,101,891
2	138,253	1,097,839	249,515	50,707	59,252	388,714	711,475	2,695,755
3	82,656	1,005,641	262,017	39,981	35,424	289,514	592,436	2,307,669
4	52,513	1,152,224	215,923	34,457	22,505	281,097	380,683	2,139,402
1960-1	61,377	915,065	234,360	36,214	26,305	336,235	466,587	2,076,134
2	147,580	1,044,113	228,515	40,246	63,248	328,584	590,443	2,442,729
3	99,566	1,004,058	249,210	38,354	42,672	270,412	496,335	2,200,607
4	87,644	1,046,737	317,199	45,737	37,640	317,079	455,960	2,307,996
1961-1	102,229	1,046,256	349,489	50,104	41,756	421,870	603,976	2,615,680
2	212,228	1,051,532	348,761	56,415	86,685	420,494	773,635	2,949,750
3	142,949	888,359	375,589	48,823	58,388	347,292	616,925	2,478,325
4	106,471	864,960	404,132	49,768	43,488	372,269	493,153	2,334,241
1962-1	186,290	1,068,492	413,886	56,063	79,838	506,762	676,359	2,987,690
2	306,227	990,525	393,992	75,177	131,240	518,989	1,043,065	3,459,215
3	181,143	900,933	351,280	60,631	77,633	406,610	692,411	2,670,641
4	159,584	1,196,249	392,675	60,306	68,393	488,417	560,706	2,926,330
1963-1	297,534	1,171,180	355,344	65,125	85,886	600,180	978,324	3,553,573
2	355,905	1,109,870	235,083	72,321	102,735	529,362	1,033,204	3,438,480
3	236,054	1,374,176	308,037	71,090	68,139	467,928	799,225	3,324,649
4	129,155	1,414,964	300,275	63,101	37,282	382,824	579,596	2,907,197
1964-1	129,568	1,151,993	278,421	68,241	32,392	394,209	699,810	2,754,634
2	178,585	1,054,759	178,054	67,190	44,644	288,744	687,302	2,499,280
3	59,993	1,202,157	124,134	55,308	14,998	219,560	544,237	2,220,387
4	31,831	1,247,157	95,708	48,765	7,958	172,442	406,393	2,010,254

Table 17. Continued.

Quarter	Male Calves (1)	Steers (2)	Young Steers (3)	Bulls (4)	Female Calves (5)	Heifers (6)	Cows (7)	Total (8)
1965-1	84,359	1,245,039	160,023	62,308	18,518	236,148	529,800	2,336,195
2	141,445	1,161,790	196,437	62,054	31,049	238,075	647,615	2,478,465
3	76,827	954,336	248,170	55,955	16,865	220,249	527,507	2,099,909
4	71,087	1,171,339	256,591	54,751	15,604	250,622	486,812	2,306,806
1966-1	100,722	1,140,980	300,669	50,059	43,167	361,731	554,429	2,551,757
2	185,138	990,719	279,869	55,346	79,345	383,756	768,943	2,743,116
3	141,185	1,216,738	329,687	72,553	60,508	405,312	723,695	2,949,678
4	147,165	1,262,936	348,411	69,078	63,071	448,677	595,839	2,935,167
1967-1	184,167	1,275,074	328,118	76,644	101,806	532,865	777,503	3,276,177
2	296,421	1,186,609	346,939	77,757	163,860	545,436	947,632	3,564,654
3	188,736	1,202,147	359,200	63,060	104,332	432,138	720,676	3,070,289
4	158,425	1,082,411	353,952	73,957	87,577	436,500	634,300	2,827,122
1968-1	215,615	999,895	341,379	78,451	151,702	579,383	876,121	3,242,546
2	317,313	961,721	306,234	75,619	223,254	527,027	956,134	3,367,302
3	172,999	1,233,033	331,406	73,681	121,719	496,940	716,049	3,145,827
4	137,296	1,405,542	364,798	72,759	96,599	553,603	576,323	3,206,920
1969-1	179,226	1,232,068	347,517	67,686	157,033	603,466	721,194	3,308,190
2	260,739	1,317,710	310,769	74,475	228,453	584,413	833,064	3,609,623
3	175,956	1,466,768	350,287	86,190	154,168	551,529	804,567	3,589,465
4	151,689	1,534,083	375,678	79,631	132,905	580,523	639,219	3,493,728
1970-1	220,211	1,215,297	343,010	77,638	146,808	567,100	818,455	3,388,519
2	338,901	1,284,011	364,230	89,547	225,934	551,170	1,034,083	3,887,876
3	197,976	1,238,611	425,913	83,127	131,984	426,216	745,478	3,249,305
4	120,169	890,814	372,612	67,900	80,113	358,521	504,069	2,394,198

*Number of heads.

Source: Computed on the basis of information obtained from Junta Nacional de Carnes; see text for computational procedure.

series of ADW's per category of animals is as follows:

1. quarterly totals of volumes of liveweight meat per category were obtained for each of marketing outlets in which sales were "reported" by multiplying the number of animals times their corresponding ALW_j;

2. the resulting series were summed (over-all markets) and then divided by the corresponding sum (over-all markets) of the number of animals of each category slaughtered; in this way ALW_j for each (j) category of animals was obtained on the basis of "reported sales for slaughter;" and finally,

3. quarterly series of average dressed weights (ADW_j) for each (j) category of animals were obtained by multiplying quarterly ALW_{jt} times the corresponding quarterly average dressing percentages (DP_{jt}). The resulting series are reported in Table 18.

Data on Volume of Exports

The estimation of the model required quarterly data on volume of exports expressed in dressed weight (equivalent carcass weight: e.c.w.). Since the only data available refers to actual volume of exports per product and are expressed in product weight, they were converted to

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7/ Includes "Frigorigicos Centrales, Frigorifico Lisandro de la Torre y Mataderos incluidos en el regimen de tipificacion oficial." Source: Junta Nacional de Carnes (JNC), Resena Anual, several issues.

Table 18. Quarterly Average Dressed Weight of Animals Marketed for Slaughter and Export on Foot, Per Category, Period I/1958-IV/1970.*

Quarter	Steers (1)	Young Steers (2)	Cows (3)	Heifers (4)	Calves (5)	Bulls (6)	All Categories (7)
1958-1	250.57	177.10	212.30	162.52	108.92	295.50	211.47
2	241.16	178.98	201.16	167.36	108.83	275.80	200.43
3	245.59	185.95	196.69	162.46	111.08	275.97	204.31
4	250.46	182.80	209.24	162.97	111.19	292.62	213.65
1959-1	246.85	182.70	204.45	163.40	110.49	268.92	211.02
2	246.21	180.02	190.33	165.70	106.13	254.35	203.62
3	253.76	184.77	193.92	168.92	104.03	276.15	212.65
4	257.42	186.16	216.77	171.49	113.43	298.98	227.32
1960-1	249.75	185.50	213.69	167.84	109.96	275.16	215.67
2	245.19	183.00	198.09	169.59	111.60	253.48	206.43
3	254.27	182.54	207.11	171.41	123.36	278.26	217.29
4	252.66	183.25	214.73	163.85	114.04	289.38	216.63
1961-1	253.34	188.44	215.58	170.73	112.36	263.62	215.20
2	249.97	187.56	206.17	173.36	116.56	268.18	207.01
3	255.25	190.96	202.12	172.31	116.70	285.37	210.00
4	256.16	189.75	204.78	164.56	115.25	284.43	210.75
1962-1	252.82	181.58	197.86	161.12	107.01	265.32	202.20
2	253.16	183.23	185.65	164.96	106.74	260.21	193.24
3	264.53	184.88	194.86	169.77	111.56	269.40	206.85
4	263.26	179.79	198.65	160.84	109.47	286.64	211.08
1963-1	244.47	177.33	187.96	158.75	101.15	268.15	192.69
2	248.36	177.49	191.96	164.69	107.46	266.03	194.70
3	249.10	184.38	196.78	163.65	111.87	278.49	206.57
4	254.52	185.40	207.86	163.67	115.57	283.66	218.79
1964-1	237.14	179.14	204.00	166.06	109.10	269.42	205.96
2	238.68	171.86	204.03	168.56	106.77	255.74	204.97
3	246.15	179.02	206.69	172.30	106.45	291.17	221.83
4	251.30	181.14	237.88	172.15	104.40	297.37	236.55
1965-1	253.74	188.77	189.52	176.77	106.43	227.90	219.77
2	253.54	182.95	199.29	177.39	92.77	232.00	214.72
3	249.94	192.46	216.80	176.87	114.75	243.92	220.97
4	247.11	185.54	213.30	167.97	117.59	245.25	219.62
1966-1	246.73	185.03	207.31	166.36	112.64	255.84	212.12
2	250.18	180.80	197.28	168.21	109.25	268.95	203.59
3	252.43	183.87	203.61	168.67	115.62	266.81	212.28
4	247.96	183.82	210.91	163.49	116.37	279.86	211.24
1967-1	251.12	187.12	199.93	169.27	112.91	289.98	208.09
2	245.84	182.35	194.59	168.50	105.13	267.12	196.50
3	248.07	190.44	192.61	163.95	115.94	266.24	204.23
4	243.13	186.91	186.83	153.60	116.06	277.73	199.13

Table 18. continued.

Quarter	Steers (1)	Young Steers (2)	Cows (3)	Heifers (4)	Calves (5)	Bulls (6)	All Categories (7)
1968-1	239.52	173.53	186.77	148.17	103.90	266.52	187.29
2	249.38	176.31	186.65	157.37	106.90	260.93	187.91
3	266.02	188.51	190.95	160.07	110.53	280.88	209.81
4	268.04	188.39	207.64	158.78	116.84	297.53	218.90
1969-1	268.45	177.32	190.40	154.02	103.80	267.53	204.23
2	264.50	177.59	194.20	165.19	103.89	266.45	200.32
3	263.85	181.40	185.39	162.34	107.67	284.24	208.75
4	262.31	183.30	219.40	156.65	98.81	294.29	210.54
1970-1	252.47	187.02	202.73	157.88	110.96	283.11	213.78
2	253.91	186.58	195.68	162.01	110.30	272.68	183.33
3	254.74	191.99	194.98	162.01	113.95	281.92	221.33
4	254.46	190.51	206.26	156.93	115.35	292.34	146.15

*Kilograms per head.

Source: Computed on the basis of information obtained from Junta Nacional de Carnes; see text for computational procedure.

e.c.w. by means of fixed transformation coefficients generally accepted. These transformation coefficients reflect the amount of carcass beef required to produced one unit of each of the beef products exported, and are reproduced in Table 19.

Table 19. Transformation Coefficients of Beef Product-Weight into Beef Carcass-Weight.

Export type of product	Coefficient λ_k
1. Chilled Carcasses (cuartos enfriados)	1.05
2. Chilled Cuts (cortes enfriados)	1.50
3. Frozen Carcasses (cuartos congelados)	1.05
4. Frozen Cuts (cortes congelados)	1.50
5. Manufacture Type bone-in (manufactura con hueso)	1.05
6. Manufacture Type deboned (manufactura sin hueso)	1.50
7. Cooked and Frozen (cocida y congelada)	2.50
8. Canned Beef (carne vacuna enlatada)	2.50
9. Total Beef Exports (exportaciones totales)	variable*

*depends on the composition of exports in terms of products.

The basic series corresponding to beef exports per product (expressed in product weight) are presented in Table 20. This information is reproduced here in as much as it has been published only in incomplete form. The source of it are (a) Junta Nacional de Carnes (JNC), Monthly Bulletins several issues, (b) JNC, Boletin de Comercio Exterior, several issues; and (c) JNC, Oficina de Exportaciones, monthly accounting sheets. The series corresponding to beef exports per product (expressed in equivalent carcass weight) are presented in Table 21.

Table 20. Volume of Beef Exports Per Product, in Tons of Product Weight. Period I/1960-IV/1970.*

Quarter	Chilled Quarts (1)	Frozen Quarts (2)	Chilled Cuts (3)	Frozen Cuts (4)	Manufactured Type with Bone (5)	Manufactured Type Deboned (6)	Cooked & Frozen (7)	Canned (8)
1960-1	50898	9619	---	---	743	4743	482	11425
2	45697	13855	---	---	1300	8296	427	11330
3	47441	12512	---	---	1649	10522	722	14309
4	57054	10210	---	---	1458	9305	633	11805
1961-1	45334	11084	---	---	3017	10829	1092	12949
2	47968	13566	---	---	3610	12956	1300	21415
3	26511	10822	---	---	4419	15860	966	16771
4	34334	10471	---	---	3945	14159	815	11972
1962-1	42614	11812	---	---	4093	14234	1840	9046
2	43926	14770	---	---	8064	28039	1259	18881
3	40463	23329	---	---	8582	29840	901	15583
4	70675	23251	---	---	5673	19727	476	10864
1963-1	77006	16286	---	---	7667	21846	1823	15118
2	64669	26458	---	---	7173	20437	1448	21592
3	63321	50225	---	---	9736	27739	1090	20489
4	64072	48092	---	---	6854	19527	513	17480
1964-1	44526	45482	---	---	7956	15160	755	13957
2	40827	52476	---	---	7225	13778	998	14034
3	50262	29937	---	---	5192	9221	491	9410
4	45606	40389	---	---	5145	7619	959	9702
1965-1	39742	34161	---	---	6489	5661	1773	7425
2	41278	34465	---	---	7840	6839	2183	8281
3	34115	28961	---	---	6241	6812	1173	10392
4	45482	35540	---	---	8033	6083	1847	9038
1966-1	34306	37399	---	1638	7646	6319	1616	9131
2	38708	38220	---	3277	8864	10141	3092	10789
3	42653	44537	---	4915	10250	11863	4144	14641
4	42446	29600	---	6554	10275	11126	4121	14593

Table 20. Continued.

Quarter	Chilled Quarts (1)	Frozen Quarts (2)	Chilled cuts (3)	Frozen Cuts (4)	Manufactured Type with Bone (5)	Manufactured Type Deboned (6)	Cooked & Frozen (7)	Canned (8)
1967-1	37167	42373	965	8380	10272	19135	3133	15748
2	42048	31272	1414	11685	7351	23414	3224	17626
3	33195	21930	1619	9631	4355	13738	4438	21712
4	16727	21941	895	8142	3961	9172	5472	17890
1968-1	8964	20243	213	7806	5865	12404	7143	16590
2	8214	15398	1887	12361	4839	12421	7248	21883
3	9183	20902	4722	12915	7071	7377	6267	15968
4	12217	20542	5577	17928	11652	9849	5820	21993
1969-1	17027	14447	4406	20341	9823	14359	6911	18535
2	24956	20917	6549	22255	6361	15919	6993	19098
3	25583	27727	9200	25084	9253	18568	7377	18243
4	14345	26059	9065	29246	6797	18420	7640	18288
1970-1	7867	28700	7881	22627	8118	17080	6475	20047
2	13025	32026	9023	26198	8039	24130	7016	20529
3	11090	23003	10719	23075	5731	18457	11504	20205
4	5276	10649	4205	16668	3925	10444	4252	9075

Source: Junta Nacional de Carnes.

*In metric tons.

Table 21. Volume of Beef Exports Per Product, Equivalent Carcass Weight. Period I/1960-IV/1970.*

Quarter	Chilled Carcass (1)	Frozen Carcass (2)	Chilled Cuts (3)	Frozen Cuts (4)	Manufacture type with Bone (5)	Manufacture type Deboned (6)	Cooked and Frozen (7)	Canned Beef (8)	Total Beef Exports (9)
1960-1	53443	10099	---	---	780	7144	1205	28562	101203
2	47982	14548	---	---	1365	12443	1067	28325	105730
3	49813	13138	---	---	1731	15785	1805	35773	118045
4	59906	10720	---	---	1531	13957	1583	29512	117209
1961-1	47601	11638	---	---	3169	16246	2730	32373	113757
2	50366	14244	---	---	3790	19434	3250	53537	144621
3	27836	11363	---	---	4640	23792	2415	41927	111973
4	36051	10995	---	---	4141	21234	2037	29930	104388
1962-1	44745	12403	---	---	4299	21353	4600	22615	110015
2	46122	15508	---	---	8467	42058	3148	47203	162506
3	42486	24495	---	---	9010	44758	2252	38957	161958
4	74209	24414	---	---	5957	29591	1190	27160	162521
1963-1	80856	17100	---	---	8049	32761	4557	37795	181118
2	67902	27781	---	---	7531	30652	3620	53980	191466
3	66487	52736	---	---	10224	41613	2725	51222	225007
4	67276	50497	---	---	7197	29296	1283	43700	199249
1964-1	46752	47756	---	---	8354	22740	1887	34892	162381
2	42868	55100	---	---	7586	20667	2495	35085	163801
3	52776	31434	---	---	5452	13831	1228	23525	118246
4	47886	42408	---	---	5402	11429	2397	24255	133777
1965-1	41729	35869	---	---	6813	8491	4432	18563	115897
2	43342	36188	---	---	8232	10259	5458	20702	124181
3	35821	30409	---	---	6525	10218	2932	25980	111885
4	47756	37317	---	---	8435	9124	4618	22595	129845
1966-1	36021	39269	---	2457	8028	9478	4040	22828	122121
2	40644	40131	---	4915	9307	15212	7730	26972	144911
3	44786	46764	---	7373	10763	17794	10360	36603	174443
4	44568	31080	---	9831	10789	16689	10302	36482	159741

Table 21. Continued.

Quarter	Chilled Carcass (1)	Frozen Carcass (2)	Chilled Cuts (3)	Frozen Cuts (4)	Manufacture Type with Bone (5)	Manufacture Type with Bone (6)	Cooked and Frozen (7)	Canned Beef (8)	Total Beef Exports (9)
1967-1	39025	44492	1447	12570	10785	28702	7832	39370	184223
2	44150	32836	2121	17527	7718	35121	8060	44065	191598
3	34855	23026	2428	14446	4573	20607	11095	54280	165310
4	17563	23038	1342	12213	4159	13758	13680	44725	130478
1968-1	9412	21255	319	11709	6158	18606	17858	41475	126792
2	8625	16168	2830	18541	5081	18631	18121	54707	142703
3	9642	21947	7083	19372	7424	11066	15667	39920	132121
4	12828	21569	8365	26892	12235	14773	14550	54982	166194
1969-1	17878	15169	6609	30511	10314	21538	17277	46337	165633
2	26203	21963	9823	33382	6679	23879	17483	47745	187157
3	26862	29113	13800	37626	9716	27852	18442	45607	209018
4	15062	27362	13597	43869	7137	27630	19100	45720	199477
1970-1	8260	30135	11821	33940	8524	25620	16187	50117	184604
2	13676	33627	13535	39297	8441	36195	17540	51322	213633
3	11644	24153	16078	34612	6018	27685	28760	50512	199462
4	5540	11181	6307	25002	4121	15666	10630	22687	101134

*In metric tons.

Source: computed on the basis of information obtained from Junta Nacional de Carnes; see text for computational procedure.

Data on Domestic Consumption

The quarterly series of domestic consumption utilized in this study was computed by subtracting from the quarterly volume of beef obtained from slaughter (excluding exports on foot) the total quarterly volume of beef exports expressed in e.c.w. The resulting series is presented in Table 22. The annual series of domestic consumption corresponding to this quarterly series shows a small discrepancy with the official statistics published on domestic consumption. The discrepancy ranges from a negative two percent (-2.0 percent) to a positive four percent (4.0 percent); being consistently positive for the period 1960-1963 and consistently negative for the period 1964-1970. This only reflects the fact that official statistics on consumption for these two periods were computed using two different methods.

Data on Export Prices and Exchange Rates

The estimation of the models required quarterly data on (a) FOB price of beef exports (Y'_{59}) expressed in equivalent carcass weight, (b) net price of beef exports (Y_{70}) also expressed in terms of equivalent carcass weight, and (c) net effective exchange rage (X_{40}) expressed in real terms.

Quarterly series of "value of beef exports per product" were obtained from the same (previously indicated) sources as "volume of beef exports." These series of "values" which are consistent with the corresponding series of "volumes" are presented in Table 23.

Table 22. Quarterly Volume of Beef Obtained From Slaughter, Volume of Beef Exports and Domestic Consumption, Population and Per Capita Consumption, Period I/1960-IV/1970.

Quarter	Volume of Beef Obtained From Slaughter	Volume of Beef Exports	Domestic Consumption	Population	Per Capita Consumption
	tons (1)	tons (1)	tons (1)	1,000 inhabitants	per capita kgs. (1)
1960-1	440,236.4	101,203.0	339,033.4	20,539.9	16.506
2	493,647.0	105,730.0	387,917.0	20,623.4	18.809
3	470,619.8	118,045.0	352,574.8	20,705.9	17.028
4	488,326.8	117,209.0	371,117.8	20,787.2	17.853
1961-1	532,611.1	113,757.0	418,854.1	20,867.3	20.072
2	589,300.7	144,621.0	444,679.7	20,946.4	21.229
3	524,037.3	111,973.0	412,064.3	21,024.5	19.600
4	499,114.9	104,388.0	394,726.6	21,101.5	18.706
1962-1	574,057.9	110,015.0	464,042.9	21,177.5	21.912
2	637,660.7	162,506.0	475,154.7	21,252.5	22.357
3	568,788.3	161,958.0	406,830.3	21,326.5	19.076
4	598,319.0	162,521.0	435,978.1	21,399.5	20.364
1963-1	659,247.7	181,118.0	478,129.7	21,471.7	22.267
2	646,894.1	191,466.0	455,428.1	21,542.8	21.141
3	675,918.8	225,007.0	450,911.8	21,613.1	20.863
4	623,226.4	199,249.0	423,977.4	21,682.5	19.553
1964-1	560,970.2	162,381.0	398,589.2	21,750.9	18.325
2	508,471.9	163,802.0	344,669.9	21,818.6	15.797
3	483,693.6	118,246.0	365,447.6	21,885.4	16.698
4	466,104.3	133,777.0	332,327.2	21,951.4	15.139
1965-1	506,234.5	115,897.0	390,337.5	22,016.6	17.729
2	524,549.9	124,181.0	400,368.9	22,080.9	18.132
3	461,777.7	111,885.0	349,892.7	22,144.5	15.800
4	502,533.9	129,845.0	372,688.9	22,207.3	16.782
1966-1	535,336.0	122,121.0	413,215.0	22,269.3	18.555
2	556,210.0	144,911.0	411,299.0	22,330.7	18.418

Table 22. Continued.

Quarter	Volume of Beef Obtained From Slaughter	Volume of Beef Exports	Domestic Consumption	Population	Per Capita Consumption
	tons (1)	tons (1)	tons (1)	1,000 inhabitants	per capita kgs. (1)
1966-3	620,472.6	174,443.0	446,029.6	22,391.3	19.920
4	608,912.4	159,741.0	449,171.4	22,451.1	20.007
1967-1	664,273.2	184,223.0	480,050.2	22,510.3	21.326
2	687,058.5	191,598.0	495,460.5	22,568.7	21.953
3	616,772.4	165,310.0	451,462.4	22,262.5	19.953
4	553,848.9	130,478.0	423,370.9	22,683.7	18.664
1968-1	596,494.1	126,792.0	469,702.1	22,740.1	20.655
2	622,774.9	142,703.0	480,071.9	22,795.9	21.059
3	652,683.3	132,121.0	520,562.3	22,851.1	22.780
4	689,367.9	166,194.0	523,173.6	22,905.7	22.840
1969-1	670,919.2	165,633.0	505,286.2	22,969.5	22.008
2	712,294.0	187,157.0	525,137.0	23,012.9	22.819
3	738,170.6	209,018.0	529,152.6	23,065.6	22.941
4	728,616.1	199,477.0	529,139.1	23,117.8	22.889
1970-1	691,889.9	184,604.0	507,285.9	23,169.4	21.895
2	735,226.4	213,633.0	521,593.4	23,220.4	22.463
3	675,540.8	199,462.0	476,078.8	23,270.9	20.458
4	507,342.9	101,134.0	406,208.9	23,320.8	17.419

(1) Equivalent carcass weight.

Source: Computed on the basis of information obtained from Junta Nacional de Carnes and Instituto Nacional de Estadisticos y Censos; see text for computational procedure.

Table 23. Value of Beef Exports Per Product, Period I/1960-IV/1970.*

Quarter	Chilled Quarts (1)	Frozen Quarts (2)	Chilled Cuts (3)	Frozen Cuts (4)	Manufacture Type With Bone (5)	Manufacture Type Deboned (6)	Cooked and Frozen (7)	Canned Beef (8)	Total (9)
1960-1	25034	3906	---	---	284	2104	493	9258	41079
2	20434	6122	---	---	508	3759	464	9355	40642
3	22931	5507	---	---	[illegible]	4540	890	12063	46545
4	23939	4519	---	---	[illegible]	3868	853	10224	43926
1961-1	19386	4712	---	---	1119	4865	1378	11500	42960
2	17551	5720	---	---	1327	5769	1633	18900	50900
3	10971	4353	---	---	1536	6679	1217	14705	39461
4	15703	4234	---	---	1347	5856	1029	10221	38390
1962-1	19129	4849	---	---	1422	5986	2323	7657	41366
2	18614	6007	---	---	2586	10885	1593	15632	55317
3	17661	8767	---	---	2572	10826	1132	11962	52920
4	24911	8522	---	---	1677	7061	594	8146	50911
1963-1	26302	6376	---	---	2479	7644	2292	11057	56150
2	26863	9986	---	---	2288	7057	1827	15502	63523
3	28892	18461	---	---	3229	9958	1380	14700	76620
4	27078	18630	---	---	2470	7620	623	12024	68445
1964-1	24610	20710	---	---	3658	8350	920	9735	67983
2	26101	27882	---	---	3793	8685	1179	10723	78363
3	30422	15461	---	---	2743	5119	524	7136	61405
4	27837	25501	---	---	3296	5665	1188	8137	71624
1965-1	25894	21704	---	---	4498	4766	2195	6164	65221
2	28146	21747	---	---	5257	5582	2757	7127	70616
3	22800	18876	---	---	3985	5650	1463	8577	61351
4	28115	22667	---	---	5099	4944	2242	7619	70686
1966-1	21988	22123	---	1313	4711	5133	1919	7679	64866
2	25166	23473	---	2626	5223	8414	3832	9133	77867
3	22801	27066	---	3938	5941	8679	5104	12388	85917
4	20651	16298	---	5251	5385	6836	5120	12448	71989

Table 23. Continued.

Quarter	Chilled Quarts (1)	Frozen Quarts (2)	Chilled Cuts (3)	Frozen Cuts (4)	Manufacture Type With Bone (5)	Manufacture Type Deboned (6)	Cooked and Frozen (7)	Canned Beef (8)	Total (9)
1967-1	20783	21855	616	6828	5278	12235	3727	13634	84974
2	21425	14921	853	9520	3634	14524	3429	15678	83984
3	17368	10544	1260	7575	2041	8048	4796	19112	70744
4	9385	10627	704	6397	1854	5374	5827	16101	56269
1968-1	5631	10107	240	6598	2748	7251	7468	14878	54921
2	5128	7654	1569	9740	2253	7246	8490	19944	62024
3	5728	7954	4480	9786	3040	3721	7661	14321	56691
4	6683	11460	4986	14162	4873	4771	8099	20763	75707
1969-1	9207	6682	3969	14782	4078	6899	9332	16734	71683
2	13346	9805	6058	16325	2625	7704	9271	16783	81917
3	14537	13058	8873	18086	3770	9019	9875	15694	92912
4	8362	13833	9106	21342	2807	9051	9990	15740	90231
1970-1	5152	14028	7549	16129	3391	8463	8698	17596	81006
2	9727	16439	10258	20672	3668	12908	10298	18310	102280
3	8392	12637	13464	19077	3008	11707	18441	19223	105949
4	3849	6557	5505	16399	2332	7422	6740	9276	58080

*In thousand dollars.

Source: Junta Nacional de Carnes.

Nominal effective exchange rate applied to beef exports, and percentage rates of export duties and export subsidies[8/] are presented in Table 24. All these series are quarterly averages weighted by the number of working days during which the particular rates were effective or enforced. The construction of the quarterly series on export duties and subsidy rates applied to exports of the different k beef products was based on the pertinent legislation; legislation which is listed in Tables 27, 28, and 29.

From these basic series and the ones on "values" (Table 23) and on "volumes" (Tables 21 and 22) of beef exports it was possible to obtain the series on prices and exchange rates required for the estimation of the model. The procedure adopted is described below.

1. FOB price ($FOBP_{kt}$) of the kth beef product exported during quarter t (in dollars per ton product weight) was obtained by dividing the value of exports of the kth beef product by its corresponding quantity; i.e.,

$$\underset{\text{(dollars)}}{FOB(p.w.)_{kt}} = \frac{\text{FOB Value}_{kt}}{\text{FOB Quantity}_{kt}}$$

2. Net export price (NEP_{kt}) of the kth beef product exported during quarter t (in pesos of 1960 per ton equivalent carcass weight) was obtained by multiplying the FOB price times the

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[8/] Export subsidies are represented as negative export duties.

Table 24. Nominal Effective Exchange Rate and Export Duty Rates Per Product, Period I/1960-IV/1970.

Quarter	Nominal Effective Exchange Rate1/ (pesos per dollar)	Export Duty Rates 2/			
		Chilled and Frozen Carcasses and Manufacture Type (percent)	Chilled and Frozen Cuts (percent)	Cooked and Frozen (percent)	Canned Beef (percent)
1960-1	82.673	10.00	10.00	10.00	10.00
2	82.830	10.00	10.00	10.00	10.00
3	82.517	10.00	10.00	10.00	10.00
4	82.517	10.00	10.00	10.00	10.00
1961-1	82.477	10.00	10.00	10.00	10.00
2	82.590	10.00	10.00	10.00	10.00
3	82.590	3.33	3.33	3.33	3.33
4	82.820	0.00	0.00	0.00	0.00
1962-1	82.797	0.00	0.00	0.00	0.00
2	105.657	0.00	0.00	0.00	0.00
3	123.890	0.00	0.00	0.00	0.00
4	140.943	0.00	0.00	0.00	0.00
1963-1	134.397	0.00	0.00	0.00	0.00
2	137.210	0.00	0.00	0.00	0.00
3	137.643	0.00	0.00	0.00	0.00
4	141.927	0.00	0.00	0.00	0.00
1964-1	132.903	0.00	0.00	0.00	0.00
2	136.933	0.00	0.00	0.00	0.00
3	140.517	0.00	0.00	0.00	0.00
4	147.170	0.00	0.00	0.00	0.00
1965-1	150.350	0.00	0.00	-12.00	0.00
2	167.570	7.40	7.40	-12.00	0.00
3	172.673	9.50	9.50	-12.00	0.00
4	181.380	8.92	8.92	-12.00	- 3.00
1966-1	188.350	6.00	6.00	-12.00	- 6.00
2	193.367	6.00	6.00	-12.00	- 6.00
3	210.597	2.46	2.46	-12.00	- 6.00
4	235.447	0.00	0.00	-12.00	-10.00
1967-1	274.063	4.17	4.17	- 7.06	- 7.06
2	349.650	25.00	25.00	16.00	16.00
3	349.650	25.00	23.72	16.00	16.00
4	349.650	19.94	14.31	4.62	10.31
1968-1	349.650	18.00	12.00	0.00	8.00
2	349.650	18.00	12.00	0.00	8.00
3	349.650	16.00	10.66	0.00	6.67
4	349.650	15.00	10.00	0.00	1.47

Table 24. Continued.

Quarter	Nominal Effective Exchange Rate 1/ (pesos per dollar)	Export Duty Rates 2/ Chilled and Frozen Carcasses and Manufacture Type (percent)	Chilled and Frozen Cuts (percent)	Cooked and Frozen (percent)	Canned Beef (percent)
1969-1	349.650	15.00	10.00	0.00	0.00
2	349.650	15.00	10.00	0.00	0.00
3	349.650	15.00	10.00	0.00	0.00
4	349.650	14.40	9.60	0.00	0.00
1970-1	349.650	12.00	7.00	- 2.50	- 2.50
2	362.970	13.06	7.20	- 3.27	- 3.27
3	399.600	20.00	15.00	8.00	8.00
4	399.600	6.33	1.33	- 2.75	- 2.75

1/ Buying rate. Source: Banco Nacion Argentina

2/ Export subsidies = negative export duties. Compiled on the basis of the pertinet legislation, see Tables 27, 28 and 29.

corresponding net effective exchange rate ($NEER_{kt}$), and divided by the corresponding transformation coefficient (λ_k);[9] i.e.,

$$NEP(e.c.w.)_{kt} = FOBP(p.w.)_{kt} \cdot \lambda_k^{-1} \cdot \hat{NEER}_{kt}$$

(pesos of 1960) (dollars) (pesos of 1960 per dollar)

where $NEER_{kt} = (EER_t/CLI_t) \cdot (1 - r_{kt} + s_{kt})$

EER_t = nominal effective exchange rate (current pesos per dollar).

CLI_t = cost of living index (1960 = 100).

r_{kt} = export duty rate for the kth product.

s_{kt} = export subsidy rate for the kth product.

λ_k = transformation coefficient indicating the amount of carcass beef required to obtain one unit of kth product.

3. To obtain an average net export price (NEP_t) for all beef exports, the individual net export prices (NEP_{kt}) of the k products were weighted by their share of total beef exports; i.e.,

$$NEP(e.c.w.)_t = \frac{\sum_k [NEP(e.c.w.)_{kt} \cdot \text{Quantity } (e.c.w.)_{kt}]}{\sum_k \text{Quantity } (e.c.w.)_{kt}}$$

4. Average FOB prices of total exports ($FOBP_t$) were obtained by dividing the FOB value of total beef exports by the total volume of beef exports expressed in equivalent carcass weight; i.e.,

$$FOBP\ (e.c.w.)_t = \frac{\sum_k \text{FOB Value}_{kt}}{\sum_k \text{Quantity}(e.c.w.)_{kt}}$$

(dollars)

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[9] See Table 19.

5. An average net effective exchange rate ($NEER_t$) corresponding to total beef exports was obtained by weighting the net effective exchange rates ($NEER_{kt}$) by the value share of the k products in the total value of beef exports; i.e.,

$$\underset{\substack{\text{(pesos of 1960}\\ \text{per dollar)}}}{NEER_t} = \frac{\sum_k (NEER_{kt} \cdot \text{FOB Value}_{kt})}{\sum_k \text{FOB Value}_{kt}}$$

In summary, aggregate prices and quantities of beef exports were expressed in terms of dressed beef or equivalent carcass weight (e.c.w.). That is, in order to aggregate quantities and to compute meaningful average prices, quantities and prices of the different beef products exported were first converted into a common basis: carcass weight. The resulting price series are presented in Table 26. Given the computational procedure, it can be shown that net export price as defined, equals the product of the FOB prices times the net effective exchange rate, not only for the individual products but also for the aggregate of total exports, i.e.,

$$\underset{\text{(pesos of 1960)}}{NEP\ (e.c.w.)_t} = \underset{\text{(dollars)}}{FOBP\ (e.c.w.)_t} \cdot \underset{\substack{\text{(pesos of 1960}\\ \text{per dollar)}}}{NEER_t}$$

which in terms of the notation used in the model is:

$$Y_{70,t} = Y'_{59,t} \cdot X_{40,t} / 100.$$

Table 25. Real Net Exchange Rates Effective for Beef Exports, per Product, Period I/1960-IV/1970. 1/

Quarter	Chilled and Frozen Carcasses and Manufacture Type	Chilled and Frozen Cuts	Cooked and Frozen	Canned Beef	Total
1960-1	76.29	76.29	76.29	76.29	76.29
2	74.62	74.62	74.62	74.62	74.62
3	73.66	73.66	73.66	73.66	73.66
4	72.51	72.51	72.51	72.51	72.51
1961-1	71.47	71.47	71.47	71.47	71.47
2	66.77	66.77	66.77	66.77	66.77
3	70.04	70.04	70.04	70.04	70.04
4	67.60	67.60	67.60	67.60	67.60
1962-1	65.63	65.63	65.63	65.63	65.63
2	75.85	75.85	75.85	75.85	75.85
3	79.74	79.74	79.74	79.74	79.74
4	87.07	87.07	87.07	87.07	87.07
1963-1	80.48	80.48	80.48	80.48	80.48
2	77.93	77.93	77.93	77.93	77.93
3	75.81	75.81	75.81	75.81	75.81
4	71.60	71.60	71.60	71.60	71.60
1964-1	63.67	63.67	63.67	63.67	63.67
2	63.10	63.10	63.10	63.10	63.10
3	64.76	64.76	64.76	64.76	64.76
4	62.04	62.04	62.04	62.04	62.04
1965-1	60.20	60.20	67.42	60.20	60.44
2	57.96	57.96	70.11	62.60	58.91
3	53.06	53.06	65.66	58.63	54.14
4	51.09	51.09	62.82	57.77	52.18
1966-1	51.46	51.46	61.32	58.03	52.53
2	50.46	50.46	60.13	56.90	51.69
3	54.61	54.61	62.70	59.34	55.77
4	56.78	56.78	63.66	62.46	58.26
1967-1	60.27	60.27	67.33	67.33	61.71
2	57.00	57.00	63.84	63.84	58.56
3	52.42	53.31	58.71	58.71	54.65
4	51.99	55.64	61.93	58.24	55.27
1968-1	51.87	55.67	63.26	58.20	55.61
2	52.05	55.86	63.48	58.40	56.35
3	52.90	56.27	62.98	58.76	56.59
4	50.42	53.38	59.31	58.44	54.31

Table 25. Continued.

Quarter	Chilled and Frozen Carcasses and Manufacture Type	Chilled and Frozen Cuts	Cooked and Frozen	Canned Beef	Total
1969-1	50.16	53.11	59.02	59.02	54.15
2	50.27	53.22	59.14	59.14	53.89
3	49.45	52.36	58.18	58.18	52.70
4	47.19	49.84	55.13	55.13	50.35
1970-1	47.85	50.56	55.73	55.73	51.20
2	47.72	50.93	56.68	56.68	51.20
3	46.73	49.65	53.74	53.74	50.12
4	49.33	52.09	54.10	54.10	51.68

1/ Pesos of 1960 per dollar.

Source: Computed on the basis of information obtained from Banco Nacion Argentina and legislation on export duties and subsidies; see text for computational procedure.

Table 26. Average Net Export Price, Average FOB Price and Average Net Effective Exchange Rate, Period I/1960-IV/1970.

Quarter	Average Net Export Price (pesos of 1960 per ton carcass weight)1/	Average FOB Price (dollar per ton carcass weight)	Net Effective Exchange Rate (pesos of 1960 per dollar)
1960.1	309.666	405.906	74.29
2	286.835	384.394	74.62
3	290.440	394.298	73.66
4	371.892	374.766	72.55
1961.1	269.904	377.647	71.47
2	236.999	351.954	66.77
3	246.831	352.415	70.04
4	248.607	367.762	67.60
1962.1	246.770	376.003	65.63
2	258.192	340.399	75.85
3	260.551	326.751	79.74
4	272.752	313.257	87.07
1963.1	249.502	310.018	80.48
2	258.549	331.771	77.93
3	258.172	340.522	75.81
4	245.990	343.514	71.61
1964.1	266.563	418.663	63.67
2	301.872	478.403	63.10
3	336.298	519.298	64.76
4	332.161	535.398	62.04
1965.1	340.125	562.749	60.44
2	334.993	568.653	58.91
3	296.870	548.339	54.14
4	284.061	544.387	52.18
1966.1	279.019	531.161	52.53
2	277.752	537.343	51.69
3	274.678	492.521	55.77
4	262.554	450.660	58.26
1967.1	284.641	461.256	61.71
2	256.688	438.334	58.56
3	233.873	427.947	54.65
4	238.352	431.252	55.27
1968.1	240.879	433.158	55.61
2	244.917	434.636	56.35
3	241.957	429.078	56.39
4	247.340	455.533	54.31

Table 26. Continued.

Quarter	Average Net Export Price (pesos of 1960 per ton carcass weight)	Average FOB Price (dollar per ton carcass weight)	Net Effective Exchange Rate (pesos of 1960 per dollar)
1969.1	234.351	432.782	54.15
2	235.871	437.691	53.89
3	234.259	444.516	52.70
4	227.752	452.337	50.35
1970.1	224.670	438.809	51.20
2	245.127	478.764	51.20
3	266.223	531.173	50.12
4	296.791	574.287	51.68

source: Computed on the basis of information obtained from Junta Nacional de Carnes, Banco Nacion Argentina and legislation on export duties and subsidies; see text for computational procedure.

1/ Hundred pesos of 1960 per ton carcass weight.

Table 27. Legislation on Export Duties (Retenciones), 1958-1970.[1/]

Legislation		Effective Date month/ day / year
Decree	11917/58	1/12/59
Decree	807/59	1/28/59
Decree	5827/59	5/23/59
Decree	4898/61	7/12/61
Decree	6309/61	7/29/61
Decree	4258/62	5/19/62
Decree	46/65	1/13/65
Decree	2826/65	4/20/65
Decree	3043/65	4/28/65
Decree	11346/65	12/16/65
Decree	3193/66	11/9 /66
Law	17198/67	3/15/67
Decree	1408/67	3/14/67
Law	17255/67	4/27/67
Decree	5572/67	8/ 8/67
Decree	7769/67	10/26/67
Decree	4241/68	7/30/68
Decree	4471/68	8/12/68
Decree	6228/68	10/22/68
Decree	7833/69	12/12/69
Decree	459/70	2/18/70
Law	18714/70	6/26/70
Law	18718/70	6/ 7/70
Decree	192/70	7/14/70
Decree	1495/70	10/8/70
Decree	2183/70	11/13/70

[1/] Source: Digesto de Legislacion Argentina and Boletin Oficial, Several issues.

Table 28. Legislation on Export Subsidies (Reintegros), 1960-1970.[1]

Legislation[2]		Effective Date Month/ day /year
Decree	12913/62	12/ 4/62
Decree-Law	1127/63	2/16/63
Decree-Law	4855/63	6/21/63
Decree	46/65	1/13/65
Decree	9972/65	11/18/65
Decree	643/66	2/ 4/66
Decree	4274/66	11/28/66
Decree	319/67	1/30/67
Law	18714/70	6/26/70
Decree	1495/70	10/ 8/70
Decree	2183/70	11/13/70

[1] Source: Digesto de Legislacion Argentina and Boletin Oficial, several issues.

[2] Complemented by legislation on export duties (Retenciones).

Table 29. Legislation on Regimen of Exchange of Foreign Currencies, 1958/1970. 1/

Legislation		Effective Date month/ day/ year
Decree	2000/55	10/27/55
Circular BCRA	3298/58	7/28/58
Decree	11916/58	12/30/58
Decree	6169/62	7/2/62
Decree	6615/62	7/11/62
Decree	6877/62	7/17/62
Decree	7776/62	8/ 6/62
Decree	9209/62	9/13/62
Decree	2581/64	4/10/64
Circular BCRA	161/64	4/13/64
Circular BCRA	164/64	5/ 8/64
Decree	5027/64	7/ 7/64
Circular BCRA	198/64	11/30/64
Decree	2826/65	4/20/65
Decree	4528/65	6/16/65
Decree	1407/67	3/14/67
Circular BCRA	322/67	3/13/67
Decree	6/67	6/18/70
Circular BCRA	386/70	6/18/70
Circular BCRA	387/70	6/18/70

1/ Source: Digesto de Legislacion Argentina and Boletin Oficial, Several issues.

Data on Beef Prices at the Farm Level

The prices used in this study as "beef prices at the farm level" (Y_{18}) are quarterly weighted average prices paid at the Central Market of Liniers (Mercado Nacional de Hacienda). More than twenty-five percent of the beef cattle marketed for slaughter are channeled through this particular market. Moreover, since quotations of prices paid at this market are reported daily by the news media and in special bulletins published by JNC, it may be safely assumed that if differences in prices paid in this and other markets arise in excess of transportation and related costs, more cattle would flow to the market in which prices are higher.

Prices corresponding to different categories of animals were weighted by their corresponding share in total slaughter during the period 1960-1962. These weights (w_j) are: .43869 for steers (j=1), .11743 for young steers (j=2), .25560 for cows (j=3), .11923 for heifers (j=4), .04341 for calves (j=5) and .02564 for bulls (j=6). The weighted average price of beef at the farm level (e.c.w.) was then computed in real terms as follows:

$$Y_{18,t} = \sum_{j=1}^{6} w_j \, (FP_{jt}/DP_{jt} \cdot CLI_t)$$

where FP_{jt} = average price paid at the Liniers' Market for animals of the jth category (pesos per kg. of alive animal).

DP_{jt} = average dressing percentage of animals of the jth category.

CLI_t = Cost of Living Index (1960 = 100).

The resulting series is presented in Table 30.

Table 30. Real Price of Beef at the Farm and at the Retail Level, Wholesale Price of Fish and Average Official Settlement Wage Rate, period III/1959-IV/1970. 1/

Quarter	Farm Price of Beef (pesos of 1960 per kg. dressed weight)	Retail Price of Beef (pesos of 1960 per kg. dressed weight)	Wholesale Price of Fish (Cod) (pesos of 1960 per kg.)	Official Settlement Wage Rate (pesos of 1960 per hour)
1959 3	31.842	34.684	8.97	26.505
4	27.438	34.134	8.96	25.316
1960 1	28.409	38.444	9.39	24.495
2	25.784	35.922	9.18	24.024
3	24.863	34.951	8.67	26.284
4	23.456	34.635	8.69	26.816
1961.1	22.809	33.861	8.68	28.307
2	19.360	30.619	7.73	28.345
3	20.105	29.012	8.05	28.630
4	21.253	29.528	7.70	27.980
1962.1	18.765	28.833	8.20	28.916
2	18.041	26.365	7.04	28.691
3	20.012	26.898	7.77	26.389
4	20.697	27.365	8.14	26.873
1963.1	22.107	27.595	8.60	28.138
2	22.594	28.651	8.21	27.871
3	21.591	28.021	9.46	28.021
4	24.857	28.174	9.16	27.351
1964.1	29.873	35.564	8.41	29.330
2	34.561	41.367	7.18	29.599
3	33.312	38.162	6.45	30.516
4	31.709	35.863	5.90	29.836
1965.1	32.388	41.345	5.92	31.233
2	30.326	40.618	5.23	31.263
3	32.777	46.187	5.54	30.934
4	26.917	40.624	5.05	28.734
1966.1	25.094	38.156	4.92	29.997
2	23.979	36.896	4.88	32.268
3	22.460	34.612	4.92	32.488
4	21.394	29.689	4.69	30.678
1967.1	23.173	31.324	6.56	30.601
2	22.317	29.489	7.04	34.131
3	22.501	29.116	7.04	31.891
4	25.021	34.604	6.85	29.630
1968.1	22.753	30.999	7.50	28.867
2	19.944	29.168	8.95	28.965
3	21.016	30.141	9.06	28.739
4	18.407	27.311	8.94	27.065

Table 30. continued.

Quarter	Farm Price of Beef (pesos of 1960 per kg. dressed weight)	Retail Price of Beef (pesos of 1960 per kg. dressed weight)	Wholesale Price of Fish (Cod) (pesos of 1960 per kg.)	Official Settlement Wage Rate (pesos of 1960 per hour)
1969.1	17.994	27.118	11.03	29.085
2	19.268	27.173	10.96	29.144
3	20.605	27.953	13.06	28.672
4	18.051	26.227	13.90	28.770
1970.1	21.527	27.989	13.28	31.037
2	23.196	28.831	11.91	30.182
3	25.851	32.890	11.58	29.860
4	30.724	39.666	10.50	28.151

1/ All series are deflated by CLI (1960 = 100).

Source: Computed on the basis of information obtained from Junta National de Carnes, and Instituto Nacional de Estasdisticos of Censos; see text for computational procedure.

Data on Beef Prices at the Retail Level

Since January 1964 the JNC publishes monthly retail prices which are weighted average prices based on a sample or retail stores located in the Federal District and Greater Buenos Aires. The weights correspond to the percentage weight of each of the twenty-eight principal cuts in the carcass, including weight losses. That is, retail prices are expressed in terms of carcass weight. Only annual information on retail prices computed on the basis of a different sample is published prior to 1964. However, monthly information on retail prices of six of the principal cuts is collected for the construction of the CLI. The procedure adopted here to construct a consistent quarterly series of retail prices is as follows:

1. First, a quarterly average retail price (X_t) was computed for the whole period on the basis of the six cuts included in the CLI, weighted by the equivalent percentage weight of each cut in the carcass as follows:

$$X_t = \left(\sum_{s=1}^{6} w_s \cdot RP_{st} \right) / CLI_t$$

where RP_{st} = retail price of the sth cut.

w_s = weight corresponding to the sth cut.[10/]

[10/] The weights used are at as follows:

s = cut	w_s = weights
1. Asado	.2036
2. Bife	.1955
3. Carnaza	.3420
4. Cuadril	.1007
5. Falda	.0757
6. Hueso con carne	.0825

2. A regression equation was estimated for the period I/1964-IV/1970, where the dependent variable is the average retail price (Y_{17}) - expressed in real terms - as published by JNC; the explanatory variable is the average retail price (X_t) of the six cuts computed as indicated above. The resulting equation is:

$$Y_{17} = \underset{(-1.514)}{-.01318} + \underset{(39.952)}{.8764}\ X_t \quad ; \quad R^2 = .988$$

where the figures in parentheses below the coefficients are t ratios.

3. Finally, the series on average retail price (Y_{17}) was completed for the period I/1960-IV/1963 on the basis of the predicted values obtained from the above regression equation. The resulting series is reproduced on Table 30. The sources of the basic data used in the computations are: JNC, Resena Anual; and Instituto Nacional de Estadisticas y Censos, Indice de Costo de Vida, several issues.

Data on Price of Fish and Wage Rate

Although fish consumption is still low in Argentina (between 8 and 12 pounds per capita per year), it has been growing steadily during the last decade. Average wholesale price of cod (merluza) expressed in real terms was included in the demand equations to represent the price of a beef substitute. Retail prices of fish are not available. Wholesale prices of other fish as well as a price index of those fish which are marketed regularly are also published on monthly basis. Simplicity considerations and the high correlation (.991) between this index and the price of cod (both expressed in real terms) led to consider this latter in the study. Quarterly average

wholesale price of cod deflated by the CLI is presented in Table 30. The basic series in nominal terms was obtained from: Instituto Nacional de Estadisticas y Censos, Boletin de Estadisticas. From the same source a series of average official settlement wage rate was obtained. This series expressed in real terms is also presented in Table 30.

Data on Rationing or Beefless-days

Different rationing policies were applied during the last decade. They differ in:[11/] (a) the region of the country in which they were enforced, (b) the number of days per week which were beefless, and (c) whether only the sale of beef dishes in restaurants was forbidden, or retailing of beef was also forbidden or slaughter for domestic consumption was also forbidden. Since it was not feasible to include only one dummy variable for each alternative reationing policy implemented during the sample period, two weighting criteria were used to construct two series which could be used alternatively to represent rationing. Both weighting criteria are based on characteristics (a), (b) and (c) of such policies. With respect to characteristic (a) weights are based on the population base. With respect to characteristic (b) weights are proportional to the number of days per week which were beefless. With respect to characteristic (c) weights are arbitrary and based on judgement; this is the reason why two alternative weighting

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11/ See pertinent legislation: Law 12830/46; Decree 11438/58; Decree 4070/64; Decree 9737/64; Decree 5495/65; Decree 5496/65; Decree 3702/66; Decree 1654/70 and corresponding resolutions of Junta Nacional de Carnes.

schemes were considered. However, it turns out that the results were invariant to weights. The correlation coefficient of the series generated under both alternative weighting schemes was .9994, and in terms of statistical estimates of the parameters of the demand equations, they were similar in magnitude for all practical purposes; the only coefficient that changed was that of this variable reflecting the difference in weights. The weighting schemes are presented in Table 31 and the resulting series are presented in Table 32. Beefless Days Dummy I was the one used in this study. It must be pointed out that all dummy variables were weighted by the proportion of the quarter during which the particular policy was enforced, or during which the event occurred as in the case of restrictions of exports to England due to the hoof and mouth epidemy.

Data on Population

According with the census of 1947, 1960 and 1970, the rate of increase of the Argentine population has been declining during the last two decades. Thus a linear function could not be used to adequately interpolate between census. The procedure adopted here to obtain a quarterly series of population is rather simple. First, graphical interpolation was used to generate a quarterly series (Y_t) for the period II/1947-III/1970; a series which encompasses the census observation. Then a logarithmic reciprocal transformation function was fitted against a time trend variable (Z_t). The function is

$$Y_t = e^{a-(b/Z_t)} + u_t$$

and the least squares estimates obtained are:

Table 31. Weighting Schemmes for the Construction of Series Representing Beefless-Days. 1/

Type of Policy / Area of Enforcement	Enforced on					
	Restaurants		Restaurants and Retailing		Restaurants, Retailing and Slaughter for Domestic Consumption	
	I	II	I	II	I	II
1. Federal District	1	2	2	3	2.5	3.5
2. Federal District and Counties of Greater Buenos Aires	2	4	4	6	5	7
3. Federal District, Greater Buenos Aires and Urban Areas	3	5	6	7.5	7.5	9
4. All the country	4	6	8	9.5	10	11.5

1/ For criteria used to construct weights see the text.

Table 32. Series Used to Represent Beefless days, Hoof and Mouth Disease in England, Price of Danish export type of Steer, and Net Change in Loans Granted to the Cattle Sector.

Quarter	Beefless Days Dummy (I) 1/	Beefless Days Dummy (II) 1/	Hoof and Mouth Disease in England Dummy 1/	Average Price of Danish Export Type of Steer (dollars per hundred kgs) 2/	Net Change in Loans Granted to the Cattle Sector 3/
1960.1	0	0	0	40.8	1.748
2	0	0	0	42.4	11.576
3	0	0	0	41.7	12.481
4	0	0	0	40.1	15.215
1961.1	0	0	0	40.8	7.220
2	0	0	0	40.5	5.788
3	0	0	0	38.9	9.770
4	0	0	0	37.3	9.154
1962.1	0	0	0	38.5	-19.470
2	0	0	0	39.2	-23.772
3	0	0	0	38.2	-13.799
4	0	0	0	35.5	-10.893
1963.1	0	0	0	35.3	-13.456
2	0	0	0	38.6	-2.980
3	0	0	0	41.5	-1.872
4	0	0	0	43.0	4.651
1964.1	0	0	0	47.8	-1.315
2	25	30	0	51.9	29.020
3	80	95	0	52.7	35.033
4	80	95	0	51.8	20.325
1965.1	35	42	0	54.2	1.403
2	0	0	0	53.4	14.961
3	85	96	0	52.8	9.494
4	100	115	0	51.0	-2.849
1966.1	100	115	0	50.5	-14.829
2	100	115	0	50.0	- 0.415
3	100	115	0	46.3	- 1.300
4	67	77	0	41.1	- 9.246
1967.1	0	0	0	42.2	- 8.960
2	0	0	0	44.7	5.203
3	0	0	0	40.9	7.686
4	0	0	50	38.0	6.762

Table 32. continued.

Quarter	Beefless Days Dummy (I) 1/	Beefless Days Dummy (II) 1/	Hoof and Mouth Disease in England Dummy 1/	Average Price of Danish Export Type of Steer (dollars per ton) 2/	Net Change in Loans Granted to the Cattle Sector 3/
1968.1	0	0	100	40.8	20.778
2	0	0	100	43.3	- 1.456
3	0	0	80	38.9	17.117
4	0	0	0	39.5	2.381
1969.1	0	0	0	44.5	- 0.989
2	0	0	0	45.5	17.789
3	0	0	0	50.8	18.679
4	0	0	0	48.5	-4.892
1970.1	0	0	0	49.6	-19.400
2	15	25	0	51.0	-4.393
3	0	0	0	53.5	0.818
4	0	0	0	52.7	-3.934

1/ See text for computational procedure.

2/ Source: FAO, Monthly Bulletin of Agricultural Economics and Statistics, Several issues.

3/ In hundred million pesos of 1960. Source: BCRA, Boletin Estadistico, Several issues.

$$a = 10.384874 \; ; \; b = 504.768311 \text{ and } R^2 = .9998$$

The predicted values obtained on the basis of this function (presented on Table 22) were used as actual observations on population in the estimation of the model. Two issues must be pointed out with respect to this series. First, it is based on preliminary estimates of the 1970 census.[12/] Secondly, it overestimates the decline in the rate of population growth. While for the year 1960 an annual rate of 1.6 percent was obtained which seems reasonable, for the year 1970 an annual rate of .9 percent was obtained which is considered to be too low. The implication of this is that, given the particular form of this function, the parameter of the population variable in the domestic demand equation will be overestimated.

Data on Rainfall

A quarterly series of average rainfall in the Pampean Region was constructed on the basis of monthly information on rainfall recorded at seventy four weather stations spread over the region.[13/] The weather seations were selected on the basis of: (a) availability

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12/ Source: Instituto Nacional de Estadisticas y Censos, Censo Nacional de Poblacion, Familias y Viviendas 1970 - Resultados Provisionales.

13/ In cases in which monthly information was not available, the information was obtained from the daily records of the corresponding stations. In few cases in which no information was recorded, data was generated on the basis of the monthly isohyet charts and the observation for the nearest station. The source of this information is the Servicio Meterologico Nacional.

of data, (b) density of the cattle stock according to the Census of 1960; (c) isohyet charts for the Pampean Region, and (d) location and distance among weather stations. Twenty five of the selected stations correspond to what is usually called the "breeding area" and forty-nine correspond to what is usually called the "mixed area" (breeding and fattening area). The location of each weather station is plotted in Figure 11.

In the construction of the quarterly series of average rainfall for the Pampean Region, equal weight was given to the observations on precipitation in each weather station. The resulting series is presented in Table 33. Then, each observation was expressed as a percentage of the sample mean of the corresponding quarter.[14/] This last variable was included in the model to take account of "abnormal" weather conditions on slaughter.

[14/] See Chapter I, footnote 13/

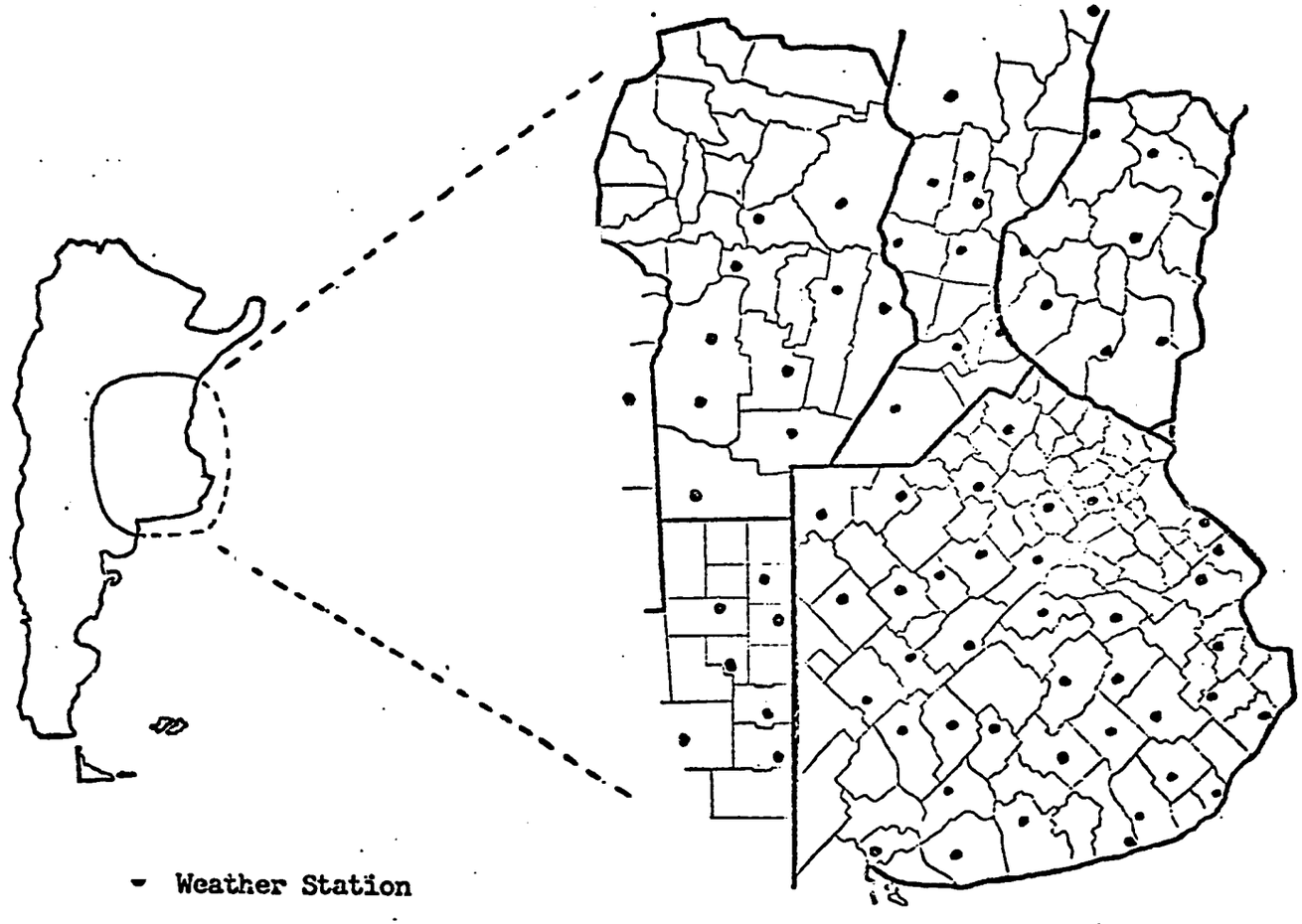

Figure 11. Location of Weather Stations in the Pampean Region from which Precipitation Data was Obtained.

Table 33. Quarterly Average Rainfall in Cattle Breeding and Mixed Areas, Period 1/1958 - 4/1970.*

Quarter	Breeding Area	Mixed Area	Percentage of the Mean of the Quarter		Average Pampean Region	Percentage of the Mean of the Quarter (Pampean Region)
			Breeding Area	Mixed Area		
1958-1	322.28	319.25	123.93	107.09	320.27	112.28
2	192.72	101.20	116.88	73.48	132.12	89.93
3	236.76	155.90	143.58	135.67	183.22	139.01
4	251.96	263.88	105.21	91.78	259.85	95.78
1959-1	247.08	493.76	95.01	165.64	410.42	143.80
2	242.48	290.84	147.05	211.18	274.50	186.86
3	122.72	171.31	74.42	149.08	154.89	117.51
4	273.20	323.20	114.07	112.40	306.31	112.90
1960-1	302.04	239.53	116.14	80.35	260.65	91.37
2	118.28	86.45	71.73	62.77	97.20	66.16
3	185.92	126.67	112.74	110.23	146.69	111.29
4	177.80	247.57	74.24	86.10	224.00	82.56
1961-1	342.36	351.55	131.65	117.93	348.44	122.15
2	105.84	106.53	64.18	77.35	106.30	72.36
3	151.80	79.55	92.05	69.22	103.96	78.87
4	214.20	301.86	89.44	104.98	272.24	100.35
1962-1	167.92	186.59	64.57	62.59	180.28	63.20
2	114.36	82.98	69.35	60.25	93.58	63.70
3	199.64	131.94	121.06	114.82	154.81	117.45
4	162.60	193.71	67.89	67.37	183.20	67.52
1963-1	295.96	331.61	113.80	111.24	319.57	112.03
2	152.88	115.29	92.71	83.71	127.99	87.12
3	263.24	115.90	159.63	100.86	165.68	125.70
4	311.32	354.53	129.99	123.30	339.93	125.30
1964-1	278.12	314.29	106.94	105.43	302.07	105.89
2	154.60	164.61	93.75	119.52	161.23	109.75
3	175.32	112.35	106.31	97.77	133.62	101.38
4	188.60	211.06	78.75	73.40	203.47	75.00
1965-1	169.60	154.14	65.21	51.70	159.36	55.86
2	188.04	142.35	114.03	103.36	157.79	107.41
3	140.24	75.00	85.04	65.26	97.04	73.62
4	204.48	368.84	85.38	128.28	131.31	115.48
1966-1	238.96	378.08	91.89	126.82	331.08	116.06
2	240.24	190.10	145.69	138.03	207.04	140.93
3	100.40	65.80	60.88	57.26	77.49	58.79
4	330.20	324.59	137.87	112.89	326.49	120.34
1967-1	198.56	212.29	76.35	71.21	207.65	72.79
2	107.80	159.59	119.95	115.88	172.50	117.42
3	162.00	175.41	98.24	152.64	170.88	129.65
4	308.68	374.37	128.89	130.20	352.18	129.81

Table 33. Cont.

Quarter	Breeding Area	Mixed Area	Percentage of the Mean of the Quarter		Average Pampean Region	Percentage of the Mean of the Quarter (Pampean Region)
			Breeding Area	Mixed Area		
1968-1	248.92	264.29	95.72	88.65	259.10	90.83
2	62.60	77.82	37.96	56.50	72.68	49.47
3	144.60	127.45	87.68	110.91	133.24	101.09
4	302.84	332.63	126.45	115.68	322.57	118.90
1969-1	255.24	293.73	98.15	98.53	280.73	98.41
2	252.72	198.10	153.26	143.84	216.55	147.41
3	120.60	50.84	73.13	44.24	74.41	56.45
4	240.84	246.53	100.56	85.74	244.61	90.16
1970-1	313.68	336.18	120.62	112.77	328.58	115.19
2	120.96	74.47	73.35	54.07	90.18	61.38
3	140.48	105.71	85.19	91.99	117.46	89.11
4	146.64	194.96	61.23	67.80	178.64	65.84

*Milimeters for quarter.

Source: Constructed on the basis of information obtained from the Servicio Meterologico Nacional; see text for computational procedure.

VITA

VITA

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