AN ECONOMETRIC STUDY OF THE BRAZILIAN BEEF SECTOR

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ABBREVIATIONS

General

CR.$ - new cruzeiro

c.w. - carcass weight

e.c.w. - equivalent carcass weight

p.w. - product weight

The dating system used is month/day/year unless otherwise specified.

Institutions

BASA - Banco da Amazonia

BB - Banco do Brasil

BDNE - Banco Nacional de Desenvolvimento Economico (National Bank of Economic Development)

BNE - Banco do Nordeste

CEPEN - Coordenadoria de Estatistica da Pecuaria Nacional (National Livestock Statistical Service) MA

CIBRAZEM - Companhia Brazileira de Armazemagem (Brazilian Storage Company), MA

CIEF - Centro de Informacoes Economico-Fiscais (Centre of Economic and Fiscal Information) formerly SEEF (Servico de Estatistica Economica e Financeira), Ministerio de Fazenda.

COBAL - Companhia Brasileira de Alimentos (Brazilian Food Company), MA

CONDEPE - Conselho Nacional de Desenvolvimento da Pecuaria (National Counsel of Livestock Development), MA

DIOPA - Divisao de Inspecao de Produtos de Origem Animal (Inspection Division of Animal Products), MA

CREAI - Carteira de Credito Agricola e Industrial (The desk for Agricultural and Industrial Credit), BB

EAGRI - Escritorio de Estatistica (Office of Statistics), Formerly, ETEA (Equipe Tecnica de Estatistica Agropecuaria) and before that SEP, (Servico de Estatistica da Producao), MA.

EAPA - Escritorio de Analise Economica e Politica Agricola (Office of Economic Analysis and Agricultural Policy), MA.

FGV - Fundacao Getulio Vargas (The Getulio Vargas Foundation).

GECRI - Gerencia de Coordenacao do Credito Rural e Industrial (Coordinating Office of Rural and Industrial Credit), Banco Central do Brazil.

IEA - Instituto de Economia Agricola (Agricultural Economic Institute of the Secretariat of Agriculture of the State Government of Sao Paulo).

INPES - Instituto de Pesquisas (Research Institute), MP.

IPLAN - Instituto de Planejamento (Planning Institute), MP.

MA - Ministerio da Agricultura (Ministry of Agriculture).

MP - Ministerio da Planejamento (Ministry of Planning).

SUNAB - Superintendencia Nacional do Abastecimentio (National Supply Agency), MA.

SUPLAN -Subsecretaria de Planejamento e Orcamento (Subsecretariat of Planning and Budgeting), MA.

ABSTRACT

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This research is a study of the structure of the Brazilian beef economy over the past 25 years. The first part thus consists of a description of the wide range of government policy that has influenced the beef sector over the period and an evaluation of the key factors influencing beef policy. The hypotheses formed in this part of the study, together with various theories presented in recent studies of this type for other countries, form the basis for specifying an empirical model of the Brazilian beef economy as a whole.

The model is compromised of behavioral relations representing each of the subsectors which make up or influence the beef sector: supply, domestic demand, foreign trade and government policy. The empirical model is based on the theory that Brazil is a price-taker in the world market for beef, but that the government can and does alter the relationship between the world beef price, which is given to it, and the domestic beef price, by using a series of instruments of beef trade policy. It is hypothesized that these adjustments have been made in the past in an attempt to meet certain objectives involved in development strategy, inflation control and the balance of payments.

The model was estimated using annual time series data for the period 1947-71. The statistical model was then used to examine the structure of the beef sector and to analyze how the sector might be expected to react to various policy changes and changes in exogenous factors. One analysis consisted of making projections of beef supply, demand, exports and price over the period 1972-80. This served to evaluate the predictive performance of the model and to demonstrate the effects that the present policy mechanism appears to have under varying exogenous conditions.

The results of the analysis have a number of important policy implications. First, beef supply in Brazil appears to be quite elastic in the long-run. However, a major problem arises because the supply sector is very slow to react to more favorable conditions, primarily because the level of technology employed in the sector is very low and the resulting low level of animal productivity severely constrains the responsiveness of producers. Second, the demand for beef in Brazil appears to be inelastic with respect to price, and thus increasing prices do not result in a marked increase in the availability of beef for export.

Finally, the degree to which government intervenes in the exports of beef, placing a wedge between the international price and the domestic price, is reasonably well predicted by the model. Furthermore, the manner in which various Brazilian Governments have responded with policies in this area does not appear to have changed markedly in the post-World War II period except during the period 1953-59, when policymakers appear to have intervened less against beef exports than over the remaining periods.

The structural aspects of the model interact in the projection analysis to produce a rather sobering outlook for Brazil in terms of the beef export targets set by the government.

Under one set of assumptions, Brazil is projected to attain a level of beef exports close to the 600,000 ton target by 1980, but at a cost of reduced domestic consumption per capita. Under the remaining set of assumptions beef exports are projected to fall well short of the target. This result stems directly from the policy intervention mechanism and the slow response of the supply sector vis-a-vis beef consumers. Those results reinforce the hypotheses forwarded concerning the basis for the 'beef problem' in Brazil and the policy measures that might be used to correct the problem.

CHAPTER ONE

INTRODUCTION

The Brazilian National Development Plan published in 1970 (8) laid considerable emphasis on the need for greatly increased export earnings from a number of so-called non-traditional exports. This expressed need was one aspect of what appears to be a switch to a development policy which includes export expansion as a major component, and a shift away from primary dependence on import-substituting industrialization as the basis for development policy.

Prior to 1953 various governments had followed a policy of overvaluing the cruzeiro in order to maximize export earnings from what was assumed to be an inelastic world demand for Brazilian coffee.[1/] This policy had an adverse effect, however, on the exports of other products in which Brazil had a comparative advantage in world markets, By 1953 the government had apparently realized that this policy was not in the long term interests of the economy, and the first instrument was introduced to stimulate exports of products other than coffee. This instrument, multiple exchange rates, was followed by a series of measures over the next 12 years designed to further reduce the distortion in trade policy that had been inherited from the pre-1953 governments. The most notable of these adjustments took place in 1960 and 1964, when the system

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1/ Detail on Brazilian trade policy can be found in Bergsman (7), Skidmore (67), and Veiga (75).

of multiple exchange rates was simplified considerably.

However, this process of rationalizing trade policy was unable to proceed smoothly or achieve great success because there were certain variables over which the government did not have full control. In particular, the government was not able to effectively control the money supply,[2/] with the result that on occasions domestic inflation accelerated rapidly, thereby forcing policy-makers to adjust their plans of liberalizing exports. Governments reacted to increasing inflation by trade intervention because of a concern about the price of food products for the rapidly growing urban masses, and it was these same products whose prices increased with the gradual removal of trade distortions. The emphasis was probably placed on trade policy as contrast to domestic price ceilings because of the drive to autarchic development (see below) and the fact that trade policy was easier to police.

At the same time that halting steps were being taken to improve and diversify exports the country was also following a policy of import substitution to stimulate the growth and modernization of the industrial sector and to reduce the dependence on foreign imports.[3/] An over-valued exchange rate was part of the policy mix designed to implement this policy, since it lowered the price in terms of domestic currency for the critical inputs needed for the expansion of the industrial sector.[4/]

2/ For a detailed discussion of the institutional problems involved in trying to formulate a unified monetary policy in Brazil, see Skidmore (1967).

3/ For a detailed discussion of Brazilian trade policy as it has affected the agricultural sector, see Bergsman (7), Von Doellinger (76), and Veiga (75).

4/ Imports considered to be non-essential were prohibited by quotas and tariff protection. The scarce exchange earnings were allocated in large part by administrative decree rather than by the free working of the market.

However, it is easy to overstate the importance put on these latter objectives as the basis for over-valuing the currency, and to understate the weight put on holding down food prices. Bergsman goes so far as to say that "the overvalued exchange rate (in Brazil, 1947-67) probably owed its existence at least as much to a desire to keep food prices down as to a desire to industrialize" (7, p. 152).

The new government that came to power in 1964 introduced new policies (and extended old ones) to further reduce the distortions to trade caused by the over-valued cruzeiro. Direct incentives were introduced for exports of manufactured products and the incentives for foreign investment were extended. In 1967 a complete tariff reform was carried out, and in 1968 the government adopted a crawling peg exchange rate. All these policies together were instrumental in moving the exchange rate closer to its equilibrium value.

The effects of these reform measures on growth was not immediate, primarily because the government was also following tight monetary and fiscal policies to reduce the rate of inflation, and these had a depressing effect on output. The results of the realignment of the exchange rate became obvious after 1967, however, when a general expansionary policy was adopted. The value of exports, imports and foreign capital inflows rose sharply from 1968 onwards (see Table 1.1), and the real rate of increase of gross national product (which had averaged 3.4 percent[5/] from 1963 to 1967) rose to an average of 10.1 percent over the next six years.

The largest export gains over the period 1964-71 were made by iron ore, soybeans, corn, fresh, frozen, and chilled beef, and manufactured

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5/ See (71).

products (see Table 1.2). In addition, because one of the means of export promotion was an explicit devaluation of the cruzeiro, this export expansion led to higher domestic food prices. The increase in food prices has in turn caused consumer pressures from urban sections of society, with the result that periodic trade interventions have returned, especially in the beef sector.[6/]

The trade stimulus offered by the post-1964 policies has not, however, resulted in an equilibrium on the trade accounts. Over the period 1965 to 1972 export earnings increased 244 percent, but the value of imports and import services (including interest payments on foreign debt) increased 413 percent (see Table 1.1). Nevertheless, it has been possible to maintain a surplus in the overall balance of payments by means of the large increase in private foreign investment and foreign borrowing.

At the time of this writing, the general attitude to development policy appears to be virtually the same as it was in the early post-1964 years, except that the alternatives have narrowed. Since 1969 the level of foreign debt has increased sharply (Table 1.3), and the share of export earnings going to service this debt has increased accordingly. This trend is reflected by the data in Table 1.1. In 1965 total import service charges[7/] amounted to 22 percent of export earnings, but by 1972 this proportion had increased to 33 percent. In addition, principal repayments on foreign loans are putting increased pressure on the overall balance of

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[6/] These trade interventions have taken the form of export quotas and export taxes, with, for example, both being imposed on beef and soybeans in 1973.

[7/] Import service charges include interest payments on foreign borrowing.

Table 1.1. Selected Data from Foreign Sector Accounts, Brazil 1965-1972 (Millions of US$)

Item	Year											
	1965	1966	1967	1968	1969	1970	1971	1972[1]	1973	1974	1975	1976
Exports (f.o.b.)	1,596	1,741	1,654	1,881	2,311	2,739	2,904	3,900	—	—	—	—
Imports (f.o.b.)	-941	-1,303	-1,441	-1,855	-1,993	-2,507	-3,250	-3,884	—	—	—	—
Services	-362	-463	-527	-556	-630	-815	-978	-1,310	—	—	—	—
Capital Inflow[2]	384	634	548	1,091	1,439	1,801	2,718	3,760	—	—	—	—
Capital Outflow[3]	-315	-431	-444	-528	-558	-765	-874	-1,419	-1,761[4]	-1,306[4]	-883[4]	-726[4]
Errors and Omissions (Surplus+)	331	153	245	32	549	545	555	—	—	—	—	—

Source: Boletim do Banco Centro do Brasil, various issues.

1/ The data for 1972 are estimates based on the figures available up to June 1972.

2/ Capital inflow equals new foreign investment plus loans received plus capital transfers plus the sundry category.

3/ Capital outflow equals principal repayments on foreign loans plus subscriptions to international organizations.

4/ The capital outflow from 1973-76 is the amount of the principal repayments due for payment on the foreign debt as it stood at September 1972.

Table 1.2. Increases in Export Earnings, Selected Products, Brazil, 1962-70 (Millions of US$).

Product	1962-64 Average Value	1962-64 Percent of Total	1968-70 Average Value	1968-70 Percent of Total	Percentage Change
Basic Products					
Coffee[a/]	716.7	53.1	874.9	37.9	+ 22
Iron Ore	73.1	4.4	153.5	6.6	+110
Soybeans[b/]	4.8	0.4	28.6	1.2	+496
Corn	10.8	0.8	58.9	2.5	+445
Beef[c/]	7.4	0.5	48.0	2.0	+548
Manufactured Products					
Beef Products	5.4	0.4	16.3	0.7	+202
Industrial Products[d/]	46.6	3.5	206.0	8.9	+342
Total Exports	1350.0	100.0	2310.0	100.0	+ 71

Source: Annuario Estatistico, Fundacao IBGE, Rio de Janeiro, various issues.

Notes: a/ Including preparations.

b/ Meal and flour,

c/ Fresh, frozen, and chilled.

d/ Excluding foods and drinks.

payments. This is shown by the projection of the principal repayments that Brazil must make over the next four years on the foreign debt as it existed as of September, 1972.

Table 1.3 Foreign Debt and Foreign Reserves, Brazil, 1964-72 (Millions of US$)

	Year[1/]			
	1969	1970	1971	1972
Foreign Debt	4403	5085	6125	8779
Foreign Reserves	589	962	1450	3234

Source: Boletim do Banco Central do Brasil, February 1972.

1/ At September.

Some observers[8/] believe that Brazil will have a continuing need for foreign loan capital if the current high rate of growth is to continue, because domestic savings will probably not be sufficient to meet investment needs. And if the level of foreign borrowing continues to grow, Brazil will require greatly increased export earnings or increased foreign private capital inflows to maintain equilibrium in the overall balance of payments.

However, there is reasonable doubt that Brazil will be willing or able to accept an increased inflow of private foreign capital. These flows have been very high over the past two years, and a resurgence of nationalistic sentiment may eventually force the government to restrict foreign ownership. Thus, if imports continue to grow as in recent years

8/ This viewpoint is expressed by Fishlow (26), for example.

and foreign borrowing continues to expand, there will be greatly increased requirements for exports. Furthermore, this need will be greater, the greater is the desire to restrict private foreign investment and foreign ownership.

This is the background and the outlook which appears to be behind the formulation of the 1970 National Development Plan in which the government reiterated its intention to maintain the export drive. In addition, the government has stated its intention to introduce policies that will enable the agricultural sector to grow more rapidly, since an important share of the required export earnings will have to come from this sector.

The Problem

It was seen in the previous section that beef exports have played an important role in the recent expansion of Brazilian exports. From a low base in 1964, the value of fresh, frozen and chilled beef exports rose more than seven times over the next seven years. The government apparently expects this rate of increase to continue, since it has set very high beef export targets up through 1980. It is anticipated that beef exports will amount to 300 thousand tons p.w. in 1975 and 600 thousand tons p.w. in 1980.[9/] These targets are to be compared with actual exports in 1972 of 192 thousand tons p.w.

In spite of the promising recent trend in beef exports there is considerable doubt that Brazil will be able to meet these export targets. The basis for this assertion stems from three sources: (1) the limitations

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9/ These export targets are given in CONDEPE (12) and O Globo, October 23, 1972.

to increasing domestic supply, (2) the rapid increases in domestic demand, and (3) government price policy with respect to beef--broadly defined.[10/] Each of these aspects will be examined in turn.

The Limitations of Domestic Supply

The 1970 Agricultural Census reported that Brazil had 78 million head of cattle. Of this total, approximately 85 percent are of the various Zebu races or crossbreds of Zebus with native creole cattle. Fifteen percent of the national herd are of European breeds and crosses. Moreover, according to a recent study of the cattle industry (Cunha (16)), 15 percent of the total cattle population are of predominantly dairy breeds[11/] and 35 percent are of breeds which are suitable for both milk and beef production.[12/] Thus, the interdependency between the beef and milk sectors is quite marked in Brazil, and as will be seen later, this has some important ramifications for beef policy.

Beef production is geographically centered in the Central-Southern region of the country, and traditionally the most important cattle-producing States have been Mato Grosso, Goias, Minas Gerais, Sao Paulo and Rio Grande do Sul. However, the cattle-producing regions have been gradually moving North and West, towards the frontiers, as the area in crops has expanded. Thus, the relative importance of Mato Grosso, Goias, Para, Bahia, Minas Gerais, and Maranhao is increasing rapidly.

10/ Government price policy with respect to beef for present purposes includes domestic price controls and trade policy as it affects beef prices.

11/ These are mainly Holstein and Holstein cross cattle.

12/ These are mainly crossbreds with Zebu cattle of the Gir type.

Table 1.4 Beef Output, Exports and Consumption, Brazil, 1947-71.

Year	Beef Output (thousands of tons c.w.)	Beef Output Per Capita (Kg/inhabitant)	Beef Exports (thousand tons e.c.w.)	Apparent Domestic Beef Consumption (thousands of tons c.w.)	Apparent Consumption per Capita (kg c.w. per inhabitant)
	(1)	(2)	(3)	(4)	(2)
1947	866	17.9	55.5	810.5	16.7
1948	986	19.9	75.1	910.9	18.4
1949	1035	20.4	42.6	993.4	19.6
1950	1036	19.9	30.0	1006.0	19.4
1951	1087	20.3	12.2	1074.8	20.1
1952	1056	19.2	6.1	1049.9	19.0
1953	1067	18.8	3.8	1063.2	18.7
1954	1087	18.6	1.6	1085.4	18.6
1955	1075	17.9	9.9	1065.1	17.7
1956	1213	19.6	15.8	1197.2	19.3
1957	1254	19.9	36.1	1217.9	19.3
1958	1393	21.2	58.6	1334.4	20.3
1959	1386	20.4	95.6	1290.4	19.0
1960	1291	18.5	26.9	1264.1	18.1
1961	1301	18.1	50.0	1251.0	17.4
1962	1288	17.4	37.2	1250.8	16.9
1963	1293	17.0	29.2	1263.8	16.6
1964	1365	17.5	41.1	1323.9	16.9
1965	1422	17.7	85.1	1336.9	16.6
1966	1379	16.7	51.7	1327.3	16.0
1967	1431	16.8	30.6	1400.4	16.4
1968	1609	18.4	93.9	1515.1	17.3
1969	1735	19.2	145.2	1589.8	17.6
1970	1753	18.9	171.7	1581.3	17.0
1971	1670	17.5	205.4	1464.6	15.4

(1) Beef output as reported by EAGRI, less 5 percent to convert to cold carcass weight basis. Beef output refers to slaughter.

(2) Population data from Annuario Estatistico, various issues.

(3) Beef exports from CIEF, Ministerio da Fazenda, on product weight basis converted to carcass weight equivalents. (See Appendix B).

(4) Output minus exports.

The degree of specialization of production activities (breeding, rearing and fattening), both within the sector as a whole and on a regional basis, is quite marked. Cunha[13/] estimates that only 36 percent of beef cattle farms are integrated units which breed, rear and fatten cattle on the same farm. The more common production pattern is for calves or young steers to be sold from one of the major breeding regions (Southern and Western Mato Grosso, Goias, Northern Minas Gerais and the Western sections of Sao Paulo, Parana and Rio Grande do Sul) for fattening in more intensive farming regions (Bahia and the Central regions of Minas Gerais, Sao Paulo and Rio Grande do Sul). But even beyond this, there is a great deal of local specialization, with broad cow herds kept on poorer land and the fattening operation carried out on higher quality land.

The fattening phase is generally carried out on grass alone, and even this final stage of the production process has traditionally been a very land-extensive system when compared to those of other exporting countries.[14/] However, this pattern is changing, and intensive grass-fattening systems based on artificial pasture are becoming more common, especially in the Southern states where the opportunity cost of land is highest.

On a national basis the level of animal productivity in the beef sector is extremely low and this is a severe constraint on the rate at which the sector can respond in the short and medium term. Weaning rates are normally about 50 percent, and mortality rates are very high,

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13/ Cunha (16).

14/ A more detailed discussion of Brazilian beef cattle technology in relation to other producing countries is given in FAO (73).

especially for young stock. Steers are slaughtered around four to four-and-a-half years of age, and the average carcass weight at slaughter for all cattle is generally between 190 and 200 kilograms.[15/] The turnoff rate[16/] in the sector is about 15 percent, which is low by comparison with Argentina (25 percent), Australia (25 percent) and New Zealand (40 percent)[17/], the other major beef exporting countries.

Because the level of animal productivity is so low, increases if this variable are expected to be relatively cheap if government expenditures on research and extension are increased and farmers have sufficient incentive to adopt new technology. By the same token, one of the reasons why productivity is so low is that public expenditures on beef cattle research have been low in the past.[18/] In summary, then, Brazil's ability to expand beef exports rapidly is constrained by low productivity within the supply sector, which limits the speed with which the sector can respond to the current export drive, at least in the short run.[19/]

15/ These data are published by the Ministry of Agriculture.

16/ The turnoff rate is defined here as the proportion of the cattle stock which go for slaughter in a given year. The rate varies, however, not only according to the level of technology, but also depending on the stage in the cattle cycle. The figure quoted here refers to the turnoff rate as measured by the official ratio of the official slaughter data to the census stock data for 1970.

17/ The value for New Zealand is inflated by the large number of surplus dairy calves slaughtered for veal. Hence, this figure is not really comparable with the others.

18/ Although hard facts are difficult to obtain on this subject, the above view is commonly held by researchers both within the government and the universities. For a discussion of this problem, see FAO (73). There is some indication that the Ministry of Agriculture intends to correct this deficiency with the creation, in 1972, of a public research corporation to coordinate all agricultural research.

19/ It should be noted that this same factor provides considerable potential for expansion over the long run, however.

Table 1.5. Beef Consumption by Income Class, Brazil, 1960.

Family Income Class (Cr$/Year)	Per Capita Beef Consumption (Kgm/year)
less than 100	6.76
100-149	9.38
150-249	11.68
250-349	16.67
350-499	16.03
500-799	19.52
800-1199	26.24
1200-2499	29.72
above 2500	39.61

Source: Food Consumption in Brazil, Center for Statistical and Econometric Studies, FGV, Rio de Janeiro (November, 1970).

Increasing Domestic Demand

The second factor which may restrict Brazil's ability to export beef is domestic demand. The average consumption of beef in Brazil is very low (Table 1.4), but consumption rises rapidly with income (Table 1.5). Further evidence on this point is provided by a series of budget studies conducted by the Fundacao Getulio Vargas (FGV) and other research institutions, and summarized in CONDEPE (12). These studies show that the income elasticity of demand for beef in Brazil varies from 0.5 for the higher income groups to 1.6 for the lower income groups. Hence, the current large income gains from rapid economic development can be expected to increase domestic demand at a fairly high rate. This tendency towards an increase in domestic demand will be accentuated if the distribution of income improves,[20/] because an improvement in the relative income position of the poorer sections of society implies a greater than proportional rise in the quantity of beef demanded by consumers.

Beef Price Policy[21/]

The third major constraint on Brazil's beef export potential is the manner in which the government has traditionally used domestic price policy and trade policy to hold down the price of beef, and to discriminate against beef exports. These policies have historically caused a large variation in the volume of beef exports. Since Brazil began exporting beef in 1914, for example, the annual volume exported has averaged 54 thousand tons p.w.,[22/] but with a standard deviation of 39 thousand

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20/ Based on the 1970 Census data, at least, there is some doubt as to whether the distribution of income in Brazil is improving or not. For a discussion of this issue see Fishlow (25) and Langoni (44).

21/ A detailed discussion of policy that affected the beef sector in Brazil over the period 1947-73 is given in Appendix A.

22/ This export data is given in FAO (73).

tons p.w. Exports have ranged from a high of 150,000 tons p.w. in 1940[23/] to a low of less than 2000 tons p.w. in 1954.

This export record is the result of policies adopted to meet a high priority objective common to all post-war Brazilian goverments, namely an attempt to control the inflation in food prices directly with domestic price controls and indirectly with trade policy. These policies were applied because the bulk of the food products also had export potential. Within the food subgroup, these policies have traditionally discriminated rather heavily against the domestic beef sector because beef is an important component in the diet of middle income groups who have considerable political influence. In fact, beef has probably received more attention from policy-makers in this regard than any other product, with the possible exception of milk.

The effect of these policies on beef exports over the period 1947-71 can be seen in Table 1.4. Per capita beef output (slaughter) fell 5 percent from the period 1947-51 to the period 1967-71, and per capita consumption fell by nearly 7 percent. This means that beef output has not kept pace even with the growth in population, and since exports have trended upwards over the period, per capita consumption has fallen even more.

To summarize, the desire to expand beef exports as part of the policy to liberalize trade has often been frustrated in the past by reourring high rates of inflation. The government response to these crises has been to reverse policies designed to remove trade distortions. These policy switches have very likely had a detrimental effect on beef

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23/ Actually, this record was surpassed in 1972 with estimated exports of 192 thousand tons p.w.

production by reducing investment in cattle and new production technology. If this process continues into the future without a better understanding of the structural parameters of the beef sector, then Brazil's ability to export beef is very likely to be severely constrained.

Objectives and Procedures

The objective of the present study is to analyze the structure of the Brazilian beef economy by estimating a national econometric model which links the supply, demand, export and government sectors. The last sector is included in a policy-making role in an attempt to explain the historical discrimination against beef exports with a view of including a policy variable in the model. It is hoped that the results of the model will provide a better understanding of the structural relationships within each sector of the beef economy and the relationships among them. The estimates of the parameters of the model will be used to quantify the effects of policy changes and particular exogenous variables on beef production, consumption, and exports.

The model is estimated with secondary data for the period 1947-71. The statistical model is used as a basis for making various analyses of the beef sector and for drawing implications about policies that might be needed to attain government objectives.

Previous Studies of the Brazilian Beef Sector

Two classes of studies are of relevance as background to the present study. The first class includes previous attempts to make estimates of the export potential for beef. The second class includes previous attempts

to identify and estimate structural equations which describe some part of the beef sector. The material in this section is organized under these two sub-headings.

Export Projections

There are four recent studies which demonstrate some of the points raised in earlier sections concerning Brazil's ability to export beef over the next ten years. These studies are projections of the supply, demand and exports of beef until 1980. The principle demand parameters and the beef export projections from these studies are summarized in Table 1.6.

The first of these studies was carried out by the Fundacao Getulio Vargas (30). This study used an estimate of the production function for the livestock sector as the basis for projecting supply, and assumed rates of growth of population and per capita income (together with an assumption about the income elasticity of demand) to project domestic demand. The study also made a series of adjustments to projected changes in the age distribution of the population.

The parameter assumptions and resulting projections are presented in line (1) of Table 1.6. Domestic demand for 1975 was projected to exceed domestic supply at a constant real price of beef by almost 1.3 million tons c.w.

The second study was made by the Food and Agriculture Organization. This study used basically the same approach as the Fundacao Getulio Vargas on the demand side, but without accounting for sectoral differences in consumption patterns. To project beef supply the FAO simply extrapolated

Table 1.6. Projections of Brazil's Beef Export Potential, Selected Studies.

Study	Parameter Assumptions				Export Projections	
	Growth Rate, Population (Percent)	Growth Rate, Income per Capita (Percent)	Income Elasticity of Demand	Projected Real Price of Beef	1975 (thousand tons c.w.)	1980 (thousand tons c.w.)
FGV[a/]	3.1	3.1	0.64	constant	-1290	--
FAO[b/] (1)	2.9	3.1	0.60	constant	-14	190
FAO[b/] (2)	2.9	5.1	0.60	constant	-62	67
FGV[c/] (1)	2.7	4.7	0.51	constant	-198	-499
FGV[c/] (2)	2.7	4.7	--	past trend	308	471
CONDEPE[d/] (1)	2.86	av.5.08[e/]	0.5 to 1.6[e/]	up 23% 1975 up 41% 1980	300	600
CONDEPE[d/] (2)	2.86	av.5.08[e/]	0.5 to 1.6[e/]	constant	-277	-650

Source: [a/] FGV (30)
[b/] FAO (72)
[c/] FGV (31)
[d/] CONDEPE (12)
[e/] Income was projected by income class and different income elasticities were assumed for each income level. The projected growth rate in per capita income presented here is the average for the income classes, and the income elasticity of demand is the range covered among classes.

past trends in production. The export projections from this study are more optimistic than those produced by the FGV, but they still show an exportable surplus of only 190,000 tons or 67,000 tons c.w. in 1980, depending upon which rate of income growth is used. This improvement is due in part to the lower income elasticity used to project demand.

In 1973 FGV made a new set of supply and demand projections, using a simpler technique than in the previous study. Beef supply (output) was projected by extrapolating the 1950-70 trend. The domestic demand for beef was projected first by assuming that the real price remained constant, and second, by extrapolating the past trend in per capita consumption as a function of income alone. That is, the second projection, FGV (2),assumes that the past trend in price will continue up through 1980.

This study is an advance over the previous studies since it highlights the influence of price on domestic demand. If the real price of beef remains at its 1970 level, then by 1980 domestic demand is expected to exceed supply by 499,000 tons c.w. On the other hand, if price increases of the past continue into the future, Brazil is expected to have an exportable surplus of 471,000 tons c.w. by 1980.

The final study, CONDEPE (12), is the most sophisticated of the four. Domestic demand is projected by state, income class, and an urban-rural distinction. For this purpose the study incorporated available data on income elasticities of demand by income class and by region. The study contains demand projections from 1971 to 1980,assuming first that the real price of beef remains constant, and second, that the price elasticity of demand is within the range of -0.8 to -1.0

Beef output, on the other hand, is obtained by projecting forward the stocks of cattle and assuming a specified slaughter age. This is done by means of a simulation model which incorporates various technological improvements and increases in productivity. The simulator is taken from Dias (19), and the results presented in Table 1.6 are those referring to the maximum rate of growth of the cow herd.

The results of this study are very similar to those obtained in the second FGV study. If the real price of beef remains constant, CONDEPE (2), domestic demand is projected to exceed supply by 650,000 tons c.w. This is of the order of magnitude given by FGV (2). Similarly, if the real price of beef rises 41 percent by 1980 (CONDEPE (1)), Brazil is expected to have an export surplus of 600,000 tons c.w. Again, this is of the same order of magnitude as given by FGV (2).

There are some general comments that can be made with regard to these studies. First, the studies do not make perfectly clear the quantity units that are being used to measure the volume of exports. Hence, they tend to be confusing and not directly comparable. For example, the CONDEPE study projects output and demand in terms of the carcass weight of beef, and calculates potential exports as the difference between the two. Hence, potential exports are also on a carcass weight basis. However, these export potentials are then compared to, or even equated with, current export volumes and target export levels, which are reported in terms of the weight of beef products.

This leads to an over-estimate of the export potential or the import requirement, because there is a considerable difference between the carcass and product weight of beef in Brazil.[24/] This is significant

[24/] See Table B.4.

because an important proportion of beef exports consists of manufactured products and boneless cuts. For example, in 1971 Brazil exported 124 thousand tons of beef on a product weight basis. Of this total, 28.3 percent was in the form of manufactured beef products (corned beef, canned beef, etc.), and 61 percent of the remainder consisted of boneless cuts. When these products are accounted for, the volume of beef exported that year was 205 thousand tons in terms of carcass weight.

A second comment on the studies is that they have not attempted to explicitly include the effect of input and product prices on the supply of beef. The study which comes closest to providing such information is the CONDEPE study, which makes supply projections for various changes in animal productivity considered feasible by the authors. Thus, the beef price is implicitly accounted for on the supply side.[25/] However, the reader is left with the dilemma of matching the various demand projections, in which the effect of price is explicitly accounted for, and the various supply projections, in which the effect of beef price is accounted for at best only implicitly.

Third, the studies appear to have been rather conservative in their projections of per capita incomes and in their estimates of the income elasticity of demand for beef in Brazil. An exception again is the CONDEPE study, which uses considerably higher estimates of the income elasticity than the other studies.

The studies assume that the growth rate of per capita income will be between three and five percent per annum. However, over the last

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25/ Changes in the price of beef are accounted for in these supply projections through its influence on the demand for new technology, which raises the level of productivity, and through its effect on the retention of cattle.

five years increases in per capita incomes have varied between 6.0 and 8.3 percent per year, and this rate of growth has been trending upward. To the extent that Brazil is able to sustain growth rates of this magnitude, the export (or alternatively, demand) projections in these studies will be upper (lower) bounds rather than expected values.

Fourth, there is some evidence to suggest that the income elasticities used in the first three studies underestimate the real situation. The income elasticity used in the FGV studies was obtained from cross section studies of urban households only. Hence, when one considers that almost half the population is classified as rural, and that average per capita incomes in the rural sector are substantially below those in the urban sector, one is alerted to a possible (downward) bias in the estimated income elasticity, especially since it is used to project demand for Brazil as a whole.

This view is substantiated by the CONDEPE study, which shows that the income elasticity of demand for beef by the rural poor is as high as 1.6. In addition, the income elasticity among the urban upper income groups is shown to be around 0.5.

A further point is that the sample of families used in the FGV study appears to be biased in favor of the middle and upper income groups. For example, the FGV sample in 1960 had only 27 percent of their observations among families with annual incomes less than Cr$250.[26/] However, a study by Fishlow[27/] showed that in the same year 68 percent of Brazil's

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[26/] FGV (29), p. 5.

[27/] Fishlow (25), p. 392. It is necessary to adjust the two sets of income data because different deflators were used in the original sources.

population was in that same income class. If the results of the Fishlow study, which is based on the census data, more closely approximate the real situation, then the income elasticity used in the FGV study could be underestimated and, accordingly, projected demand will be biased downward.

The fifth point is the ad hoc manner in which price projections (both international and domestic) were incorporated in the studies. The only two estimates which assumed anything but constant real domestic prices were the FGV (31) and CONDEPE (12) studies, and even these studies made no attempt to relate the domestic price to the international market. The former study assumes a constant price trend, but the CONDEPE study, by incorporating a price elasticity of demand, permits a projection of demand for any given domestic beef price. For example, it is possible to estimate the domestic price increase necessary to provide the export surplus envisaged by the government planners from the CONDEPE study. The current beef export target is 600 thousand tons p.w. in 1980. If we assume that the export product mix remains the same as it was in 1971 (see above), then this target converts to 992 thousand tons c.w. Then, if the price elasticity is -1.0, the domestic price would have to rise 82 percent in real terms by 1980 to generate the necessary export surplus, given the most favorable productivity assumptions. This calculation is identified as CONDEPE (3) in Table 1.5. The question that remains unanswered, of course, is what assumptions are being made about the growth in world prices and Brazilian trade policy.

In summary, these studies serve to alert policy-makers to the possible difficulties in attaining the beef export targets. The source of the difficulty, as identified by these studies, is the large expected

increase in the domestic demand for beef.

Structural Relationships

There are a number of studies of the structural relationships of the beef cattle economy in Brazil. On the production side, Engler (21) and Richter (61), using linear programming models, have analyzed the substitution relationships between beef and crop production at the farm level in Sao Paulo and Rio Grande do Sul, respectively. In addition, there are a number of statistical analyses of resource productivity and technology at the farm level for selected regions. Examples of such studies include Silva (65), Santos (63), Guillen (36), Simoes (66), and Rocha (62).

The demand for beef in Brazil and marketing considerations have not received the same attention as the production side, but there are some studies for particular regions: Camargo (9) for the Zona Metalurgica of Minas Gerais, and Carmo (10) for the State of Sao Paulo. The export demand for Brazilian beef has been analyzed in two studies, Knight (41) and Von Doellinger, et. al. (76). These studies have estimated export functions for beef from Brazil in the post-war period.

In addition to these studies there has been one comprehensive econometric study of the Brazilian beef cattle economy. This study, Dias (18), consists of a short run econometric model for the Central-Southern region of the country. The model is composed of three structural equations which describe the slaughter of steers and cows and domestic demand. The estimated coefficients of the model are all in accord with a priori expectations. They show, for example, the negative short-run elasticity of output with respect to the price of beef. However,

because the model does not include the investment side of beef supply, it does not provide information with respect to the longer-run coefficients. Furthermore, the export sector was not included in the model, on the grounds that exports were not a significant proportion of total demand over the period under consideration (1946-64). This conclusion was arrived at, in part, because the volume of exports was not converted to the units used to measure output, and hence the importance of the export sector was underestimated.

In conclusion, there are a number of issues that are not covered by past studies of the Brazilian beef cattle economy. Specifically there is a need for information at the national level concerning the price elasticity of beef supply over time with respect to its own price, the possible linkages between the beef sector and other agricultural sectors, the effect of inflation on investment in cattle, and an understanding of the mechanism whereby trade and price policy act to influence the domestic price of beef and exports over time.

Organization of the Remainder of the Thesis

Chapter II brings together various pieces of economic theory which are required to specify an economic model of the Brazilian beef cattle economy. The results and discussion of the statistical analysis are given in Chapter III.

Implications for policy and general economic interpretation, together with a set of export projections are presented in Chapter IV. And a summary, list of principal conclusions, and suggestions for further research are presented in Chapter V. Supporting material such as the

data used in estimation, a description of the data, a review of beef policy over the period 1947-73, and supplemental data which may be usful in future studies are presented in the Appendices.

CHAPTER TWO

MODEL SPECIFICATION

The objective of this chapter is to develop an economic model of the Brazilian beef cattle economy which can be used as a basis for the statistical analysis to be presented in Chapter Three. After a brief explanation of the focus of the economic model, this chapter deals with each of the four components of the beef economy (supply, demand, policy, and exports) that make up the complete system under consideration. The chapter ends with a complete specification of the economic model.

Focus of the Study

This study is concerned with the economic behavior, at the national level, of the supply, demand and exports of beef from Brazil. This focus is derived from the primary aim of the study, which is to provide an empirical basis for the evaluation of government policy. Interest centers on cattle producers and the final consumers of Brazilian beef (domestic and foreign), and abstracts from the processing, marketing and transport intermediaries between the farm gate and retail outlets. This approach is taken, not because these sectors are unimportant in understanding the beef sector, but because their inclusion would greatly complicate and extend the analysis, and the limitations of resources--both in time and money--were real. It is believe that the suppression

of these sectors of the beef economy for the purposes of the present study introduces no serious distortions to the findings presented below, even though the other sectors are important and of interest in their own right.

The Supply Behavior of Cattle Producers

The dynamic supply response and investment behavior of cattle producers poses some difficult issues for policy-makers and economic analysts alike. There are two basic reasons for this. First, beef cattle are simultaneously an investment and a consumption good. And second, the production period of slaughter cattle is normally longer than the observation periods commonly used in empirical studies (a quarter of a year). Thus, for example, when annual observations are used to infer changes in the trend in supply, it is very easy to arrive at erroneous conclusions. Previous researchers have succinctly stated the source of this confusion as follows: in contrast to other industries, the primary input into cattle production is the animal itself[1/] and the (beef) consumer cannot tell whether he is eating the machine or the product.[2/]

These characteristics often lead to confused thinking amongst policy-makers and laymen, with the result that it is common for the stated objectives of beef policy in a given country to be completely at odds with the instruments introduced to attain them. However, applied economists themselves are not free from criticism in this regard, either because often they have failed to fully understand the investment-output mechanism of beef production, or because they specify empirical models which do not

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1/ Jarvis (39, p. 42).

2/ Yver (77, p. 5).

correspond to the theory from which they purportedly have been derived. Jarvis (39), Yver (77) and Carvalho (53) have pointed out a number of specific examples of these deficiencies.

Recent studies provide us with the more important elements of the theory relating to the investment and supply behavior of cattle producers. The following paragraphs are dedicated to reviewing these studies with the aim of combining the various ideas to produce a rather complete but simplified view of the problem.

Yver (77) enumerates the three basic decisions facing a cattle producer. These are: (1) the amount of capital to own, (2) the composition of that capital, and (3) the rate of utilization of the capital in the production process. The first two questions are basically portfolio issues, while the third is the typical output decision. The output decision for beef is similar to that for other products, and will not be discussed further here. However, the investment process is more complicated, and merits some explanation.

There are two basic methods of investing in cattle: (1) investing more inputs per animal, and/or (2) breeding more animals. These are the familiar capital-deepening and capital-widening aspects of capital theory. The three studies mentioned previously, (Jarvis, Yver, and Carvalho) treat the capital-deepening issue of cattle investment rather extensively. These studies adapt a basic capital theory model which focuses on the concept of a desired stock of cattle and the optimum adjustment path to reach that stock to derive the optimum slaughter ages of cattle. Jarvis (40) and Yver (77) derive this theory in a comparative static framework, and show how the theory can be used to explain the development of the cattle industry in Argentina.

Jarvis (39), in an excellent summary of these models, begins by considering a very much simplified model to determine the optimum slaughter age and optimum input stream of a steer, given the growth function of the animal and the following parameters faced by producers: the price of beef, the interest rate, and the cost of inputs other than capital. The producer is assumed to maximize the present discounted profit of the fattening process, which in perfect markets will equal the value of the calf at birth.

Similarly, Jarvis considers a model where the only input is the steer itself. In this case the "profit" function is given by equation 2.1, after setting the beef price arbitrarily equal to one:

$$V(\theta) = w(\theta)e^{-r\theta} \qquad (2.1)$$

where:

$V(\theta)$ = the present discounted value of an animal at age ,

$w(\theta)$ = weight of the steer at age θ, $\frac{\partial w}{\partial \theta} > 0$, $\frac{\partial^2 w}{\partial \theta 2} < 0$,

r = interest rate,

θ = age of the steer.

The first-order condition for a maximum requires that:

$$\frac{\frac{\partial w}{\partial \theta}}{w} = r.$$

That is, the optimal slaughter age (θ) occurs when the rate of growth of the animal is equal to the interest rate. The second-order condition, $\frac{\partial^2 V}{\partial \theta^2} < 0$ follows, and requires that the rate of gain be declining.

It follows from this model that an increase in the interest rate will lower the optimum slaughter age, and vice-versa:

$$\frac{\partial \hat{\theta}}{\partial r} = - \frac{\frac{\partial^2 V}{\partial \theta \partial r}}{\frac{\partial^2 V}{\partial \theta 2}} < 0$$

because

$$\frac{\partial^2 V}{\partial \theta^2} < 0,$$

and

$$\frac{\partial^2 V}{\partial \theta \partial r} = e^{-r\theta} \left(r\theta w - \frac{\theta \partial w}{\partial \theta} - w\right) < 0$$

by the first order condition. That is, a decrease in the cost of the one input, capital, will increase the optimum slaughter age and decrease the number of animals slaughtered in the short run.

An adjunct of this important result can also be derived with respect to a change in the price of beef ($p(\theta)$). Take the case $\theta<\hat{\theta}$. Because $\frac{\partial w}{\partial \theta} > r$ at this age, the animal must be worth more as a growing machine than as a consumption good. Hence, its price is determined by its capital value. That is:

$$p(\theta)\, w(\theta) = p(\hat{\theta})\, w(\hat{\theta}) e^{-r(\hat{\theta}-\theta)}$$

Letting

$$w(\hat{\theta}) = e^{g(\hat{\theta}-\theta)}\, w(\theta),\ g>r.$$

Then

$$\frac{p(\theta)}{p(\hat{\theta})} = \frac{w(\hat{\theta})}{w(\theta)}\ e^{-r(\hat{\theta}-\theta)} = e^{(g-r)\ (\hat{\theta}-\theta)}$$

and

$$p(\theta) > p(\hat{\theta}),\ \theta<\hat{\theta}.$$

Similarly, it can be shown that

$$p(\theta) > p(\hat{\theta}),\ \theta>\hat{\theta}.$$

Therefore, although the value of the animal itself increased monotonically, the price per pound of beef from the animal, $p(\theta)$, will have a U-shaped profile, with the minimum price occurring at the optimum slaughter age.

The model can be made more realistic by recognizing that a steer requires other inputs. Now the optimal slaughter decision also depends on the animal being given an optimal level of these inputs. The criterion becomes the maximization of the present discounted "profit", $(\pi(\theta))$. This is given by equation 2.2:

$$\pi(\theta) = p(i,\theta)\ w(i,\theta)\ e^{-r\theta} - ci_o \int^{\hat{\theta}} e^{-rt}\ dt, \qquad (2.2)$$

where:

i = fixed bundle of daily inputs to the sterr, independent of θ, and

c = the cost of the fixed bundle, i.

The first-order conditions for the maximization of π yield the following relationships:

$$p\frac{\partial w}{\partial \theta} + w\frac{\partial p}{\partial \theta} = rpw + c\hat{i} \qquad \text{and}$$

$$p\frac{\partial w}{\partial i} + w\frac{\partial p}{\partial i} = c_o \int^{\hat{\theta}} e^{-rt}\ dt = \frac{c}{r}\ (e^{r\hat{\theta}} - 1).$$

That is, at $\hat{\theta}$ a change in the value of the animal is equal to the current interest foregone plus the cost of feeding. Similarly, at $\hat{i}$ the present discounted value of the marginal net weight gain and price increase less the present discounted cost of feeding must be zero.

The comparative statics analysis of this model is rather lengthy and is not repeated here. Jarvis, however, presents the following qualitative results:

$$\frac{\partial \hat{i}}{\partial p} \quad , \quad \frac{\partial \hat{\theta}}{\partial p} > 0.$$

A rise in p increases the marginal value product of each input, thereby increasing the optimal feed ration and the optimal slaughter age:

$$\frac{\partial \hat{i}}{\partial c} \quad , \quad \frac{\partial \hat{\theta}}{\partial c} < 0.$$

A rise in the cost of inputs reduces both the daily input and the optimal slaughter age. Animals are not only fed less per day, but for a shorter period of time, because they grow more slowly at any given age. Hence,

$$\frac{\partial \hat{i}}{\partial r} \quad , \quad \frac{\partial \hat{\theta}}{\partial r} < 0.$$

A rise in r reduces the daily feed inputs because higher feed investment implies higher interest costs. The increase in r also reduces the optimal slaughter age since it increases the interest foregone at every age. Again, these results indicate a negative slaughter response in the short-run.

The model can be extended to cover female cattle by including a term in the profit function to cover the expected value of calves born in addition to the revenue from the sale of the animal. The comparative static results are qualitatively the same as for the steer model, but the magnitudes of the responses will be different. In particular, the longer is the discounting horizon of the animal, the greater the change in the capital value of the animal for a given change in the price of beef relative to the cost of the inputs. That is, the change in the capital price will be greater for a younger animal than an older animal, and greater for a female than for a male.

However, as Jarvis points out, these differences in the responsiveness of the capital price are not carried over directly to the slaughter elasticities. This is because the elasticity of slaughter is also a function of the relative availability of animals in each category. Nevertheless, Jarvis suggests that a convenient rule of thumb is that female animals should have a higher slaughter elasticity than males, and younger animals greater than older. Yver (77) states this condition more strongly, and shows that under "normal" growth characteristics of male and female cattle, the short run slaughter elasticity for female cattle will be greater in absolute value than that of male cattle.

The previous models have indicated that the short-run slaughter response is negative for all classes of stock. However, there are a number of reasons why the estimated signs may differ from this expected pattern. First, the beef price referred to in the model is the price expected to prevail over the lifetime of the animal. Thus, if an empirical model does not utilize a good approximation to the producers' expected price, the coefficients may be perverse. Second, the negative slaughter elasticity is strictly a short run phenomenon, and will only be revealed in empirical analysis if the observation period is short enough. Third, data for empirical analysis are restricted to that which can be generated from existing sources. When these categories do not mesh with the observation period used, animals can switch between three or more classes between observations and so tend to confound the statistical results.

A fourth possibility has been pointed out by Yver. In the short run, the ability of farmers to retain all classes of stock may be limited by

technolgical or other constraints.[3/] In this situation, farmers must choose which classes of stock to retain and which to sell, and the profit maximizing producer will tend to retain young stock and females and sell older cattle, especially steers.

If the ability of farmers to retain all classes of stock is restrained, then investment in male cattle and the sales of male animals can be expected to follow the pattern shown by the dotted lines in Figure 2.1. That is, intially the sales of male cattle will increase to ease the constraint, and male investment will be negative. These effects are shown as the dotted lines in Figure 2.1. As the constraint relaxes over time, the investment and sales patterns for these cattle will gradually correspond to those for female cattle which, in this case, may be represented by the solid lines.

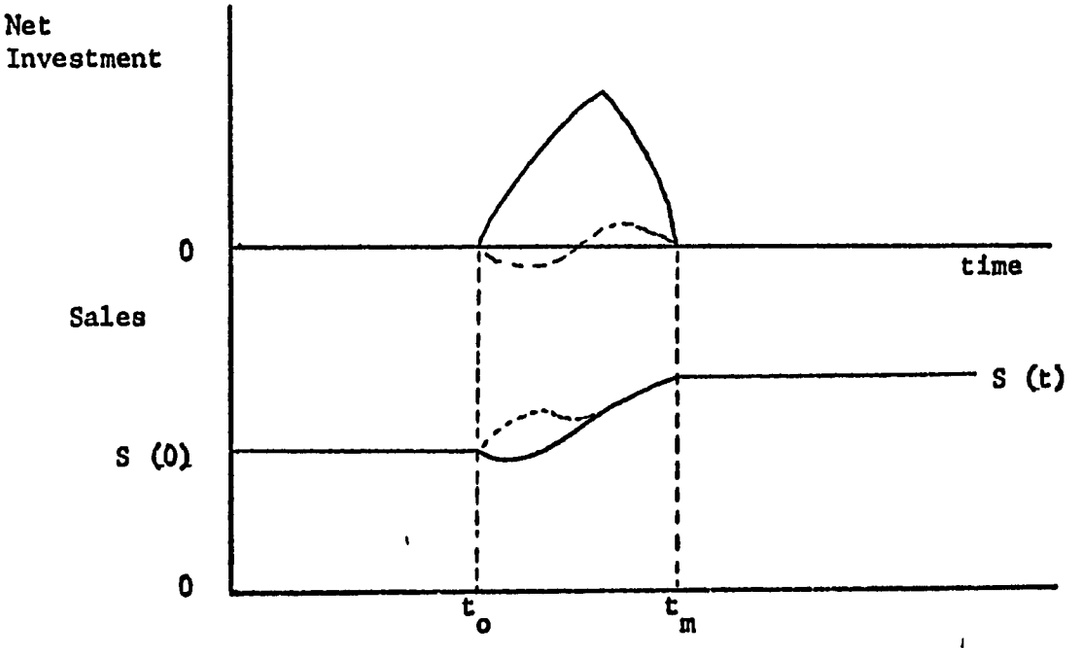

Figure 2.1. Changes in Investment and Sales When the Price of Beef Increases

3/ For example, these might be feed constraints or cash liquidity constraints. It may be noted here that it is theoretically possible for these constraints to be so restrictive that aggregate cattle sales do not fall after a price rise, as is being described here. This point will be taken up in the next section.

Carvalho (54) extends the model of the two previous studies. He utilizes a dynamic programming framework to derive an explicit dynamic model along the lines suggested by Nerlove (25). This theoretical model enables Carvalho to specify precisely the lag structure that is implied by the various biological and technical considerations in the production process. This represents a considerable improvement over previous studies, but it presents some formidable data problems.

The capital-widening aspect of investment in beef cattle is not dealt with extensively in these studies. However, this theory has been considered in other studies,[4/] and is well summarized by Hirshleifer (37). Furthermore, the implications that the theory of capital-widening has for empirical analyses of the present type have been described by Nerlove (53). Nerlove showed that in a distributed lag specification of supply and investment models, the coefficient of adjustment is a 'sink' in which is embedded the effect of all binding constraints on the rate of adjustment of the dependent variable other than those explicitly excluded elsewhere in the model.

The Investment Behavioral Relations

In the previous section the investment behavior of producers in terms of two classes of animals (males and females) was discussed. The theory also enables investment functions to be specified in terms of age groups as well, to the desired degree of accuracy.

One possible specification of these investment functions can be derived by assuming that actual investment in cattle of a given sex and age group is a function (α) of the difference between the desired stock of

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[4/] See, for example, Foley and Sidrawski (27) and Musalem (51).

cattle and the actual number on hand in that class from the previous year. This specification is given as equation 2.3.

$$\text{Investment}_{ijt} = S^{a}_{ijt} - S^{a}_{ijt-1} = \alpha_{ij} (S^{d}_{ijt} - S^{a}_{ijt-1}) \qquad (2.3)$$

where:

S_{ijt} = the stock of cattle of the i^{th} sex and the j^{th} age group in year t, (measured by weight)

a,d = actual and desired stocks respectively,

α = technological or economic constraint limiting the rate of adjustment.

The stock of cattle is expressed in terms of weight because the producer can invest either in more animals, or more weight per animal in the same number of animals, or some combination of both.[5/]

The model hypothesizes that cattle producers are unable to adjust instantaneously from their current stock position to the new optimum stock dictated by a change in exogenous factors. However, they move in the direction of the optimum by an amount which is proportional to the difference between that optimum and their present position. The greater is that difference, the bigger is the step they make towards the new optimum stock.

The desired stock of cattle is not an observed quantity, but it can be replaced by the economic variables which determine it. The desired stock of cattle is assumed to be determined as in equation 2.4:

$$S^{d}_{ijt} = F_{ij}(P^{b}_{t}, P^{f}_{t}, 1/r_{t}, : P^{m}_{t}) \qquad (2.4)$$

where the P's refer to prices and b,f,m, and r refer to beef, feed, milk and the interest rate, respectively.

5/ It was necessary to modify this specification in the empirical work because of the lack of data on live weights. (See below)

That is, desired stocks are postulated to be a function of the product price (which may be the joint products milk and beef in the case of females and calves), and the prices of inputs, feed and capital.

The price of milk is included in equation 2.3 for the cases of females and young stock because a large proportion of the beef herd in Brazil consists of dual purpose cattle which may be used to produce milk for sale in addition to calves. Hence, milk tends to be a complementary product with cow beef, but calves must compete with commercial sales for milk.

By substituting equation 2.4 into 2.3 and rearranging, the following equation results:

$$S^{a}_{ijt} = \alpha_{ij} \cdot F_{ij} \; (P^{b}_{t}, P^{f}_{t}, 1/r_{t}: P^{m}_{t}) + (1 - \alpha_{ij}) \; s^{a}_{ijt-1} \qquad (2.5)$$

The ideal situation would be to have a set of equations like equation 2.5 to represent investment in each class of cattle. However, the degree of refinement possible is limited by the availability of data.

In Brazil, there are no data available on the live weight of cattle on farms. Hence, it is not possible to specify the investment functions in terms of weight. Instead, numbers of animals are used to represent the stock of cattle.[6/] In addition, the official data on the stock of cattle on farms are not considered to be reliable. This problem can be appreciated by comparing the official statistics with the Census data and an independent stock estimate made in 1971 which tends to support the Census data. These data are presented in Table 2.1.

6/ This simplification is implicit in many studies of this type. See, for example, Nores (56), Yver (77) and Carvalho (54).

Table 2.1. Alternative Estimates of the Cattle Population in Brazil, Selected Years, 1950-1971.

	Total Number of Head ('000)		
Year	Official	Census	CEPEN
	(a)	(b)	(c)
1950	52,655	44,600	n.a.
1955	63,608	n.a.	n.a.
1960	73,962	55,693	n.a.
1965	90,629	n.a.	n.a.
1970	97,864	78,330	n.a.
1971	n.a.	n.a.	84,823

Source: a. EAGRI, Ministerio da Agricultura, Brasilia.
b. Censo Agricola, Fundacao IBGE, Rio de Janeiro.
c. CEPEN, Convenio M.A./CONDEPE, Rio de Janeiro.

Because of these data problems it was necessary to use stock estimates constructed from the slaughter data. These data are taken from a study by Dias (19), and the technique used to simulate the data permits the specification of two investment functions, one for females and another for males. These are given as equations 2.6 and 2.7.

$$EV_{t+1} = \alpha_1 F_1 \left(P_t^b, P_t^f, 1/r_t, P_t^m\right) + (1 - \alpha_1)\, EV_t \qquad (2.6)$$

$$EM_{t+1} = \alpha_2 F_2 \left(P_t^b, P_t^f, 1/r_t\right) + (1 - \alpha_2)\, EM_t \qquad (2.7)$$

where:

EV_t = stock of female cattle at the beginning of period t,

EM_t = stock of male cattle at the beginning of period t.

In addition to these variables there is an additional consideration to take into account. The Brazilian economy has experienced varying degrees

of inflation over the last 25 years, and this phenomeon may have had an effect on the short-run investment-output decisions of cattle producers. Beef cattle are a very liquid physical asset and are often used as a hedge against inflation in the absence of good alternative financial assets. To account for this, it was postulated that Brazilian entrepreneurs have included cattle in their portfolios together with other assets (physical and financial), not only for their productive value, but also for their value as a hedge against inflation. The hedging effect referred to here is a hypothesized short run phenomenon in an unstable inflationary environment. It is not the result of a change in the rate of inflation which is sustained for long periods of time.

Prior to 1965 Brazil did not have a well developed capital market, and since the inflation in Brazil was very unstable from 1947 to 1965, it is hypothesized that when the rate of inflation was expected to rise, cattle producers retained more stock than they would otherwise have done. Furthermore, this reaction might reduce slaughter in the short-run, ceteris paribus. In the long-run, however, such action would lead to an increase in beef output as a result of the previous increase in cattle stock.

In September 1965, the Brazilian Government made a series of improvements in the capital market. Tax incentives were introduced for investors and a system of monetary correction was applied to some bonds and time deposits.[7/] However, these improvements are not expected to have had an immediate or drastic impact on investor behavior, and hence are not taken into account here.

7/ Monetary correction in Brazil is a system whereby the return on some fixed interest rate bonds is adjusted for changes in the general price level. The aim of the scheme is to neutralize the effects of inflation.

In the empirical testing of the model, the beef price is taken as the real weighted average farm price as reported by the Ministry of Agriculture.[8/] The expected rate of inflation is represented by the rate of change in prices of all products for domestic use. The price of feed is represented by an index of the real prices of crops which compete with beef production at the margin. This variable is used as a proxy for the opportunity cost of land for pasture. The crops selected for this purpose are corn, wheat, soybeans, beans, cotton, and coffee. This proxy variable is used in the absence of a reliable indicator of the rental value of grazing land. Unfortunately, there does not appear to be good data on the real rate of return on capital over the period under consideration. For this reason, the cost of capital was excluded from the investment equations.

The investment equations which are used in the empirical analysis are given as equations 2.8 and 2.9.

$$EV_{t+1}=\alpha_1 F_1 \ (P_t^b,\ P_t^f,\ P_t^m,\ \dot{P}/P_t) + (1-\alpha_1)\ EV_t \qquad (2.8)$$

$$EM_{t+1}=\alpha_2 F_2 \ (P_t^b,\ P_t^f,\ \dot{P}/P_t) + (1-\alpha_2)\ EM_t \qquad (2.9)$$

where $\dot{P}/P$ = expected rate of inflation.

The signs of all the coefficients are expected to be positive, with the exceptions of those of the feed prices (P_t^f).

Slaughter Equations

The second part of the supply side of the model (equation 2.10 and 2.11) is postulated to explain the slaughter of male and female cattle:

$$B_t = F_3 \ (P_t^b,\ P_t^f,\ \dot{P}/P_t,\ EM_t) \qquad (2.10)$$

[8/] The data series used in the empirical analysis together with their sources are given in Appendix B.

$$V_t = F_4 (P^b_t, P^f_t, P^m_t, \dot{P}/P_t, EV_t) \qquad (2.11)$$

where:

B = number of male cattle slaughtered, and

V = number of female cattle slaughtered.

The stock variables are included in the slaughter equations as proxies for the number of cattle available for slaughter at the beginning of the period. An increase in the price of milk is expected to reduce cow slaughter, ceteris paribus. As noted in Appendix A, the price of milk to the farmer has been controlled for most of the period under consideration. For this reason, the milk price is represented in the empirical analysis by the milk price announced by the Government immediately prior to the onset of the dry season. As with all other prices used in the analysis, the milk price is expressed in real terms.

In equation 2.10 the signs of the coefficients are expected to be positive for the price of competing crops and the male stock, and negative for the rate of inflation and the price of beef.

Domestic Demand

Beef is an important component in the diet of Brazilians, especially those in the middle and upper income groups. The demand for beef on the domestic market is postulated to be a function of the price of beef, the price of substitutes like pork and chicken, real disposable income, and population. This relationship is given as equation 2.12:

$$D_t = (P^b_t, P^s_t, Y_t, Pop_t) \qquad (2.12)$$

where:

P^s = price of substitutes,

Y = real disposable income, and

Pop = population.

In the empirical analysis, demand is expressed in terms of the number of slaughter cattle in order to be consistent with the supply side of the model. The price of substitutes is represented by the real price of pork, in the absence of data for other beef substitutes.

The Level of Government Intervention

The Brazilian government has relied rather heavily on trade policy (broadly defined) to influence the domestic price of beef.[9/] These policies have included export quotas, export taxes, overvalued exchange rates, and the tying of exports to the quantity of beef supplied (through storage) to the domestic market during the entre-safra.[10/] The net effect of these policies has been to lower the domestic price of beef in terms of the domestic currency when the latter is evaluated at the effective exchange rate for beef exports.[11/] Hence, these policies have driven a wedge betwen the world price and the domestic price of beef. This does not necessarily mean that the domestic price of beef (in terms of the domestic currency) has actually shifted with the introduction of these policies, but rather that the domestic price is lower than it would otherwise be.

9/ For detail, see Chapter I and Appendix A.

10/ The entre-safra is the period between the seasonal peaks in production. The period roughtly corresponds to the dry season or winter.

11/ The effective exchange rate for beef is the rate that applies to beef exporters, corrected for any taxes or subsidies which apply to those exports.

There are a number of reasons why it is important to be able to explain the effect of these policies and if possible, to be able to predict the policy changes. First, export restrictions of this type tend to reduce the profitability of the enterprise and hence reduce investment. Thus, if poor performance can be attributed to such policies, corrective policies can be recommended to stimulate the sector. Second, in projection work it is often convenient and meaningful to project trends in world price and then to project the export performance of a given country in the light of such world conditions. However, in order to do this a way must be found of predicting the effective exchange rate which is likely to link the two price levels, international and domestic. The model described in this section is designed to meet these objectives.

The basic hypothesis is that the level (or amount) of government intervention in the export market for beef is a variable which is explainable in terms of economic variables. Hence, the level of intervention is assumed to be predictable on the basis of certain exogenous and predetermined variables.

In general, the level of trade intervention for a given product is the sum effect of policies introduced to meet a number of objectives. Typically, these include a desire (a) to remove resources from the export sector into the import competing sector, (b) to increase government revenues and (c) to hold down the domestic price of exportable products.[12/] Given this framework, researchers commonly assume that the level of intervention for the product being studied is determined exogenously to the model being studied, since the policies introduced to meet the above objectives can be extremely complex.

12/ In developing countries, these are typically agricultural food products.

However, a maintained hypothesis of the present study is that over the period 1947-71, trade intervention against beef exports by the Brazilian government was determined primarily by a concern to hold down the domestic price of beef, and that the importance of other discriminatory motives was small by comparison with this objective. In order to visualize this maintained hypothesis, consider the simplest model of the Brazilian beef sector in which the export demand for beef is perfectly elastic (Figure 2.2). DD, SS and EE represent the domestic demand, domestic supply, and(foreign) export demand functions for Brazilian beef respectively. Notice that the export demand function, EE, is expressed in cruzeiros evaluated at the free-trade exchange rate. That is, the exchange rate would exist in the market if Brazil followed a policy of free-trade.

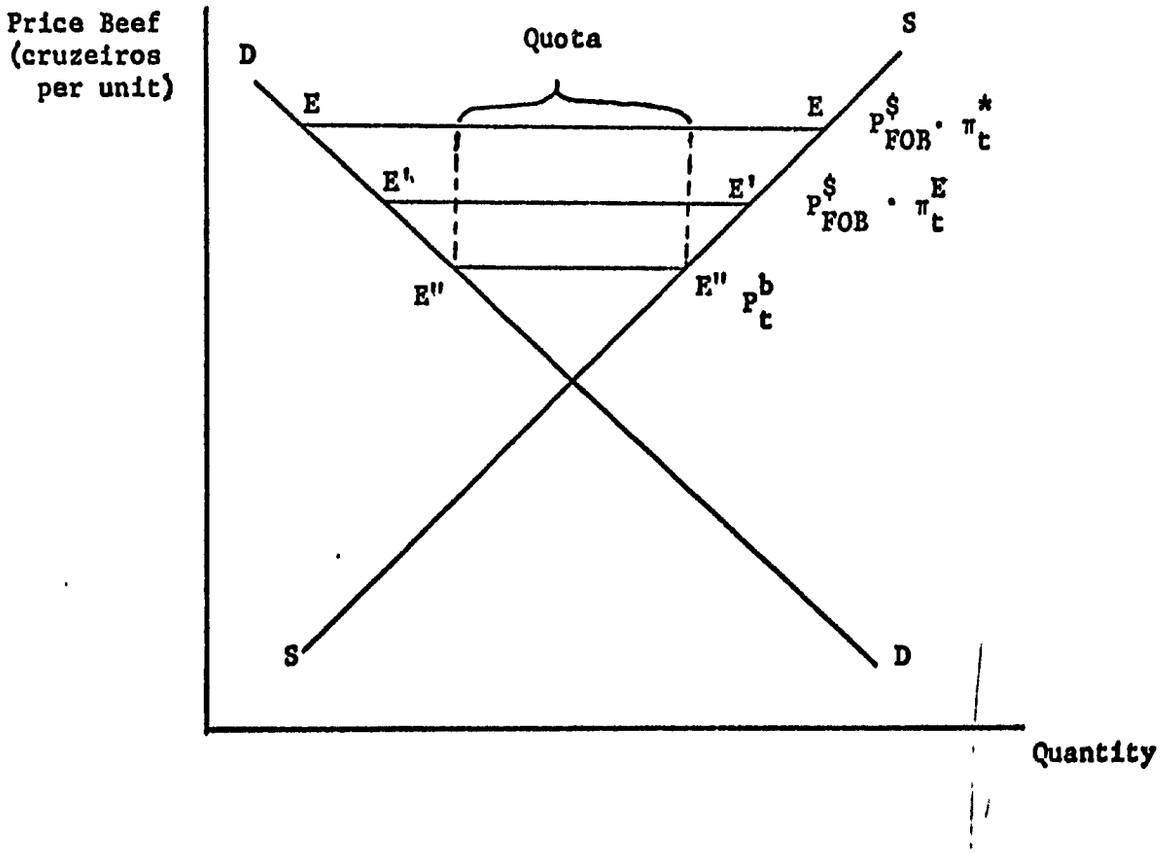

Figure 2.2. The Effects of Intervention in the Beef Export Market.

If the government introduces price-related commercial policy (e.g., export taxes or an overvalued exchange rate), the beef exchange rate is effectively lowered and the new export demand schedule is given by, say, E'E'. In this situation the domestic beef price (P^b) is equal to the F.O.B. price times the effective exchange rate (π^E), and the level of intervention is given by equation 2.13:

$$I_t = P_{fob} (\pi^*_t - \pi^E_t) \qquad (2.13)$$

where:

I_t = the level of intervention in time period t, measured in cruzeiros per unit weight,

P_{fob} = the price of beef for export, measured in U.S. $ per unit,

π^* = the free trade exchange rate, and

π^E = the effective exchange rate.

This intervention mechanism works in the following manner. If there is an increase in the quantity of beef demanded by the rest of the world, then the external or FOB price will rise, other things being equal. If the government should wish to prevent the domestic price from rising, the only instrument it has available to it in this model is to lower the effective exchange rate by means of one of the policies mentioned earlier. In this manner the degree of over-valuation of the beef exchange rate is increased (assuming that it was already over-valued), and the level of trade intervention against beef rises.

So far the discussion has included only price-related trade policies. However, at various times the Government has introduced quantitative restrictions as well. When these restrictions have acted as constraints on the volume exported, they have in effect reduced the export demand function to a position like E"E" in Figure 2.2. Since it is very difficult to

calculate the export tax that is equivalent to a quantitative restriction, it is usually not possible to express the domestic price in terms of the FOB price. However, since the domestic beef price is observable, it is possible to calculate the level of intervention (I') as the difference between the FOB price evaluated at the free-trade exchange rate and the domestic beef price (equation 2.14):

$$I'_t = (P_{fob} \cdot \pi^*) - P^b_t \qquad (2.14)$$

where:

I'_t = the level of intervention, including the effect of quantitative restrictions over time period t.

The major difficulty with this formulation is that the data available on beef prices at FOB and internally are not in the same units. This aspect is discussed in more detail in Appendix B.

Given, then, that it is possible to calculate the level of discrimination against exports in the beef sector, the problem that remains is to explain past levels of intervention. As shown previously, there are two basic forces impinging on the government with respect to beef export policy. One is the desire to hold down the price of beef to domestic consumers. The other is the need for foreign exchange earnings.

It is hypothesized that one measure of the government's interest in holding down beef prices is the current rate of inflation, as measured by the general level of prices. That is to say, it is assumed that the government reacts to rising domestic beef prices in as much as these prices influence the index of general prices, because it is the latter index which has been most visible to Brazilian policy-makers over the period. Increases in the price of beef have a significant effect on the

general price index because beef products have a weight of 0.25 in the food price index.

The desire to increase foreign exchange earnings and thus to reduce the level of intervention against beef exports is hypothesized to be a function of the overall position in the balance of payments. That is, when the balance of payments account is in surplus (or expected to be in surplus) then the Government is expected to increase the level of intervention, ceteris paribus. This is because the country can afford to sacrifice beef export earnings, which will in turn meet their policy goals vis-a-vis domestic consumers, without precipitating a balance of payments problem. The arguement also applies in the opposite case. If the government expects an overall balance of payments deficit (or if the deficit is expected to rise), it will tend to reduce the level of intervention in beef exports in the hope of overcoming a shortage of foreign exchange.

There is another factor which is hypothesized to interact with the two given above. It can be seen in Figure 2.2. that the higher the level of the FOB price, the greater must be the level of intervention against beef exports to maintain a particular price (or quantity consumed) in the domestic market. For this reason the FOB price is included with the other variables in equation 2.15 to explain the level of intervention:

$$I_t = F_6 (P_{fob}, \dot{P}/P_t, BOP_t, D_1, D_2, D_3, D_4) \qquad (2.15) .$$

where:

I_t = the level of intervention in the beef export market, as measured by equation 2.14,

BOP_t = the overall position in the balance of payments, and

D_i = the policy dummies, to account for major stances on trade policy which have changed over time. (This will be discussed in more detail below.)

In the empirical work an index of the price of Argentine beef in London is used as a proxy for the Brazilian FOB beef price.[13/] The balance of payments variable used is the overall balance of payments position. These data are discussed in more detail in Appendix B.

The set of dummy variables is included in the equation to account for hypothesized major shifts in trade policy response over time. It appears that all post-World War II governments in Brazil have discriminated in some degree or other against beef exports in the manner described above. However, it is not known, a priori, whether they have all reacted to the same degree in response to inflation or to the need for export earnings.

Vegia (75) has broken up the post-war period, 1947 to 1967, into four relatively homogenous sub-periods vis-a-vis trade policy. He made his classification on the basis of consistency of trade policy. The first period, 1947-53 was characterized by fixed nominal exchange rates for exports and imports, and import controls to correct imbalances in the balance of payments. The second period, 1953-1959, was the period during which multiple exchange rates were introduced, and during which Brazil followed a vigorous import substitution policy. A simplification of the complex exchange rate system took place in the third period, 1960-63, With still further simplificaiton (elimination of differentials) during the fourth period, from 1964-67.

13/ Export price data are available only on a product weight basis. The domestic price is given here as the farm price on a carcass weight basis. Quite apart from the problem of accounting for the value added from the farm gate to the wholesale outlet; there is the problem of the value of the offals, hide, etc. which is included in the latter price but not the former.

During the 1968-71 period a number of major reforms were carried out. The crawling peg exchange system was introduced and export incentives were added which effectively reduced the degree of over-valuation of the cruzeiro. However, since there was some consistency and continuity of policy between these last two periods,[14/] it is assumed that the years 1964-71 form one homogenous period.

Table 2.2. Brazil's Share of World Beef Exports, 1965-1970 (1000 tons).

Year	Beef Exports[a/] World	Brazil	Brazil's Share %
1965	2,082	54	2.6
1966	2,169	32	1.5
1967	2,289	19	0.8
1968	2,364	54	2.3
1969	2,595	94	3.6
1970	2,798	115	4.1
		Average	2.5

Source: FAO World Trade Statistics, Rome (1971)

a/ This includes unprocessed beef (fresh, frozen, and chilled) and processed meat (which is assumed to consist largely of beef).

Export Demand for Brazilian Beef

Over the past 25 years Brazil has supplied only a small proportion of total world beef exports (Table 2.2). Further, it is assumed that beef is a reasonably homogenous product throughout the world. Hence, the export demand for Brazilian beef is postulated to be perfectly elastic. This implies that the world price of beef is exogenous to the system and

14/ In this regard it should be noted that major devaluations were undertaken in 1964-67 to bring the exchange rate closer to our equilibrium.

that beef exports are determined simply as the difference between domestic supply and demand at the domestic beef price:

$$E_t = B_t + V_t - D_t \qquad (2.16)$$

where:

E_t = the volume of beef exports in year t, expressed as the equivalent number of slaughter cattle,

$B_t + V_t$ = numbers of cattle slaughtered, and

D_t = domestic demand, also measured in terms of animals.

Complete Model

The equations given in the previous sections may be combined to form the complete system given by equations 2.17 to 2.24:

Block 1: Policy Intervention Equation

$$I_t = F_6 (P_{fob}, \dot{P}/P_t, BOP_t, D_1, D_2, D_3, D_4) \qquad (2.17)$$

Price Equation Linking Domestic Economy to World Market

$$P_t^b = P_{fob} \cdot \pi_t^* - I_t \qquad (2.18)$$

Block 2: Slaughter Equations, Domestic Demand Equation, and Stock or Investment Equations

$$B_t = F_4 (P_t^b, P_t^f, \dot{P}/P_t, EM_t) \qquad (2.19)$$

$$V_t = F_3 (P_t^b, P_t^f, P_t^m, \dot{P}/P_t, EV_t) \qquad (2.20)$$

$$D_t = F_5 (P_t^b, P_t^s, Y_t, Pop_t) \qquad (2.21)$$

$$EV_{t+1} = \alpha_1 F_1 (P_t^b, P_t^f, P_t^m, \dot{P}/P_t) + (1 - \alpha_1) EV_t \qquad (2.22)$$

$$EM_{t+1} = \alpha_2 F_2 (P_t^b, P_t^f, \dot{P}/P_t) + (1 - \alpha_2) EM_t \qquad (2.23)$$

Block 3: Export Equation

$$E_t = B_t + V_t - D_t \qquad (2.24)$$

The level of government intervention is determined from Equation 2.17, given the world price of beef, the rate of inflation, and the overall position in the balance of payments. This information, together with the free trade exchange rate, permits the calculation of the domestic beef price through the identity 2.18. Having calculated the domestic beef price, the supply and demand for beef and investment in cattle can be estimated from equations 2.19 to 2.23. Finally, exports can be determined through the identity 2.24. The model is recursive in nature and the estimation techniques are discussed in the following chapter, together with the statistical properties of the system.

CHAPTER THREE

STATISTICAL RESULTS

This chapter is devoted to the statistical results obtained from estimating the model presented in the previous chapter. Two statistical results from estimating two models (I, II) are presented. Model I is discussed in detail and the results of this model are used to test the various hypotheses put forward in the previous Chapter. However, a second model (Model II) was also estimated and the results used for the projection analysis in Chapter Four, because certain problems were encountered in Model I which make it less suitable for this type of analysis than Model II. These problems will be discussed in more detail at the appropriate place in the text.

The material is divided into basically two parts. The first part contains a brief discussion of the econometric procedures used to estimate the model and the data used to estimate the parameters of the model. The second part contains a discussion of the statistical results obtained.

Econometric Procedures and the Data

The model presented in the previous chapter consists of three blocks linked recursively. Given that Brazil is unimportant in world markets for beef, it is assumed that its exports have no influence over world prices and that therefore the world price of beef can be treated as

exogenous.[1] The model postulates that this price is linked to the domestic market through a trade intervention equation, which is the first block of the model. The degree of intervention is postulated to be a function of variables that are also assumed to be determined exogenously to the system. The combination of the level of trade intervention and the external price of beef determine the domestic price of beef.

The domestic price of beef is assumed to be exogenous to the domestic demand and supply equations, which constitute the second block of the model. Hence, once domestic price is established through the intervention model, it in turn determines quantity demanded in the domestic market, slaughter, and the investment in cattle. Both the slaughter and investment (or stock) equations are specified on the basis of sex to account for hypothesized differences in behavior by sex.

Once domestic demand and supply are determined, exports are in turn determined through an export identity. This last equation constitutes the third block of the model, and postulates basically a "vent for surplus" export model.[2]

If the model is block recursive as postulated, ordinary least squares (OLS) applied directly to the structural equations will not provide consistent estimates of the coefficients. If, however, the parameters of the reduced form for the domestic price of beef[3] were

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[1] Should economic conditions change and Brazil become a major exporter in the future, this assumption would no longer be valid.

[2] For a more detailed discussion of this model and its importance in Brazilian trade policy, see Leff (45).

[3] In principle this procedure should be applied to any variable that is "endogenous" to the particular block. Given the specification of the model, and in particular the fact that the stock of animals on farms is taken at the beginning of the period, the price of beef is the only variable that might be determined "endogenously".

estimated by ordinary least squares and the predictions from this equation used in place of the observed values for price, the estimates will be consistent and asymptotically efficient.[4/] The latter procedure was used in the present study, and therefore statistical results are presented in terms of both the reduced form for the price of beef and the individual structural equations.

There are 8 endogenous variables in the full system, and 8 equations to explain them. Hence, the model is complete in the sense that there is one equation for each endogenous variable. Six of the equations are stochastic with parameters that have to be estimated with observed data. Two of the equations are definitional and non-stochastic. If the maintained hypothesis about the way in which the domestic price of beef is linked to the external market is valid, and if the assumption of the block-recursive nature of the system is valid,[5/] then the parameters of the structural equations will be identified.

The model is specified on an annual basis,[6/] and estimated with data from the period 1947-71. (The data are described in detail in Appendix B, and the rationale for particular devices of data series are also given.) The model is estimated in linear form, with observed values of the individual data series used except for transformations used to express variables in real terms or to form particular price ratios. There are 12 degrees of freedom in estimating the parameters of the

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[4/] For a discussion of these properties, see Dhrymes (17), pp. 303-311.

[5/] This includes, among other things, that variables assumed to be exogenous are in fact exogenous.

[6/] Not all variables are annual averages, however. For example, the stock of cattle on farms is an end-of-the year estimate. This is, however, consistent with the economic model specified.

reduced form and at least 18 degrees of freedom in estimating the parameters of the individual structural equations.

The definitions of the variables are as follows:

Endogenous variables:

Y_{1t}: the level of discrimination against beef exports, cruzeiros of 1965/67, per ton carcass weight.[7/]

Y_{2t}: the weighted average beef price in Brazil at the farm level, cruzeiros per ton carcass weight (where the weights are tons of beef output per state, and the price observations are by state).

Y_{3t}: the number of steers and calves slaughtered in Brazil in period t and expressed in thousands of head.

Y_{4t}: the number of cows slaughtered in Brazil in period 5, expressed in thousands of head.

Y_{5t}: the domestic consumption of beef in Brazil during period t, expressed in thousands of head.

Y_{6t}: the stock of male cattle at the end of period t, expressed in thousands of head.

Y_{7t}: the stock of female cattle at the end of period t, expressed in thousands of head.

Y_{8t}: the quantity of beef exported, expressed in thousands of head.

7/ Expressing this variable in terms of carcass weight creates some problems of comparability with the rest of the model since at least some parts of it are expressed in terms of product weight rather than carcass weight. This was unavoidable because of the lack of data that would permit putting the entire model on the same basis. This lack of consistency does not necessarily create serious problems in later analysis and interpretation, because in linking the domestic model to the world price, the price of beef in London, a rather broad-based aggregate, is used as the basis of the analysis. The London price is based on frozen sides and corned beef, historically the two main components in world trade. To the extent that there should be major shifts in the composition of world exports from year to year, there may be some distortion of the results. This does not appear to be a major problem, however.

Exogenous Variables

X_1: the weighted average price of Argentine beef sides and corned beef in London, U.S. $ of 1965/67 per ton (weights 0.5:0.5).

X_2: the rate of increase of the general price level, in percentage terms.

X_3: the overall position in the balance of payments.

X_4: policy dummy, = 1,1947-52, = 0 otherwise.

X_5: policy dummy, = 1 1953-59, = 0 otherwise.

X_6: policy dummy, = 1 1960-63, = 0 otherwise.

X_7: policy dummy, = 1 1964-71, = 0 otherwise.

X_8: weighted average real price of six crops (coffee, corn, soybeans, cotton, wheat and beans), where national average prices are used and the weighting is by area in the respective crops.

X_9: the announced price of milk in May to producers supplying the State of Guanabara, cruzeiros of 1965-67 per thousand liters.

X_{10}: the weighted average price of pork at the farm level, cruzeiros of 1965/67 per ton carcass weight, with the average based on state prices and weighted by state slaughter.

X_{11}: real gross domestic product, tens of millions of cruzeiros of 1965/67 (which reflects changes in both population and per capita income).

X_{12}: a trend variable, measured as the last two digits of the calendar year (i.e., 47,...,71).

One further aspect of the econometric procedures should be noted. The model as specified includes four policy dummy or zero-one variables. These are specified as intercept shifters only, since there were not sufficient degrees of freedom to consider any possible effect on coefficients of the independent variables. In order to estimate the parameters

of the equation, at least one of the policy dummies has to be suppressed, or singularity will result. For this purpose, X_4, the policy dummy for the first period was excluded from the model, with the result that its effect is included in the intercept of the respective equation. The interpretation of the coefficients of the remaining dummy variables is therefore in relation to that first period, 1947-52.

Statistical Results

The estimate of the reduced form for the domestic price of beef for Model I is as follows:

$$
\begin{aligned}
Y_{2t} = {} & -1984.39 + 0.282\,X_1 - 0.667\,X_2 + 0.018\,X_3 + 20.79\,X_5 \\
& \quad (0.42) \quad (1.19) \quad (0.34) \quad (0.21) \quad (0.17) \\
& -55.36\,X_6 - 293.52\,X_7 + 2.165\,X_8 + 0.641\,X_9 \\
& \quad (0.26) \quad (1.01) \quad (1.23) \quad (0.45) \\
& +0.554\,X_{10} - 0.012\,X_{11} + 90.59\,X_{12} - 0.095\,Y_{7,\,t-1} \\
& \quad (1.48) \quad (0.10) \quad (1.85) \quad (1.25) \\
& +0.065\,Y_{6,t-1}: \quad R^2 = 0.95. \quad D.W. = 1.81 \\
& \quad (0.97)
\end{aligned}
$$

The numbers in parentheses below each coefficient are t-values.

In evaluating the results for this equation, it should be noted that the statistical significance of the individual coefficients is relatively weak. Only the coefficient for the trend variable is statistically different from zero at the five-percent probability level, a reflection of the persistent upward trend in the price of beef over the period covered by the study.

The lack of statistical significance is probably a result of the large number of variables in the equation, and the presence of a relatively high degree of intercorrelation among the independent variables,[8/] a

[8/] The matrix of the simple correlations among the variables is presented in Appendix C.

Table 3.1. Predicted and Observed Values of the Price of Beef from the Reduced Form--Model I.

Price of Beef			(Cr$ of 1965/67 per ton)
Year	Observed	Predicted	Residual
1947	761	756	5
1948	652	652	0
1949	678	705	-27
1950	736	761	-25
1951	727	683	44
1952	807	804	3
1953	822	887	-65
1954	888	912	-24
1955	989	948	41
1956	929	868	61
1957	865	843	22
1958	883	845	38
1959	860	933	-73
1960	1043	1058	-15
1961	1125	1119	6
1962	1129	1081	48
1963	1126	1165	-39
1964	1049	1035	14
1965	1151	1155	- 4
1966	1309	1218	91
1967	1242	1257	-15
1968	1147	1208	-61
1969	1070	1121	-51
1970	1117	1171	-54
1971	1352	1273	79

not uncommon problem with time series data. It should be noted that the R^2 for the equation is quite high, however. For present purposes this is important, since it indicates that there will be little loss in statistical efficiency from using less than full-information estimation procedures to estimate the parameters of the individual structural equations. Put differently, the predicted values of the price variable will correspond very closely to the actual values (see Table 3.1), and there will be little loss in statistical efficiency from using the predicted values in estimating the structural equations as contrasted to the actual values.

It should be noted, however, that in addition to the trend variable, the coefficients of five additional variables are larger than their respective standard errors. These include the world price of beef, X_1, the policy dummy for the 1964-71 period, X_7 (but only slightly), the index of prices for the six crops that are assumed to compete with the production of beef, X_8, the price of pork, which is assumed to compete with beef in consumption, X_{10}, and the stock of female cattle on farms at the end of period t-1. Moreover, although it is not possible to say *a priori* what sign is expected on the coefficients in the reduced form,[9/] the signs are for the most part consistent with economic intuition. Hence, the reduced form appears to have "captured" some aspects of the economics of the sector, and is not just a statistical artifact of regressing a large number of time series data on the dependent variable.

9/ *A priori* restrictions are sometimes placed on the coefficients of the reduced forms, with the postulated theory tested at that level (see Basmann (6)). This procedure requires that some *a priori* information be available on the relative size and the signs of the coefficients in the structural equations.

The estimates of the parameters of the structural equations are presented in Table 3.2 as equations 3.1 through 3.8. The over-all statistical results are reasonably good by most criteria. The R^2's for each equation are reasonably high, and in some cases quite high. This suggests that the variables included in the equations are capable of explaining a large portion of the variation in the dependent variables. However, the Durbin-Watson statistic suggests the presence of serial correlations in the residuals, although the test is inconclusive in most cases. This indicates that there is something systematic left in the residuals, and that the models are therefore not complete.

This problem is important in the case of the two investment or stock equations, since both equations have the lagged dependent variables as explanatory variables. If there is serial correlation in the calculated residuals under these conditions, there will be bias in the coefficients of at least the lagged variables. The bias will tend to be upward, and therefore, the estimates of the long-run elasticities will also be upward.

It should be noted that Griliches[10/] has questioned the validity of the Dubin-Watson statistic in the presence of distributed lag models. The specific problem that he was concerned with, however, was that the lagged variable may be eliminating the serial correlation from the calculated residuals for the "wrong" reasons, and hence not rejecting the null hypothesis of no serial correlation when in fact serial correlation was present. The fact that the test is inconclusive in our case, plus the fact that the validity of the Durbin-Watson test has been questioned in the context of distributed lag models, suggests that

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10/ See Griliches (34).

Table 3.2. Estimates of the Structural Equations of Model I of the Brazilian Beef Sector.

Equation	Dependent Variable	Constant	Exogenous Variables: World Beef Price (X_1)	Inflation (X_2)	B.O.P. (X_3)	Policy Dummies (X_5)	Policy Dummies (X_6)	Policy Dummies (X_7)
3.1	Intervention (Y_1)	-523.04	+1.538***	+7.900***	+0.249*	-218.05**	-16.39	-65.41
			(2.75)	(2.98)	(1.30)	(1.80)	(0.10)	(0.40)
3.2	Price of Beef (Y_2)		π^{e} 3/					
3.3	Male Stocks (Y_6)	-838.70		+5.707*				
				(1.32)				
3.4	Male Slaughter (Y_3)	1216.07		-1.120				
				(0.29)				
3.5	Female Stocks (Y_7)	-583.97		+2.160				
				(0.54)				
3.6	Female Sales (Y_4)	-2429.37		+3.418*				
				(1.39)				
3.7	Domestic Demand (Y_5)	-2370.70						
3.8	Exports (Y_8)							
3.9	Domestic Demand (Y_5)	4226.46						

continued on next page

Table 3.2. (Continued)

Equation	Exogenous Variables							
	Crop Price (X_8)	Milk Price (X_9)	Price Pork (X_{10})	Income (X_{11})	Trend (X_{12})	Intervention (X_1)	Beef Price (Y_2)	Male Stocks (Y_6, t-1)
3.1								
3.2						-1.0		
3.3	+3.787 (0.78)						+1.171* (1.46)	+0.956*** (15.42)
3.4	-3.667 (0.86)						-0.568 (0.80)	+0.330*** (6.00)
3.5		+11.944*** (4.47)					+2.168*** (2.74)	
3.6		-1.035 (0.63)					-1.323*** (2.74)	
3.7			-0.349 (0.37)	-0.049 (0.21)	+231.03*** (5.25)		-3.901*** (3.94)	
3.8								
3.9			+0.518 (0,34)	+0.984*** (0,99)			-1.482 (0.99)	

continued on next page

Table 3.2. (Continued)

Equation	Exogenous Variables				Statistics	
	Male Slaughter (Y_3)	Cows Slaughter (Y_4)	Demand (Y_5)	Female Stocks ($Y_{7,\ t-1}$)	R^2	D. W.
3.1					0.73	1.71
3.2					—	—
3.3					0.98	1.06
3.4					0.87	0.83
3.5				+0.942*** (34.89)	0.99	1.30
3.6				+0.132*** (8.05)	0.90	0.83
3.7					0.95	1.34
3.8	±1.0	+1.0	+1.0		—	—
3.9					0.89	0.82

Notes: 1. The figures in parentheses are t-values.
2. The asterisks refer to the probability level at which the coefficient is significantly different from zero.
   * - 10 percent level
   ** - 5 percent level
   *** - 1 percent level
3. The symbol π^e refers to the real free trade exchange rate.

the indicated serial correlation may not be serious. However, the fact that the lagged dependent variable is especially subject to specification bias suggests that the coefficient should be interpreted with care.

The signs of the estimated coefficients conform to a priori expectations, with the exception of the coefficient of expected inflation (X_7) in the slaughter equation for females, the coefficient of crop prices (X_8) in both the stock and slaughter equations for males, and the coefficient of the income variable in the demand equation. In no case were these coefficients statistically different from zero at the 5-percent level or higher, although the coefficient on the rate of inflation in the female slaughter equation was significantly different at the 10-percent level. A more detailed discussion of the statistical results is presented in the following sections, where the equations are discussed one at a time.

The Intervention Equation

The coefficients of this equation were estimated by ordinary least squares applied to the observed variables. The R^2 for this equation was the lowest of any equation in the model (.733), but the Durbin-Watson test does not suggest the presence of serial correlation in the residuals. All coefficients with a priori restrictions have the expected sign, and two of the three "economic" variables in the equation (the world price of beef and the rate of domestic inflation) have coefficients that are significantly different from zero at the 1-percent level. The remaining variable, the overall balance of payments, has a coefficient that is significantly different from zero at the 10-percent level.

Only one of the policy dummies had a coefficient that was significantly different from zero at usually accepted levels, and it was significant at the 5-percent level. This policy dummy refers to the period 1953-59, which is generally recognized as a period of liberalization of trade policy with respect to agricultural exports.[11/] The sign of the coefficient is consistent with this hypothesis, and supports the notion that there was a shift in the equation describing the intervention of policy makers at this time. The lack of significance of the coefficients for the other two policy dummies suggest that there was no difference in the remaining two periods vis-a-vis the original period, 1947-52.

Overall, the statistical support for the hypothesized intervention equation is quite good. The economic variables included tend to have a high degree of significance, and explain a relatively large fraction of the changes in the level of intervention over time. In addition, the coefficients of the policy dummies suggest that there was only one shift in this relationship over the time period studied, and that shift was consistent with *a priori* expectations.

Stock of Male Animals on Farms

This investment model was estimated assuming a distributed lag model of investment behavior. The R^2 was quite high for this equation, and all coefficients had the expected signs, with the exception of the crop price variable. It was expected that this variable would reflect the opportunity cost of land, and that as crop prices rose, other things

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11/ See Veiga (75).

being equal, the investment function would shift to the left, since cattle production in Brazil is a land-intensive activity.[12/] Admittedly, the index of crop prices is not a very good proxy for the true variable desired. The fact that the coefficient is not significantly different from zero at usually accepted levels suggests that there may not be much direct competition between crop production and cattle production in Brazil. This is not totally implausible in view of the fact that Brazil has been a land-plentiful country in the post-World War II period, and regional specialization in production is a reality.

The coefficients of the price of beef and the rate of inflation are significantly different from zero at the 10-percent level. This provides fairly strong support for the basic investment model postulated, although the support would have been stronger had the level of statistical significance for these two variables been higher.

The strongest variable in the equation is the lagged dependent variable, which is significantly different from zero at the 1-percent level. However, there is some evidence that the coefficient may be biased upward. The size of the coefficient is quite close to one, and the statistical significance of the other variable in the equation is not high. Moreover, the Durbin-Watson test suggests that there may be some serial correlation in the residuals.

The plausibility of the size of this coefficient will be considered in more detail below. For now, it should be noted that the statistical evidence in support of including the variable is quite strong. Moreover,

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12/ For a discussion of land productivity in beef production, see FAO (73).

if technological and economic constraints are such as to impose a rather sluggish response to investment behavior, it is possible that this coefficient would be expected to be close to one. In any case, there is no a priori reason for rejecting it out of hand and, as will be pointed out below, the a priori evidence would suggest that it might in fact be fairly large.

Male Slaughter

The R^2 for the male slaughter equation was again relatively high, and all coefficients had the expected sign, with the exception again of the crop price variable. This coefficient was not significantly different from zero at usually accepted levels, similar to the case in the male investment equation, and the same comments made there apply in the present case. The evidence for serial correlation in the residuals is stronger in this equation than in the investment equation, although its consequences are not so serious here, because there is no lagged dependent variable in the equation. The presence of serial correlation does suggest, however, that the model may not be complete.

The statistical results again provide reasonably strong support for the basic investment model postulated. The coefficient for the price of beef has a negative sign, as postulated by the model, although it is not significantly different from zero at usually accepted levels. The coefficient of the stock of male cattle at the beginning of the period has the expected sign and is highly significant. And finally, although the coefficient for the rate of inflation is not significantly different from zero at usually accepted levels, it does have the expected sign. It indicates that as the rate of inflation increases, producers

would shift their portfolio in favor of cattle, and the way they would do this would be by way of reducing the slaughter of male animals.

Stock of Female Animals on Farms

The statistical results for this equation are quite good. The R^2 was very high, and all coefficients had the expected sign. The coefficients for the lagged dependent variable, the price of beef, and the price of milk are all significantly different from zero at the 1-percent level, and only the coefficient for the rate of inflation is not significant at usually accepted levels. The coefficient for the price of milk indicated that as the price of milk rises, the stock of female cows is increased, other things being equal. Similarly, as the rate of inflation increases, *ceteris paribus*, the stock of female animals on farms increases.

There may again be problems with the lagged dependent variable. The test for serial correlation is again inconclusive, and the coefficient of the lagged variable is close to one. Comments similar to those made above apply here, although it should be noted that the other variables in the equation are reasonably strong in the present case, and the coefficient of the lagged dependent variable is not greatly different in size from what it was in the male investment equation. If one can have greater confidence in the present coefficient, and investment behavior should not be greatly different as amongst male and female animals, the results may suggest that the coefficient in the male investment equation is not greatly biased.

It should be noted that an index of crop prices was not included in either this or the female slaughter equation, because breeding herds

are maintained in reasonably specialized regions geographically, and these for the most part are not regions where crops have been a viable alternative. As the available supply of uncultivated land is exhausted, the competitive relationship between crops and livestock is expected to become stronger.

Female Slaughter Equation

The statistical results for the female slaughter equation is again notably strong, and for the most part supports the basic investment model used as a maintained hypothesis for investigating the produciton sets of the model. The coefficient of the price of beef has the expected negative sign and is significantly different from zero at the 1-percent level. The coefficient of the stock of female cattle on farms at the beginning of the period is also highly significant. The coefficient for the price of milk is not significantly different from zero at usually accepted levels, but it does have the expected sign.

The coefficient on the inflation variable, on the other hand, has the wrong sign and is significantly different from zero at the 10-percent level. This is the only case in which this variable had the wrong sign, although in none of the other equations were the statistical results particularly strong.

Domestic Demand

The coefficient of multiple determination is quite high in the domestic demand equation also. Two variables have coefficients that are significantly different from zero at the one-percent level: the price of beef and the trend variable, with the coefficient for price having the

expected sign. Neither the price of pork nor the national income variables have coefficients that are significantly different from zero at usually accepted levels, and the coefficient for national income has the wrong sign.

It should be noted that the national income variable reflects the effects of both population and per capita income. This procedure was used because preliminary estimates of the model indicated difficulties in disentangling the separate effects because of inter-correlation among the independent variables.

The problem of inter-correlation still remains, however. Trend is highly correlated with national income, and it is probably for this reason that the income variable had a negative coefficient and was not statistically significant. It should be noted that the price of beef variable also has a strong element of trend in it.

Because of this problem, the demand equation was re-estimated with trend omitted.[13/] The results are presented as equation 3.9 in Table 3.2. As can be seen, the statistical results are rather unstable. The coefficient for national income now has a coefficient that is positive, and statistically significant at the 1-percent level. The coefficient for the price of beef declines substantially in size, and is no longer significantly different from zero at usually accepted levels, although its coefficient is greater than its standard error. The coefficient for the price of pork increases somewhat, but its level of statistical significance does not change.

As these comments suggest, the statistical support for the hypothesized demand equation is not particularly strong. The problem is one

13/ A new reduced form was also estimated to obtain predicted values for the price of beef.

of interdependence among the independent variable, with the result that the estimates of the coefficients are rather unstable.

For these reasons a second statistical model was estimated excluding income as an independent variable in the demand equation. This model (Model II) is given in Table 3.3. Model II was estimated using the same procedure as that used for Model I and thus involved estimating a new reduced form equation without income (X_{11}) as an explanatory variable.

The sign and magnitude of the coefficients in Model II are for the most part the same as those in Model I. The exception to this is the demand equation. In Model II, the coefficient of the beef price variable is larger in absolute value than in Model I, and the coefficient of the trend variable is smaller. In both these cases the level of significance is higher in Model II. The coefficient of the pork price in Model II has a negative sign, opposite to the case in Model I, but again this coefficient is not significant at the 10-percent level. This result is not in accord with the expected sign, but it would support a hypothesis that this demand equation reflects the beef consumption habits of Brazilians in the middle and upper income groups, for whom beef and pork are not strong substitutes. This hypothesis is supported to some extent by the inelastic demand for beef with respect to its own price that was found in both equations 3.7 and 3.9 (Model I).

Model II is used in the following chapter for projection purposes because it does not have an income variable with a negative coefficient. However, the effect of income on the demand for beef is expected to be accounted for by trend, assuming there is no change in the distribution of income. These issues are discussed further in Chapter IV.

Table 3.3. Selected Structural Equations from Model II of the Brazilian Beef Sector.[a/]

Equation	Variable		Exogenous Variables				
			Constant	Inflation (X_2)	Crop Price (X_8)	Milk Price (X_9)	Pork Price (X_{10})
3.3	Y_6	=	-839.24	+5.699**	+3.791		
				(1.32)	(0.78)		
3.4	Y_3	=	1216.08	-1.126	-3.666		
				(0.30)	(0.86)		
3.5	Y_7	=	-584.12	+2.159		+11.943***	
				(0.54)		(4.47)	
3.6	Y_4	=	-2425.27	+3.400*		- 1.039	
				(1.37)		(0.63)	
3.7	Y_5	=	-2199.33				-0.237
							(0.30)

(continued)

[a/] The intervention equation, the price identity, and the export equation will be the same as in Model I.

Table 3.3. (Continued)

Equation	Endogenous Variables				Statistics	
	Trend X_{12}	Beef Price (Y_2)	Male Stocks ($Y_{6,\ t-1}$)	Female Stocks ($Y_{y,\ t-1}$)	R^2	D.W.
3.3		+1.174* (1.46)	+0.956*** (15.35)		0.98	1.06
3.4		-0.566 (0.80)	+0.330*** (6.03)		0.87	0.83
3.5		+2.168*** (2.74)		+0.942*** (35.17)	0.99	1.30
3.6		-1.315*** (2.71)		+0.132*** (8.05)	0.90	0.83
3.7	+223.38*** (9.91)	-3.924*** (4.07)			0.95	1.31

Note: 1. Equations 3.1, 3.2, 3.8 are the same as in Model I.

2. See footnotes, Table 3.2.

Some Concluding Comments

To summarize, the statistical support for the trade intervention equation was reasonably strong. This is a critical element in the postulated model, and shows how the domestic economy is linked to the world economy, while at the same time providing an economic explanation of the response of policy makers to changing economic conditions.

The statistical results also provide reasonably strong support for the basic investment model postulated on the production side. The price of beef has the expected positive coefficient in both of the investment equations and the expected negative equation in both of the slaughter equations. Moreover, in two of the four equations the coefficient is highly significant, and in one case it is significantly different from zero at the 10-percent level.

The coefficients on the lagged dependent variables are highly significant in the two stock equations, and similarly, the coefficients of the stock variables are highly significant in the slaughter equations. These results provide statistical support for the lagged mechanisms postulated, as well as the hypothesized linkages between stocks of animals on farms and slaughter. The only problem is that the coefficients of the lagged dependent variable in the investment equations may be biased upward, with the result that the estimates of long-run elasticities may be biased upward as well.[14/]

14/ An additional test of the model was made by introducing a trend variable into the two investment equations. When this was done the coefficients of both the trend variable and the lagged dependent variables were significantly different from zero, but the coefficients of the lagged variable were in both cases greater than one. This implies an unstable distributed lag model, so these results were not considered further.

The statistical support for the role of inflation is not particularly strong, although the results do not yet merit discarding the maintained hypothesis. The coefficient of this variable had the expected sign in three out of the four equations, with one sign reversal obtained as hypothesized. The ability of the model to discriminate in this way, even though the coefficients are not statistically significant, is worth noting.

The effects of inflation on the investment decision and in turn slaughter is probably rather subtle. The inflation variable has been introduced into the model in a rather simple way. It may be that the instability of inflation is as important as the rate itself. These possible alternative hypotheses were not examined further in the present study because it was rather peripheral to our main interests. However, the statistical results appear to be sufficiently encouraging to merit additional study in the future.

The statistical results suggest that the livestock sector is fairly independent of the crop sector in Brazil. In neither case in which the variable was introduced did it have a significant coefficient. These results are consistent with the hypothesis that livestock and crop production have not been competitive, at least in the period covered by the study. This is not an implausible finding, at least for Brazil in the aggregate.

Finally, the weakest statistical results were found for the demand equation. Estimates were obtained in which the coefficients for important variables such as the price and income variables had the expected signs, but the coefficients were rather unstable in the presence of alternative

specifications of the model. The estimates of the parameters will be used for further analysis in the next chapter, but their limitations should be kept in mind.

CHAPTER FOUR

ECONOMIC ANALYSIS AND IMPLICATIONS

This chapter is concerned with the economic implications of the statistical results presented in the previous chapter, and an analysis of the implications that these have for government policy in Brazil both within the beef sector and for development policy in general. The chapter is organized around five headings: the elasticities of supply and demand, the dynamics of beef supply in Brazil, the intervention model and its implications, projections of beef exports to 1980, and possible consequences of technical change in the beef sector.

Elasticities of Supply and Demand

The supply section of the model is composed of two investment equations and two output (slaughter) equations, with one each for male and female cattle. On the investment side, one important implication of the statistical results is the long adjustment period required for the stock of male and female cattle to reach an equilibrium following a shock to the system. The coefficients of adjustment are 0.044 and 0.058 for males and females, respectively, which implies that a period of 17-23 years is necessary for the system to reach 95 percent of full adjustment.[1/]

1/ The coefficient of adjustment (α) is calculated from the coefficient of the lagged endogenous variable in each of the investment equations, this latter coefficient being equal to $(1 - \alpha)$. Due to the nature of the assumed adjustment process, stocks would take an infinite amount of time to reach full adjustment. However, the amount of time necessary to reach 95 percent adjustment (N) may be found by choosing N such that $(1 - \alpha)^N \leq 0.05$.

This may seem like a long time to reach equilibrium, but it is consistent with the low level of productivity observed in Brazil, and with the biological constraints that govern the sector.

Both investment functions are quite inelastic with respect to beef price in the short run (Table 4.1), but this also follows directly from the low level of productivity in the sector and the particular technology employed. There is very little intensive feeding of cattle in Brazil, with the bulk of the cattle fattened in an extensive system. Hence, beef producers are not able to respond rapidly to changing economic conditions.

Table 4.1 Response of Cattle Stocks to Changes in the Price of Beef.[a/]

Period	Elasticity of Cattle stocks		Price of Milk
	Price of Beef		
	Female	Male	Female
Single period impact	+0.046	+0.078	+0.040
Long-run[b/]	+0.788	+1.775	+0.683

[a/] The elasticities in this and all subsequent Tables have been calculated at the mean value of the data.

[b/] The long-run elasticities are calculated by dividing each of the coefficients of the estimated equations by the coefficient of adjustment (α) and expressing these new coefficients as elasticities.

The single period impact of a change in beef prices is considerably greater for male stocks than it is for females. There are probably a number of reasons for this. First, since the female herd is almost three times the size of the male herd, female stocks are less able to achieve a given percentage increase, in spite of a greater change in the capital

price of females. This was pointed out by Jarvis (39). The second explanatory factor is that while it has been pointed out that technical change in the Brazilian beef sector has been slow over the period 1947-71, it has not been zero. Such technical improvements as have taken place have resulted in an increase in animal productivity so that the number of female cattle required to produce a given number of steers has been reduced. This effect results in a change in the composition of the herd towards a higher proportion of male cattle and the smaller magnitude of the elasticities of female stocks with respect to the price of beef. The changing composition of cattle stocks is reflected in the data on cattle stocks.[2/] In 1947 the ratio of male to female cattle was .317, but had increased to .340 percent in 1972.

These differences in the responsiveness of male and female cattle in the short run are carried over into the long run elasticities (Table 4.1), but the relative differences widen. That is, the single period impact of female stocks to changes in the price of beef is 59 percent of the corresponding elasticity for male stocks. In the long run, however, the elasticity of female stocks is only 44 percent of the elasticity for male stocks. This is due to the larger coefficient of adjustment for female stocks.

A second major implication of the statistical results is the support which the estimated parameter on the price of milk gives to the theory outlined in Chapter Two. It was argued there that the price of milk should have the important role in determining the stock of female cattle because a large proportion of cows in Brazil are used for both milk

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[2/] See Table D.1.

and beef production. The elasticities of female stocks with respect to the price of milk appear to strongly support this contention, and this may have important implications for policy, as will be discussed later.

As was pointed out in Chapter Three, the estimated coefficients of the price of crops in the equations for male stocks and slaughter do not support the maintained hypothesis. The possible reasons for this situation were also outlined in that Chapter and will not be discussed further here.

The statistical results relating to the effect of inflation do, however, provide limited support for the theory employed, at least for male cattle. The elasticities of cattle stocks and slaughter with respect to the rate of inflation are given in Table 4.2. The first point to note is that the sign of the female slaughter elasticity is not in accord with the maintained hypothesis and the elasticity of the female stock with respect to the rate of inflation is very small by comparison with the corresponding male elasticity. This latter result can be explained partly by the relative sizes of the male and female herds,

Table 4.2. Single Period Elasticities of Cattle Stocks and Slaughter to the Rate of Inflation.

	Single Period Elasticities	
	Cattle Stocks	Slaughter
Male Cattle	0.0109	-0.0064
Female Cattle	0.0013	0.0425

as was done above for the own price elasticities. A more plausible explanation, however, is that the theory of hedging against changes in the rate of inflation by investment in cattle is probably more applicable for male cattle than it is for females. This can be seen by noting that investors in the above category are often looking for short term physical assets, and the payoff from investment in female cattle as breeding stock[3/] in Brazil takes about three times as long to realize as the payoff from males.

Another possible explanation for the failure of the statistical results to provide stronger support for the inflation hypothesis may have to do with the manner in which producers form their price expectations. The capital price of a female is determined by discounting costs and returns over a much longer time horizon than for males. It is conceivable that in this process producers weight more heavily short term fluctuations in prices, especially the price of beef and the rate of inflation, thus making the capital price of a male animal more sensitive to these fluctuations.[4/]

These explanations are only hypotheses, and would need to be tested, preferably in a model of the cattle sector disaggregated by class and by sex.

The elasticities of male stocks and slaughter (Table 4.2) do support the inflation hypothesis. Furthermore, the size of the elasticity appears

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3/ The capital value of the female includes her value as breeding stock.

4/ This hypothesis is not necessarily at odds with the theory of Jarvis (39) concerning relative changes in the capital price of males and females, because it is essentially arguing that different prices are used to calculate the capital price of different classes of stock in an unstable inflationary environment.

to be realistic. At the means, a 23 percent increase in the rate of inflation (the mean value) is estimated to result in a 1.1 percent increase in the stock of males. This is an increase of 1.5 million head. The implication of this effect based on the parameters obtained in this study is that a significant rise in the expected rate of inflation could result in a measurable withholding of male cattle from slaughter (and vice versa). The effect that such a move could have in Brazil, reduced beef supplies at higher prices, are considerable, in addition to the problems likely to be caused by the inflation itself.

It is instructive to compare the single period elasticities of stocks and slaughter derived in this study with those obtained in similar studies done recently for other countries. In Table 4.2, the elasticities obtained in this study (referred to as Brazil) are compared with those obtained by Raul Yver (77) in an annual model of the Argentine beef sector, Gustavo Nores in a quarterly model from Argentina, and Cesar Barros in an annual model of the Chilean beef sector.

None of these studies have exactly the same focus as the present one, so care is necessary in making comparisons. Moreover, the models are somewhat different in specification. But the comparison can be instructive.

First of all, it should be noted that in each case the elasticity of female slaughter with respect to the price of beef in the first period is more negative than that for male slaughter, except in the Chilean study. This lends support to the theory of Jarvis (40) vis-a-vis the determination of the capital price of cattle and relative changes

Table 4.3. Comparison of Single Period Elasticities of Beef Supply from Other Studies.

	Impact Multipliers			
	Brazil	Argentina		Chile[c/]
		Yver[a/]	Nores[b/]	
Slaughter with Respect to:				
a) Price of Beef				
Males	-0.113	+0.068	-0.668	-0.23
Females	-0.575	-0.049	-0.962	-0.11
b) Price of Milk				
Females	-0.071	---	---	0.18
Stocks with Respect to:				
a) Price of Beef				
Males	0.078	---	---	0.13
Females	0.046	---	---	0.18
b) Price of Milk				
Females	0.040	---	---	-0.13

Source: [a/] Yver (77), p. 99.

[b/] Nores (56), p. 123. Note that -0.668 refers to young steers only and -0.962 refers only to heifers.

[c/] Barros, M. (5), p. 29.

in that price. In the Chilean study, Barros recognizes the apparent perversity of his results, and explains these in terms of feed constraints operating in the Chilean beef sector.

The second point is that the impact multipliers of cattle stocks in the present study and the Chilean study agree on signs. The relative sizes of these elasticities will, of course, differ according to the composition of the herd and the level of productivity, but they do not appear to be inconsistent, on the surface at least.

The third point of interest lies in the apparent reversal of the elasticities of female stocks and slaughter with respect to the price of milk between the Chilean study and the present one. Barros explains that there appears to be a strong competitive relationship between the milk and beef sectors in Chile. This contrasts with the results of this study, which are consistent with the hypothesis of a complementary relationship between the milk and beef sectors in Brazil.

The results on the demand side of the model indicate that the demand for beef is inelastic with respect to the price of beef. This reflects the fact that the consumption of beef in Brazil is concentrated in the high-income groups,[5/] and that the quantity consumed by the upper income groups varies little with changes in price. This factor is borne out further by the small elasticity of substitution between beef and pork. These elasticities are summarized in Table 4.4.

[5/] See Table 1.5.

Table 4.4. Demand Elasticities for Beef.

With Respect to:	Elasticity of Demand	
	Equation 3.7	Equation 3.9
Price of Beef (Y_2)	-0.535	-0.209
Price of Pork (X_{10})	+0.057	+0.083
Total Income (X_{11})	-0.026	+0.511
Trend (X_{12})	+1.983	---

The elasticity of total demand with respect to income in Equation 3.9 implies an income elasticity of demand much less than 0.511 since approximately half the increase in total income is a result of increases in population. This result is to be expected from time series data, where responses to changes in income tend to reflect mainly the transitory components of income rather than permanent components. More importantly, however, this result is probably caused by the fact that the skewed distribution of beef consumption (shown in Table 1.5) is highly related to the skewed distribution of income in Brazil (25). Further, these two effects may be compounded in Brazil by the effects of non-price rationing, which is believed to have been important at various times over the period of the study. Each of these factors will tend to bias downwards the estimates of the elasticity of demand with respect to total income.

There are a number of policy implications on the demand side. The inelasticity of the demand for beef with respect to the price of beef means that price policy designed to stimulate supply does not, according to these

estimates, result in a decrease in domestic demand to the same extent as the price rise. Hence, the quantity available for export does not increase as much as it would for a commodity with a more elastic demand. However, the substitution possibilities that exist on the demand side may not be well reflected by this model because no close substitutes for beef in Brazil, like fish and chicken, are included due to lack of data. For this reason, the options open to policymakers to divert demand away from beef may be greater than is reflected by these results. This diversion, if it should be needed, might be achieved either by price policy alone, or by other policies designed to stimulate the production of close substitutes for beef.

If the beef price were permitted to rise to increase the quantity available for export, low income groups would suffer little, nutritionally, since they consume only small quantities of beef at the present time. Their diet would perhaps be improved more rapidly if cheaper protein sources (like chicken, fish, or milk powders) were made available to them.

The Dynamic Supply Response for Beef

When the investment and output functions for each class of stock are taken together, it is possible to derive the adjustment path of sales over time, as described by Theil (70). These calculations have been made and the cumulative effects of these impact and interim elasticities are given in Table 4.5 together with the long run elasticities of male and female slaughter with respect to price of beef.[6/]

6/ The impact and interim multipliers are the adjustments to the endogenous variables that occur in the first and successive periods following a change in an exogenous variable. The cumulative elasticity of an endogenous variable at any point after such a change is the sum of the multipliers up to that point expressed as an elasticity.

Table 4.5. Cumulative Elasticities of Cattle Sales with Respect to the Price of Beef.

Period	Class of Stock			
	Male		Female	
	Brazil	Argentina[a/]	Brazil	Argentina[a/]
0	-0.113	+0.068	-0.575	-0.049
1	-0.036	-0.019	-0.458	-0.409
2	+0.037	+0.041	-0.347	-0.319
3	+0.107	+0.186	-0.243	+0.006
4	+0.174	+0.294	-0.146	+0.236
5	+0.238	+0.338	-0.053	+0.321
6	+0.300	+0.355	+0.033	+0.354
7	+0.358	+0.369	+0.115	+0.395
8	+0.414	+0.383	+0.192	+0.440
Long-run	+1.596	+0.394	+1.538	+0.545

[a/] Yver, Raul (77), Tables 28, p. 99.

The values from the present study are compared with the results of a similar study made for the Argentine beef cattle economy by Yver (77).

The response pattern of female cattle sales corresponds to that described in Chapter Two. When the price of beef rises, female slaughter falls initially, and thereafter rises to its new higher equilibrium level. However, there appear to be some important differences in the Brazilian case when compared to the Argentine model. In Brazil, the greatest addition to female stocks (or decrease in sales) occurs within the first period, whereas in Argentina this phase occurs in the second period. This suggests that the availability of grass and credit have been less restrictive in Brazil. Hence, beef producers have been able to realize their investment plans in all inputs other than cattle more readily, without the need to move land out of crop production or develop pastures, to the same extent as in Argentina. However, this capacity in Brazil may be diminishing as the crop area expands rapidly into traditional beef breeding regions.

Following the initial fall, female sales begin to rise, but due to the low level of productivity, the initial sales levels are not regained until the sixth period. They continue to increase thereafter, until 95 percent of full adjustment is reached in the twenty-third year, assuming the initial shock to the system remains unchanged and other things remain constant.

Some further evidence on the comparative herd expansion possibilities can be found by comparing the long-run elasticities between the two countries. In the past Brazil appears to have had greater low-cost expansion possibilities than Argentina, and thus a given increase in beef

prices has had a greater long-term impact on beef output. By the same token, however, the length of time to reach the ultimate equilibrium on the supply side in Brazil, is longer than in Argentina, a reflection of the lower level of technical efficiency in Brazil as reflected in lower calving rates, higher mortality rates, and a lower turn-off rate.

The immediate withholding of male cattle following a rise in the price of beef (which the cumulative elasticities suggest) contrasts with the hypothesis made in Chapter Two and with the results of the Yver study. As with female cattle, it appears as if investment in male cattle is not constrained greatly by the availability of feed or credit. Thus, Brazilian cattle farmers are able to retain all classes of stock, and do not appear to reduce their male herd in order to expand the female herd. This contrasts with the results of the Argentine model. However, male sales are slower to attain their former levels[7/] than in Argentina.

An important policy implication based on these statistical results is that, while beef slaughter is elastic in the long-run, the adjustment period is so long that it could (and probably has) caused problems for policymakers. It is not easy to convince policymakers of the efficacy of using price policy to stimulate beef output when such polices are known to lead to an immediate reduction in slaughter of from two (males) to six years (females). They are hence likely to be interested in using such policy to stimulate other export crops like corn, which immediately respond positively to price. Moreover, they may prefer the corn alternative, even though the long run response may be considerably less than for

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7/ In the Yver study, male sales show only a very small decline and then only during one study period.

beef.[8/]

The second major implication is the importance that the parameters of this study put on milk price in influencing the stock of cows. Milk, like beef, is weighted heavily in the consumer price index, with the result that milk price policy in Brazil is used frequently in an attempt to combat or reduce the short-term impact of inflation. The statistical results obtained herein indicate that attempts to hold down the price of milk may have a significant negative effect on investment in female cattle and hence on future beef output.

Like beef, the milk problem stems from the low level of technology employed in the industry and the importance government attaches to holding down its price to consumers. Furthermore, the longer-term solution to the problem probably lies in providing the industry with new technology to improve the productivity of milk production, and in providing farmers with the incentives to adopt such technology.

The Intervention Equation

The intervention equation (Equation 3.1) appears to satisfactorily explain the forces hypothesized to underlie government intervention in the beef sector. The elasticities derived from the equation are given in Table 4.6.

The coefficients of the dummy variables that were used in an attempt to separate various 'stages' in the process of rationalization of trade policy appear to indicate that intervention in beef trade policy from

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[8/] Robert Thompson has estimated that the long-run price elasticity of corn supply in Brazil is 0.699, made up of 0.579 on area planted and 0.12 on yield per hectare. In the same study the single period supply response is 0.25 made up of 0.13 on area planted and 0.12 on yield per hectare (71, pp. 64-67).

Table 4.6: The Elasticities of Intervention with Respect to the Exogenous Variables:

Variable	Elasticity
Balance of Payments (X_3)	0.008
World Price of Beef (X_1)	1.304
Rate of Inflation (X_2)	0.281
X_5 (1953-59)	-0.078
X_6 (1960-63)	-0.003
X_7 (1964-71)	-0.027

1953-59 was significantly less than the base period 1947-52. However, this difference is not significantly different from zero in the two later periods. This implies that policymakers have not responded differently to the stimuli over the period 1947-52 and 1960-71. This is rather remarkable, given that the period, till 1964, at least, was dotted by a large number of crises, political and economic. The elasticities of these variables are given in Table 4.6.

The relative importance of the remaining three variables (X_1-X_3) is not easy to judge from the elasticities due to the magnitude of the aggregates used. Hence it is instructive to consider the effect of a given change in each of the exogenous variables on the level of expected intervention and the domestic price of beef at the mean values. If the rate of inflation rises from its mean value of 28 percent to 56 percent (a 100 percent increase), it is estimated to increase the level of intervention by 28 percent and to decrease the domestic price of beef by 23

percent. This suggests that an initial response on the part of policy-makers would be to attempt to offset the effect of inflation through trade policy. An increase of $500 million in the overall balance of payments surplus (or a decrease in the deficit of the same amount) at the mean, on the other hand, is estimated to result in an increase of 16 percent in the intervention level and in turn a decrease of 13 percent in the domestic price of beef.

As is expected, however, intervention policy is most severe in compensating for increases in the world price of beef. A 10 percent increase in the world price of beef results in a 13 percent increase in the level of intervention at the mean. However, this results in a 7.6 percent increase in the domestic price of beef because the world price of beef is itself an argument in the identity which links the domestic price of beef to the world price.

A further important effect is the impact of a change in the exchange rate on the price of beef. A 10 percent depreciation in the free trade exchange rate at the mean would result in an 18 percent increase in the domestic price of beef, ceteris paribus,from the price identity. This is a rather special type of exchange rate devaluation, however, since it assumes that the effective exchange rate for beef exports (on the level of intervention) remains constant. However, to the extent that the level of intervention is raised to compensate for the now higher world price of beef in domestic currency, the increase in the domestic beef price will be less than 18 percent, and could completely neutralize the effect of the devaluation on price of beef.

The effects of these three variables (balance of payments, the rate of general price inflation and the world price) appear to be evidence for the case that beef trade intervention policy is determined principally

by economic variables, and therefore that it is predictable in the same way as other economic aggregates.

Social Cost of Intervention Policy

Some insights can be gained into the social cost of trade intervention in the beef sector by examining the changes in producers and consumers surplus which would accompany the removal of all intervention. At the mean values during the period, the complete reversal of intervention policies would have increased the domestic beef price by 81 percent. After full adjustment had taken place in the supply sector, this model would predict an increase in producers surplus of Cr$1.850 billion. At the same time, domestic consumption would fall, and based on the parameter values of Equation 3.7, consumers surplus could be expected to fall by Cr$0.839 billion. Thus the net social gain from such a move on the basis of this analysis would be Cr$1.011 billion. Expressed another way, it could be argued on this basis that intervention policy is a tax on beef producers of Cr$1 to save the beef consumer in Brazil 45 centavos.

The preceeding analysis can be criticized in a number of respects,[9/] but the major one of concern here is that the adjustment period to long term equilibrium is so long that the policymaker doesn't really appreciate the significance of it. What is obvious to him (and to the beef consumer) is the fact that an increase in the level of intervention has increased the supply of beef in the short-run. This is because the results of this study appear to show that the short-run supply curve for beef in

9/ Some writers would criticize the use of producers and consumers surplus to measure changes in societal welfare on the grounds that they imply a number of assumptions which may not hold in the real world. They are used here, recognizing the problems, because the distortion involved in intervention is so large that such definitional problems are unlikely to radically change the social cost involved.

Brazil[10/] is negatively sloped. Thus, it is easy to overstate the consumer benefits and understate the producer benefits in the short-run, since the net welfare cost could appear to be less than in the long-run situation.[11/] For example, if the level of intervention has increased 10 percent at the mean, cattle slaughter would increase by 158,000 head in the first year after the policy change and the price of beef would fall by 8.1 percent. This could appear as a net gain to society were it not for the fact that this increase in slaughter represents disinvestment, which involves a large net social cost through the reduction in future supply and export earnings foregone.[12/]

Projections, 1972-80

The manner in which the model reacts to changes in the exogenous variables can perhaps be best guaged by making forward projections under various assumptions. The basis for the projection was Model I. The investment and slaughter equations were collapsed with respect to crop prices and the rate of inflation by inserting the mean values. The demand equation was collapsed with respect to the price of pork in the same fashion.

10/ The short-run here refers to a period of up to two years following a change in the price of beef, see Table 4.5.

11/ This follows from the fact that the supply curve is less elastic (or negatively sloped) at any point before long-run equilibrium is reached. However, it is not clear how the social costs and benefits should be calculated for the case of a short-run supply curve, because the conventional tool of producers surplus is not normally applied to such situations. For a discussion of this problem see Mishan (47).

12/ This is the policy problem referred to by Yver (77, p. 5), and also by Dias (19) with reference to Brazilian beef policy.

Table 4.7. Estimates of the Values of Exogenous Variables, 1972.

Variable Description	Units	Value
X_1 World Beef Price (nominal)	U.S.$ per ton	1090
X_2 Rate of Inflation (real)	Percent	16.42
X_3 Balance of Payments	U.S. $ millions	555
X_9 Milk Price	Index	166
Real Free Trade Exchange Rate Cr./U.S.		2.83[b/]

[a/] It has been assumed that the U.S. wholesale price index rose 10 percent in 1973.

[b/] For a discussion of how this was calculated, see Appendix B.

The projections for 1972 were used to validate the model by comparing the predicted values of the endogenous variables with actual values. Estimates of the values of the exogenous variables for 1972 are given in Table 4.7.

The results of the projection for 1972 are given in Table 4.8. The model predicts that the domestic price of beef in Brazil in 1972 would have been Cr$1501 per ton, which is only 1.8 percent higher than the actual price.[13/] However, the projected exports for 1972 are 156 thousand tons less than actual exports on a product weight basis, or 217 thousand tons less on a carcass weight basis. This difference can be explained, at least in part, by the fact that retail price controls were widely used during 1972, and shortages of beef occurred especially during the entre-safra. These controls tended to introduce a differential between the price facing exporters and the maximum price that could be charged on the local market, which may have been considerably less.[14/] Hence, it is not unrealistic to suppose that the local market was undersupplied by 156 thousand tons of beef products in 1972.

Table 4.8. Projections for 1972.

Variable Description	Units	Actual	Predicted	Percent Difference
Y_2 Beef Price	Cr $ per ton	1475	1501	+1.8%
Y_8 Exports	1000 tons e.c.w.	+297	+60	--

13/ An alternate source of data is used for this estimate because at the time of writing the official data were not available. The alternate source is index 265 from Conjunctura Economia, FGV, Rio de Janeiro.

14/ It is difficult to confirm this statement because the cutting procedures for carcasses in these markets are different. However, observers close to the trade put this margin as high as 30 percent.

The second exercise is to make projections with the model to 1980 under various sets of assumptions, and to examine their impact on the endogenous variables. Three sets of assumptions (A, B, and C) are used in the analysis, and these are presented in Table 4.9.

The assumed values of the exogenous variables for the projections were chosen deliberately to reflect the variation in these variables over the last five years and grouped together to elicit a wide variation in model response. In this sense the projections are not predictions but rather experiments to show the varying impact of a variety of exogenous conditions.

Table 4.9. Assumed Values of the Exogenous Variables for the Projections, 1974-80.

Variable Description	Units	Assumption Set A	Assumption Set B	Assumption Set C
X_1 World Beef Price	U.S. $ per ton	1386 (1973)	1032 (1972)	718 (1970)
X_2 Rate of Inflation	Percent	8.5	17	35
X_3 Balance of Payments	U.S. $ millions	555	0	-200
X_9 Milk Price	Cr$/1000 liters	166	166	166
Real Free Trade Exchange Rate	Cr$/U.S. $	2.83	2.83	2.83

Note: 1. The figures in parentheses refer to the actual year in which the value occurred.

The procedure which has been adopted to make the projections is quite straightforward for all the exogenous variables except the world price of beef (X_1). Each projection has been made by assuming that the set of exogenous variables, except X_1, take on the values given in Table 4.9 in

each year from 1973 to 1980. In the case of the world price of beef, the procedure was somewhat different. Under each asssumption the world price of beef was taken at its actual value in 1973. This was done because this price changed considerably that year, and because this variable has such an important influence on the endogenous variables. Hence, it was thought to be more realistic to allow this variable to take on the most recent value available in the published statistics.

The results of this analysis are given in two forms. In Table 4.10, the values of the endogenous variables in the base year (1971) are compared with the final year, 1980. In Table 4.11, the adjustment path of the trade surplus (or deficit) in beef is given from 1971 to 1980 under each assumption.

Beginning in 1973, the rate of inflation was assumed to fall under assumption A from 16.42 percent in 1972 to 8.5 percent and the overall balance of payments position was assumed to remain the same. The net effect of these assumptions is to reduce the level of intervention, but this effect is overwhelmed by the 34.3 percent increase in the real world price of beef.

Under assumption set B the rate of inflation assumes a value close to the 1972 value, but the overall B.O.P. position is assumed to deteriorate by U.S. $555 million. This results in a greater tendency for intervention to be reduced than in A, and hence the rising world price in 1973 is not neutralized to the same extent in B. This results in a higher domestic price of beef, a lower level of domestic consumption, and a higher export surplus than in A.

Under assumption set C, the overall B.O.P. position is assumed to deteriorate faster in 1973 than occurred in B, from U.S.$555 million to -U.S.$200 million. This tends to reduce the level of intervention, but this is more than offset by the higher assumed level of inflation. The net effect is to raise intervention in C greater than in either A or B, and the result is lower domestic price of beef, higher domestic consumption, and a smaller export surplus.

Table 4.10. Projected Production, Consumption and Exports, 1980.

Variable	1971	1980 A	1980 B	1980 C
Stock cattle (million head)	75.3	102.6	95.0	84.9
Slaughter (1000 head)	9392	13,108	12,489	11,602
Production per inhabitant (Kg. per capita)	19.09	20.43	19.46	18.08
Consumption per capita (Kg.)	16.85	13.51	15.88	18.93
Trade in beef (1000 tons)				
e.c.w.	+205	+851	+441	-105
p.w.	+124	+515	+267	- 64
Domestic Price of Beef Cr$/ton	1352	2021	1634	1136
Level of Intervention Cr$/ton	1320	1902	1286	896

Note: The consumption statistics assume that trade is permitted to equate supply and demand.

As mentioned previously, the world price of beef has been assumed to be the same under each set of assumptions, with the only variation stemming from different assumed values for the overall B.O.P. position, the rate of inflation, and the rate of growth of income. In 1974, and in each

succeeding year, the exogenous variables are ascribed the values given in Table 4.9. From this point on, the projections are influenced only by the change in the world price of beef (which occurs in B and C only) and the growth in demand through changes in population and income and reflected by the coefficient of trend.

Under assumption A, the world price of beef is assumed to remain constant at its 1973 level, so there is no added stimulus to increase the stock of cattle. The export surplus, which decreased in 1972 as a result of stock increases, rises monotonically to 1980.

Under assumption set B, the world price of beef falls from U.S.$1386 in 1973 to U.S.$1032 in 1974, and the stock of cattle adjusts downwards. The increased slaughter is completely offset by increases in domestic consumption due to the lower price and the resulting export surplus is lower in each year, than in A.

Under C, the world beef price is assumed to fall to almost 50 percent of its 1973 level in 1974, and the downward stock adjustment is even more pronounced than it was in B. As in B, however, this increase in the short-run supply of beef is completely offset by the increase in domestic demand, and by 1977, domestic demand has overtaken domestic supply. This results in an import requirement under C in the period from 1977 to 1980.

The values of the endogenous variables at the end of the projection period are given in Table 4.10. As expected, they show that beef output is greatest under Assumption A, but that beef consumption is greatest under Assumption C. Under A, exports are expected to be close to their 'official' target level of 600,000 tons p.w. in 1980, but these levels of exports are bought at cost in terms of low per capita beef consumption.

Table 4.11. Projected Trade Surplus in Beef, 1972-80. (thousand tons p.w.[a]) (+ exports, - imports).

Year	Assumption Set		
	A	B	C
1971 (actual)	+124	+124	+124
1972	+ 36	+ 36	+ 36
1973	+181	+198	+176
1974	+241	+155	+ 29
1975	+296	+180	+ 16
1976	+348	+203	+ 1
1977	+395	+221	- 14
1978	+439	+239	- 30
1979	+479	+254	- 47
1980	+515	+267	- 64

Note: The figures in this Table are derived from the projections, assuming that the product mix of beef exports in each year remains the same as in 1971. This product mix is given in Chapter I, p. 20.

Under assumption set B, beef exports are projected to rise to 267,000 tons p.w. in 1980 from their present level, and domestic consumption per capita is expected to fall slightly. This would be consistent with the downward trends in beef consumption that Brazil has experienced since 1947 (see Table 1.4.) However, it may not be consistent with present policy.

There is an import requirement projected under C, which is increasing in size. But domestic consumption per capita is higher than at the present time,and approximately equal to consumption levels during the period 1948-54 in Brazil.

The first point about these projections is that they will tend to understate domestic demand and overstate the export surplus if there is a change in the distribution of increase towards greater equality. This stems from the nature of the demand model used to make the projection. However, in the absence of such changes, or other changes in the structure of demand, the projections are expected to be realistic. Secondly, the projections are based on a model which does not make allowances for changes in technology except inasmuch as these have occurred over the data period and are reflected in the estimated coefficients.

The projections add further weight to the hypothesis that the beef export potential of Brazil is not great, unless there is a substantial improvement in the level of productivity of the herd through the adoption of improved technology.[15/] In addition, however, they show that such improvements would lead to even higher beef output, if they were accompanied

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15/ For evidence that investments in improved production technology can improve the comparative advantage in agricultural products, see Rubens Valentini (74).

by stable price policy which maintained the domestic price of beef at a high level. As is shown in assumption A, such policy leads to higher output and to higher potential beef consumption (as reflected by production per capita), provided that consumer income rises at a rate sufficient to keep beef within the budget of consumers.

Changes in Technology

The preceeding discussion on projected beef supplies and exports has not made allowances for changes in technology in the future except in as much as past productivity improvements are embedded in this model. As previously stated, it appears that these increases have been very small, although lack of data make it difficult to make a definitive statement on this matter.

This situation is understandable in view of the small research and extension effort that has been devoted to the cattle sector in the past.[16/] However, it is interesting to assess the impact that additional research and extension resources might have, if they were applied and resulted in a net benefit to the sector.

The long-run elasticity of total supply (females and males) is 1.587. Hence a research and extension program which resulted in decreasing the real cost of beef production by 10 percent[17/] would result in a 15.87 percent

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16/ For a discussion of this point see FAO (73).

17/ Some comparability may be gained with this figure if one considers that various other studies have attempted to measure the shift in the supply function of other crops due to new technology. For example, Ayer and Schuh (1973) found that the cotton research program in Sao Paulo over the period 1925-66 moved the supply curve for cotton 53 percent to the right, in terms of quantity produced. They estimated that the supply elasticity for cotton is 0.944 and hence this quantity shift implies a 56 percent reduction in real cost of cotton production resulting from the research program.

increase in beef output at the long-run equilibrium. In addition, the time required to reach that position would be shortened provided such research increased the level of productivity in the herd. Some idea of the importance of such a shift may be obtained by examining the effect on the projections shown in Table 4.10. If the sector were in long-run equilibrium in 1980, under assumption B, a 10 percent decrease in the cost of production would imply an export surplus of 497 thousand tons of beef p.w. with the same quantity of beef consumed domestically.

However, the decision to proceed with such programs would require an evaluation of the costs involved as well as the benefits. This example merely serves to show the magnitude of the gross benefits that might result from such efforts.

CHAPTER FIVE

SUMMARY AND CONCLUSIONS

This section deals first with a summary of the objectives of the study, the background and basis for the empirical work, and the results and analysis of the statistical testing of the model. The second part contains a summary of the principal conclusions, and the implications that the statistical results appear to have for policy. The final section is devoted to a discussion of suggestions for further research.

Summary

The objective of this study was to develop an aggregate econometric model of the Brazilian beef cattle economy which would describe the structure of each of the principal sections or forces impinging on it. Thus the study describes and incorporates into a model, the farm production sector, domestic consumers, the export market and governmental policy.

A theoretical model was developed which draws on a number of theories from other studies and extends these in some aspects to correspond to the Brazilian case. The first component of the model was a policy equation to describe government intervention in the export market for beef.[1/] The model assumes that Brazil is a price-taker in the world beef market, but that policymakers intervene in the export sector, in effect putting a wedge between the international price of beef and the domestic price.

1/ Some recent studies have developed models which also attempt to predict policy. See, for example, Evans (24).

The policy model is an attempt to describe this process in terms of the policy objectives relating to foreign exchange earnings and the desire to control inflation through price policy.

The farm production sector was modeled by drawing on a theory of investment behavior for cattle and supply response for beef which has recently been developed in studies similar to the present one for the Argentine beef sector. The model distinguishes between male and female cattle, and postulates an investment and slaughter equation for each. The investment equations were specified as adjustment models which enable the dynamics of beef supply to be examined over time. The model also postulated that part of the investment in cattle in Brazil occurs as a hedge against inflation, and that in the presence of the unstable rates of inflation which Brazil has experienced over the observation period this effect has an impact on cattle slaughter. Domestic demand was represented in the model as a function of the price of beef, the price of a substitute in consumption (pork), and total consumer income.

The econometric model was constructed as a block recursive system. The first block is comprised of the intervention model, which determines the level of trade intervention in the beef export market, and hence the price of beef in Brazil given the world price. The second block determines the domestic supply and demand for beef, and consists of the two investment equations, two slaughter equations, and a domestic demand equation. The third block consists only of an identity to determine the quantity of beef exports from Brazil given domestic supply and demand.

The statistical support for the maintained hypotheses was mixed. This is not surprising, due to the high level of intercorrelation among

the variables and the paucity of good data, particularly on the demand side. There was reasonably good support for the hypotheses contained in the intervention model. This is an encouraging result, as it appears to show that intervention policy is predictable with measurable accuracy by economic variables alone. The statistical estimates of the investment and slaughter equations also provided reasonably strong support for the theoretical model. As hypothesized, the coefficient of the price of beef variable had a positive sign in the investment equation, and a negative sign in both slaughter equations. These results, together with the positive coefficients on the lagged endogenous variables in the investment equations, support the basic investment-supply model developed by Jarvis (39) and Yver (77).

The evidence of a linkage between the milk and beef sectors of the cattle industry in Brazil was not particularly strong, but the statistical results were reasonably encouraging. On the other hand, there was no strong evidence to support the hypothesized linkage with the crop sector. However, this latter result is not surprising, given the aggregate nature of the model, the land-extensive nature of beef production over the period under study, and the relative abundance of land in Brazil.

The statistical support for the hypothesis that cattle producers hedge against increases in the expected rate of inflation is not particularly strong, but again the results were encouraging, at least for male cattle. The signs of the coefficients of the inflation variable were in accord with the a priori specification in three cases out of four, but were not significant at the five-percent level.

The weakest statistical support was found for the demand equation. Coefficients did not always have the expected signs, and they tended to be rather unstable between alternative specifications of the model.

Conclusions

Based on the statistical results obtained in this study, it appears that Brazilian policymakers reacted in similar fashion to intervene in the beef export market, at least over the periods 1947-52 and 1960-71. The results suggested that the degree of this intervention may be reasonably well predicted by the international price of beef, the overall position of the balance of payments, and the rate of increase of the general price level. An analysis of these interventions suggests that Brazil has incurred a large social cost by maintaining this intervention policy, principally through the distortions created in the exchange rate, but also by a number of other instruments.

The results of this analysis also suggest that beef supply is relatively elastic in the long-run with respect to its own price, and this implies that the long term prospects for beef production are good. At the same time, however, the statistical results indicate that the adjustment time required for the beef sector to reach a long-run equilibrium may be close to 20 years. If this is correct, it has major implications for policy towards the beef sector and for general economic policy.

First, it helps to explain the many crises that have occurred concerning the beef sector in Brazil since 1947 by suggesting that the sector has continually been in a state of disequilibrium. That is, the speed with which the beef sector could adjust to new policy and the frequency with which these policies were changed meant that the sector was seldom able

to respond positively to government action. This is because the short-run response of the cattle sector is 'perverse', and if the results of this study are correct, this perversity may last 2-3 years in Brazil. A failure to recognize this mechanism and the length of time required for the beef sector to adjust to new conditions can therefore result in higher intervention, thereby causing an increase in present consumption and exports, but at a cost of lower future consumption and exports, but at a cost of lower future compensation and future exports from the sector.

The principal factor behind the slow rate of adjustment of the herd appears to be the low level of productivity and the slow rate at which technology appears to have been adopted over at least the last 25 years. This evidence suggests that measures designed to increase the productivity of the herd through research and extension, together with stable policy towards the beef sector would result in a considérable increase in beef output in Brazil in the long-run, and would decrease the time required for the industry to reach that position. Such moves would in turn increase Brazil's beef export potential considerably. In the absence of such measures, the export potential in the short term appears less bright. The projections made in Chapter Four indicate that by 1980, beef exports from Brazil could reach 500,000 tons p.w. (which is close to the 'official' target figure) under very favorable conditions of the world beef price, low rates of domestic inflation and continuing high surpluses in the overall balance of payments. However, without a substantial improvement in the level of productivity, this level of exports could be bought only at a high cost in terms of domestic consumption levels. Under less favorable conditions, domestic consumption is projected to continue at

about its current level, but in these cases, beef exports would fall well short of the target figures, or imply a deficit of beef supply over beef demand.

The apparent linkage between the milk price and beef production infers that milk policy may be very important in influencing the stock of female cattle and hence future beef production. That is, there appears to be a need to coordinate milk and beef price policy if the one is not to work at cross purposes with the other.

The statistical support for the effect of unstable inflation on investment in cattle and beef output was not particularly strong, although it may have an effect on male cattle. If the hypothesis is correct, it implies that the immediate impact of an increase in the expected rate of inflation is to cause a retention of cattle from slaughter (and vice versa), which would provide some incentive for government to stabilize the rate of inflation.

Suggestions for Further Research

The apparent success of the present study in explaining the behavior of the government sector in trade intervention in the beef sector of Brazil appears to be sufficiently encouraging to warrant further research for other products and in other countries. This endogenous explanation of policy actions by means of economic variables adds something by way of realism to models of this type, and if successful, would enable researchers to maker better projections and provide a clearer understanding of the economic forces impinging on policy.

A second avenue of research which stems from the study is the need to generate more refined data on the stock of cattle in Brazil to enable

studies of the beef sector to be formulated at a more disaggregated level. This would add considerably to our understanding of the industry, and hopefully improve the quality of descriptive advice to policymakers.

The support for the hypothesis that some part of cattle investment is speculative to hedge against inflation is sufficiently strong to warrant further research. This applies not only to countries like Brazil, but also to highly developed countries where the beef sector is important in the overall economy and where inflation is becoming a problem.

There also appears to be a great need for economic research to establish research priorities in the beef sector for Brazil, and to coordinate such studies with those for other agricultural products. The payoff from the implementation of the new technologies which should be developed from such research may be extremely high, both in terms of higher beef consumption levels in Brazil and additional foreign exchange earnings.

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APPENDICES

APPENDIX A

Appendix A

An Outline of Brazilian Beef Policy, 1947-73

This appendix is designed to provide a brief summary of the variety of public policies that have been pursued with respect to the beef sector in Brazil over the last 27 years. The review is not exhaustive, since limitations of time and the difficulty involved in finding authoritative material for such a long period of time precluded such an ambitious goal. However, it is hoped that the material presented covers the major policy changes that have had a significant influence on aggregate beef output, consumption, and exports in the past two decades, and that it provides a 'flavor' of the diversity of policy interventions in the sector.

Some of the key sectoral statistics for the period under consideration are presented in Table A.1. These data provide a base for evaluating, in a limited way, the effect of those policies whose effect is immediate or which occur with a predictable lag, and will be referred to from time to time in the text.

The discussion is organized around reasonably homogenous kinds of policies. Major headings include export policy, domestic price policy, slaughter policy, storage policy, investment and credit policy, and milk policy.

Export Policy

Export policy vis-a-vis the beef sector has been expressed in exchange rate policy, export taxes, export quotas and export incentives. Each of these measures are discussed in turn.

Table A.1. Some Key Statistics of the Brazilian Beef Sector 1947-71.

Year	Total Beef Output (thousand of tons c.w.)	Cow Slaughter (thousand head)	Real Farm Price Beef (Cr$ of 1965-67 per ton c.w.)	Beef Exports (thousand tons equivalent carcass weight)	Apparent Beef Consumption per Capita (Kg. per person)
1947	866	1371	646	55.5	16.7
1948	986	1690	624	75.1	18.4
1949	1035	1813	648	42.6	19.6
1950	1036	1689	688	30.0	19.4
1951	1087	1886	751	12.2	20.1
1952	1056	1725	883	6.1	19.0
1953	1067	1820	920	3.8	18.7
1954	1087	1725	859	1.6	18.6
1955	1075	1689	1003	9.9	17.7
1956	1213	1941	906	15.8	19.3
1957	1254	2146	801	36.1	19.3
1958	1393	2647	798	58.6	20.3
1959	1386	2603	770	95.6	19.0
1960	1291	2396	1012	26.9	18.1
1961	1301	2242	1096	50.0	17.4
1962	1288	2285	1158	37.2	16.9
1963	1293	2320	1026	29.2	16.6
1964	1365	2592	1080	41.1	16.9
1965	1422	2619	1008	85.1	16.6
1966	1379	2504	1352	51.7	16.0
1967	1431	2413	1270	30.6	16.4
1968	1609	2774	1075	93.9	17.3
1969	1735	3133	1021	145.2	17.6
1970	1753	3279	1152	171.7	17.0
1971		3062	1396	205.4	

Source: Tables 1.4, B.1, B.5, B.4, 1.4, respectively.

Exchange Rate Policy

In the post-war period exchange rate policy has had an extremely important influence not only on beef exports, but also on the quantity supplied, the quantity demanded, and the price of beef on the domestic market. In fact, prior to 1960 the only policies with any sizeable impact on the beef sector were exchange rate policy and retail price controls. However, this intervention was not always explicitly used to modify the quantity of beef exports, but rather was a by-product or consequence of policy measures designed to attain other objectives of the Government.

An important characteristic of the exchange rate situation is the persistent over-valuation of the cruzeiro throughout most of the post-World War II period. Data which document this situation are presented in Table A.2. The first column is the official exchange rate, which is the one that applies to individuals for personal financial transfers. The second column of the table contains an estimate of the quasi-free-trade exchange rate that would have existed in each year had Brazil followed a policy of free-trade. This series, which is largely taken from Bergsman (7), was calculated by adjusting the market rate by a factor which depends on the size of the import tariffs and the elasticities of import demand and export supply. Bergsman's series has been extended by the author in the manner described in Appendix B.

The average import rate is given in column three of Table A.2. This rate is the average of the rates that applied to each import category (where there was more than one), weighted by the volume of transactions in that category. The fourth column is the effective exchange rate for beef exports. This rate, which is based on a series from Veiga (75), is

Table A.2. Brazilian Exchange Rates Applied to Imports Beef Exports and the Official Rate, 1947-72. (Cr$/US$)

Year	Official Exchange Rate (nominal) (a)	Quasi Free Trade Exchange Rate (nominal) (b)	Average Import Exchange Rate (nominal) (c)	Effective Export Exchange Rate Beef (nominal) (d)	Effective Export Exchange Rate Beef (real) (e)
1947	0.0229	0.0266	0.0187	0.0184	1.66
1948	0.0272	0.0209	0.0187	0.0184	1.59
1949	0.0295	0.0240	0.0187	0.0184	1.53
1950	0.0324	0.0261	0.0187	0.0184	1.55
1951	0.0302	0.0291	0.0187	0.0184	1.43
1952	0.0343	0.0321	0.0187	0.0184	1.23
1953	0.0449	0.0351	0.0429	0.0190	1.08
1954	0.0625	0.0380	0.0624	0.0297	1.36
1955	0.0741	0.0570	0.0986	0.0489	1.88
1956	0.0741	0.0710	0.112	0.0635	2.07
1957	0.0768	0.0810	0.087	0.0660	1.93
1958	0.132	0.0950	0.166	0.0898	2.33
1959	0.160	0.160	0.221	0.1048	1.91
1960	0.190	0.210	0.229	0.181	2.52
1961	0.291	0.350	0.279	0.262	2.57
1962	0.523	0.550	0.387	0.324	2.14
1963	0.903	0.830	0.617	0.578	2.14
1964	1.536	1.700	1.234	1.185	2.49
1965	1.920	2.500	1.893	1.811	2.54
1966	2.213	2.800	2.220	2.169	2.17
1967	2.860	3.320	2.663	2.666	2.11
1968	3.577	4.435	3.409	3.390	2.24
1969	4.052	5.024	4.076	4.190	2.43
1970	4.564	5.659	4.595	5.130	2.57
1971	5.253	6.514	5.287	6.000	2.52
1972	5.880*	7.406	5.915*	6.755	2.58

*These rates refer to June 1972.

Source: (a) and (c) Conjuntura Economica, Nov. 1972.
(b) Table B.10.
(d) This series from 1947-67 is taken from Veiga (75). The series was extended using the same published data used by Veiga and making a series of adjustments by factors to account for the effect of export incentives that applied to beef after 1967. These adjustments were estimated by Horta (38) and Bacha (4).
(e) Column (d) multiplied by WPI(US)/WPI(Brazil).

an estimate of the exchange rate that applied to beef exporters. It includes a discount for export taxes when these were applied, and a premium for export incentives in the period in which these were relevant (1969 to 1972). The final column is the effective beef export rate expressed in real terms by multiplying column four by the ratio of the wholesale price index in the United States to the wholesale price index in Brazil.

The sub-period 1947-53 can be singled out for discussion because the Government held the effective beef rate constant in nominal terms.[1/] In the face of rising domestic inflation, this action resulted in a decline in the real effective exchange rate for beef, and beef exports fell from 75 thousand tons e.c.w. in 1948 to less than 4 thousand tons e.c.w. in 1953. From 1954 to 1959 the nominal effective rate was raised, and beef exports, after a decline in 1954, increased monotonically from 1.6 thousand tons e.c.w. in 1954 to 95.6 thousand tons e.c.w. in 1959. It would appear that beef exports increased over this period in part because the real effective exchange rate trended upwards over the period.

These first two subperiods, covering the period 1947 to 1959, are relatively easy to interpret because quantitative restrictions were seldom used to regulate beef exports. However, from 1960 onwards quantitative restrictions were used sporadically and therefore it is rather more difficult to correlate the real value of the effective beef rate with the volume of beef exports. Over the period 1960-67 the real effective beef exchange rate was maintained at a high level. At the same time, the rate was subject to considerable annual variation due to the highly

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1/ The effective beef exchange rate was actually raised by three percent in 1953.

unstable rates of domestic inflation. The rate of inflation rose from 24 percent in 1960 to 87 percent in 1964,[2/] and fell gradually thereafter to 27 percent in 1967. The volume of beef exports responded to the high real effective rate in those years (1961 and 1965) in which quantitative controls were not involved. However in 1960 and 1964 the volume of exports fell due to restrictive export quotas.

From 1968 to 1972, the real effective exchange rate for beef rose following the general realignment of the exchange rate and the introduction of various export incentives. Corresponding to this rise, the volume of exports followed a secular rise to reach a record level in 1972.

Export Quotas

The government has at various times used its export licensing procedures to restrict the quantity of beef exported. However, prior to 1960 the author has been unable to find any evidence to suggest that these measures were implemented to restrict the volume of beef exported except in 1954. In that year the volume of beef exports continued to decline (from 1948), but the real value of the effective beef exchange rate rose sharply. Though this is only prima facie evidence, it is consistent with the hypothesis that quantitative restrictions were used to hold down the volume of beef exports.

Knight (41) quotes non-official sources to show the existence of restrictive beef export quotas in 1960 and 1963. In 1964 beef exports were formally controlled, at first by outright prohibition,[3/] and later

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[2/] During the first four months of 1964 the rate of inflation was 120 percent on an annual rate basis.

[3/] SUNAB Resolution No. 31 (12/19/63).

by a series of government regulations (Portarias) administered by the government supply agency, SUNAB.[4/]

The next phase of quantitative controls began in 1967. These quotas were more sophisticated than the previous ones in that they tied the export quotas of each packing plant to the quantity of beef stored by the company for off-season supply to the domestic market. The export statistics appear to show that this new policy did have an effect on beef exports in 1967, but the effect in later years (if any) is not obvious. The reason for this may well be that in more recent years entrepreneurs have adjusted to the policy, or that the requirement has been offset by the storage subsidies provided for this purpose. These additional modifications to the export-storage policy are explained in more detail below.

Fxport Taxes

It appears that the government has used explicit export taxes on beef on two separate occasions. In 1965 SUNAB introduced a 30 percent ad valorem tax on the FOB value of beef exports (Resolution 188). However, this tax was reduced the following month to 20 percent for the State of Rio Grande do Sul, and in 1966 the tax was removed from all beef exports.[5/] In January 1973 the government replaced its system of retail price controls with an export tax of U.S. $200 per ton. This tax was equivalent to an ad valorem duty of 20 percent on frozen beef exports. In October of the same year this tax was increased to U.S. $500 per ton.

[4/] SUNAB Resolution No. 26 (6/4/64), Super No. 26 (¢/12/64), and Resolution No. 188 (2/1/65).

[5/] See Veiga (75).

Export Incentives

In 1964 the new government created legislation that laid the basis for the initiation of an export drive--especially for manufactured products. This legislation provided for a set of fiscal incentives, special tax deductions, and subsidized credit for exporters of manufactured products. At the same time, however, some state governments provided tax concessions for exports of primary products, including beef.

The first set of incentives for beef exports consisted of the abolition of the national sales tax(IPI) and an exemption from income tax for exports of manufactured beef products. In 1969 the exemption of the IPI tax was changed to a tax credit of the amount of tax theoretically payable.

In addition to these incentives for manufactured products, exports of fresh and frozen beef also received tax breaks. In 1968 the value-added tax (ICM) was reduced from 17 percent to 15 percent on non-processed beef exports from both the state of Sao Paulo and Rio Grande do Sul. The following year the ICM tax was reduced to 6.5 percent in Rio Grande do Sul, and apparently as a countermeasure, Sao Paulo eliminated its ICM tax on beef exports in 1970. The Federal Government officially reinstated the ICM tax on beef exports from both states in 1971, but unofficial sources claim that the tax was not paid pending the outcome of a judicial inquiry. Finally, in 1973 the ICM tax was officially abolished on beef exports when the new export tax was introduced. These export incentives are summarized in Table A.3.

Table A.3. Tax Incentives for Beef Exports, 1968-72.

Year	Type of Tax			
	ICM[a]		IPI[b]	Income Tax
	Rio Grande do Sul	Sao Paulo		
1968	15%	15%	exempt[c]	exempt[d]
1969	6.5%	6.5%	credit[e]	exempt
1970	6.5%	15%	credit	exempt
1971	0%	0%	credit	exempt
1972	--	--	credit	exempt

[a] Imposto do Circulacao e Mercadorias (ICM)
[b] Imposto de Produtos Industriais (IPI)
[c] Decreto No. 61514 (12/10/67), originally Lei No. 4502 (30/11/64).
[d] Lei No. 4663 (3/6/65)
[e] Decreto-Lei No. 491 (5/3/69).

There have also been a number of supplementary incentives granted to the export sector which are not included in Table A.3 because they are judged to be of lesser importance than the direct tax exemptions and credits. These include special income tax exemptions for overseas advertising, marketing, and product storage expenses. These subsidies were mainly introduced in the period 1964-67 in legislation relating to the tax exemptions given before.

Domestic Price Policy

The Brazilian Government has attempted to control the domestic beef price on a number of occasions over the period under consideration. These controls have been variously applied at the farm, wholesale, and retail levels, but the degree to which they have managed to hold down the price of beef is open to considerable debate. Because of the difficulty of

policing such controls,they probably had little or no effect in smaller communities, and more than likely managed to do little more than impose some lag on the price increases that inevitably took place in the larger urban centers. The shortages of beef that occurred at various times suggests that these controls did have some short term effects in the market, while at the same time resulting in non-price rationing and very probably black markets.

For the most part the price controls were limited to wholesale and retail prices. However, in 1965 SUNAB fixed the farm price of beef (Resolution 232), and took direct action to ensure a continuing supply of beef to the domestic market. (This will be explained in the next section). These price controls were lifted in 1967.

The second time that farm price controls appeared was in 1973 immediately after the removal of all price controls in December, 1972 (Portaria 63/72). This time however, the farm price was controlled by a "gentleman's agreement" between the Association of the Freezing Industry (Sindicato da Industria do Frio) and the Ministry of Finance. The effects of the controls in 1965-67 seem to have been an increase in speculative activity in cattle and an increase in smuggling cattle across Brazil's land borders. In 1973 the controls seemed to have had little effect, except perhaps for the larger meat packing companies.

The history of retail price controls on beef is far more complex, and the number of times they have been used more numerous. Without tracing out their history in detail, suffice it to say that over the period 1937-72, the government supply agency(SUNAB) or its precedessors repeatedly introduced controls and various modifications. A sample of the legislation governing these controls is given in Table A.4 in order

to give the reader an idea of the extent of their use.

The fact that price controls were used so often in an attempt to control the price of beef gives an indication of the weight which the government and consumers put on holding the price down. However, the effectiveness of these measures is rather more in doubt. For example, in 1973 when the farm price was fixed at Cr$63 per arroba,[6] it was common knowledge that some farmers were receiving up to 50 percent above that figure.[7]

In addition to the legislation listed in Table A.4., there were a number of resolutions adopted to control wholesale prices and wholesale and retail profit margins. These measures were components of the continuing packages of policies designed to bring inflation under control. This price control phase of Brazil's beef policy officially came to an end (at least temporarily) in December, 1972, when SUNAB abolished all domestic price controls on beef (Portaria 63/72).

Slaughter Policy

In addition to the price controls introduced in an attempt to hold down domestic beef prices (and perhaps partly because of them), the government also attempted to influence the quantity of beef supplied to the domestic market. The first of these policies was designed to maintain a 'reasonable' supply of beef to the market during the period of the "entre-safra",[8] when supplies tend to be less in any event due to pasture shortages. The policy, which began in 1964, was to provide subsidized credit to meat packers who would carryover frozen beef from the

[6] An "arroba" is equal to 15 kilograms.

[7] See Veja magazine, 8/8/73, p. 91.

[8] The "entre-safra" refers to the period between harvests or peaks (safra) in the killing season.

Table A.4. Selected Legislation Governing Retail Price Controls, SUNAB, 1962-72.

Legal Title	Date	Description
Portaria No. 092	02/01/62	Controls Introduced
Portaria No. 1021	12/05/62	Controls Altered
Portaria No. 140	01/17/63	Controls Rescinded
Resolution No. 6	09/19/63	Controls Introduced
Resolution No. 106	07/23/64	Controls Introduced
Resolution No. 144	10/06/64	Controls Rescinded
Resolution No. 190	02/04/65	Controls Introduced
Super No. 949	09/28/65	Controls Extended
Resolution No. 254	12/29/65	Controls Reinforced
Resolution No. 294	07/23/66	Controls Extended
Resolution No. 328	02/09/67	Controls Rescinded
Portaria No. 29/72	07/24/72	Controls Altered
Portaria No. 63/72	12/26/72	Controls Rescinded

Source: Diaria Oficial, various issues.

Note: A fuller summary of legislation affecting the beef sector and administered by COFAP and SUNAB over the period 1960-72 is given in Appendix D.

period of the "safra" (Resolution 128 and 188).

However, in 1967 (Resolution 327) this program was altered radically. Beef exporters were now allocated export quotas in proportion to the quantity stored for the period of the "entre-safra", but with the same policy as before of providing credit at negative real rates[9/] from the Banco do Brasil to offset the cost of storage. In addition, this resolution probably distorted the seasonal slaughter pattern further by limiting slaughter during the "entre-safra" in Central Brazil to a given proportion of the slaughter in the "safra". The reason for this final requirement is not entirely clear, but one explanation is that it was (and still is) used to prevent the slaughter of breeding cattle in particularly dry seasons.

This basic storage-export plan was still in operation at the time of this writing, but it now includes another regional effect, namely, that the storage-export ratio differs between Rio Grande do Sul and Central Brazil. For example, the 1972 Beef Plan requires that meat packers in Central Brazil store 1 ton of beef for every 1.5 tons exported, while in Rio Grande do Sul the ratio is 1:5.

The second slaughter policy which was used for a brief period of time was that of confiscation. In July, 1965 SUNAB was authorized to confiscate cattle from farms (Resolution 232) at the official price for beef (a price which was set by the same legislation). Such confiscations did occur, but the number of cattle involved is not known, and the authorization was withdrawn in December of the same year (Resolution 255). SUNAB also intervened at the farm level by operating its own slaughterhouses. By early 1970, SUNAB owned four slaughter houses in Sao Paulo, Minas

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9/ The policy effectively provides credit at negative real rates because the nominal interest change is less than the rate of inflation.

Gerais and Goias and leased another in Sao Paulo.[10/]

The third element of slaughter policy was initiated by Decreto 62122 (1/15/68). This decree prohibited the slaughter of female cattle less than five years of age. This policy is aimed at preventing a reduction in the cow herd in a vein similar to the enforced reduction in slaughter in Central Brazil during the "entre-safra" to 50 percent of its "safra" level.

Storage Policy

As outlined in the previous section the government has adopted a policy of encouraging beef processors to store increasing quantities of beef for the period of the "entre-safra". It has done this both by providing subsidies to private firms to provide storage space and by providing more public storage facilities at subsidized rates. We shall examine both these aspects separately.

Subsidies for Private Storage

Private meat packing firms are currently provided with credit to finance their participation in the storage-export program at a nominal interest rate of 12 percent per annum. When one considers that the average rate of return on capital invested in the private sector is about 15 percent in real terms[11/] and the current rate of inflation is running at approximately 18 percent, this implies a subsidy of approximately 20 percent.[12/] This subsidy, together with the enforced reduction in slaughter

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10/ USAID Memorandum (1/12/70), Rio de Janeiro.

11/ See Langoni (1971).

12/ In effect, the credit is extended at a real rate of -6 percent.

during the "entre-safra", can be expected to distort the seasonal distribution of cattle production and in turn cause a misallocation of resources. Too many resources will be employed in cold storage facilities and too few in "out-of-season" cattle production on farms.[13/]

The slaughter reduction requirement in Central Brazil adds to the distortion because it is this area that has considerable potential to produce more fat cattle during the "entre-safra". This is because there are areas in Central Brazil where out-of-season production is not limited by a shortage of pasture, but by a lack of infrastructure. One example of such a region is the Pantanal of Mato Grosso. This region has traditionally been one of the most important breeding areas in the country, with plentiful supplies of grass all year round. However, the production of fat cattle has not developed extensively in the region. One of the reasons for this situation appears to be that the present policies do not provide a profit margin sufficient to cover the cost of transporting fat cattle the long distances to the coastal consumption centers.

A second effect of the storage policy is to reduce the demand for the technology that is currently available to produce more fat cattle for sale during the "entre-safra". This is unfortunate because so many of the problems of the sector as a whole stem basically from the low levels of technology employed. Government programs which effectively slow the rate of adoption of such technology by lowering price incentives are hardly desirable.

Subsidies for Public Storage

Another policy which tends to distort the seasonal pattern of

production is the subsidization of cold storage facilities by the government. The Brazilian Storage Company (CIBRAZEM), which is an agency of the Ministry of Agriculture, is responsible for this policy. In 1972 CIBRAZEM controlled about 30 percent of the cold storage capacity in Brazil, but given present plans to increase its capacity 80 percent in 1973, this share will probably rise in the future.

There are two aspects to the distortion created by this public storage policy. The first is that the construction of new storage facilities for beef incurs a social cost when compared to the alternative of providing greater incentives for on-farm beef production during the "entre-safra". This has recently been shown by Dias (19). The problem apparently arises because the proposals to build these storage facilities are not evaluated on the basis of the social opportunity cost of the resources to be used.[14/]

The second aspect of public storage policy which affects the allocation of resources is the method of calculating the storage rates for private users. CIBRAZEM does not fix its storage charges according to the cost of storage for each product, but instead fixes them in direct proportion to the market value of the product being stored. Thus, the storage charge for shrimp and fish products is twice the amount per kilogram per month as that charged for frozen beef;[15/] not because the cost of storing these products differs, but simply because the market value of fish is higher than the value of beef.

The logic behind this policy appears to be that the higher the value of the product being stored, the more the firm can afford to pay for

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[14/] Dias (19).

[15/] As of December, 1972 the CIBRAZEM storage charges for shrimp and fish products were 80-100 centavos per kg. per month and 45 centavos for frozen beef.

storage facilities. This policy is doubly misleading in terms of resource allocation. In the first place, the market value of beef was under government control at the time the charges were set. In the second place the storage charge by CIBRAZEM for frozen beef was only one half of the cost of private storage in the state of Sao Paulo.[16/]

The net effect of these public storage policies appears to be to increase the private return from supplying frozen beef to the domestic market during the "entre-safra", but at a social cost of misallocating resources as between cold storage facilities and out-of-season beef production on farms. In addition to these resource allocation effects, there are obvious income distribution consequences of these policies.

Investment and Credit Policy

Prior to the mid-1950's the agricultural sector, in general, was not well served by credit institutions. Smith (68) has estimated that in 1950 only 18 percent of the total credit used in the agricultural sector was provided from institutional sources. The remainder is presumed to have come from the pre-harvest sale of crops, from input suppliers, and from local money lenders. The apparent reason for this situation was that commercial banks considered agricultural loans to be far more risky and less profitable than loans to other sectors.

However, during the 1950's, and especially in the decade of the sixties, the situation improved considerably. A number of special funds were established to encourage or finance specific activities, such

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16/ In November, 1972 the Syndicate of Cold Storage Companies in the State of Sao Paulo estimated the cost of cold storage at 91 centavos per kg. per month.

as the production of wheat and the increased use of fertilizer. However these schemes still had to rely for the most part on official banks (Federal and State); private banking institutions still preferred to invest largely in other areas.

In 1965 the government introduced a new law (Lei No. 4829) designed to increase the participation of private banks in agricultural credit activities. This law was supplemented by two other legislative actions (Decreto No. 58380 and Decreto-Lei No. 784) in 1966 and 1969,respectively. These laws obliged private banks to loan 10 percent of their funds[17/] to the agricultural sector at what were in effect negative real interest rates.

The situation for the livestock sector was generally worse than for the agricultural sector as a whole. Prior to 1966 the livestock sector was receiving 18 percent of the total rural credit while contributing approximately 30 percent of the agricultural product (as measured by the value of output). One reason for this may have been that beef producers were unwilling to borrow money for short terms (6-12 months) when the payoff period was considerably longer than that. Alternatively, in the presence of high and unstable rates of inflation, lenders may have been unwilling to extend credit for long periods of time.

Beginning in 1967 the relative position of the livestock sector changed markedly. The share of total rural credit going to this sector rose to 37 percent in 1968, and remained at a level higher than its share of agricultural output through 1971 (Table A.5).

17/ This was later increased to 15 percent.

Table A.5. Livestock Shares of Rural Credit and Value of Agricultural Output, Brazil, 1964-71.

Year	Share of Total Agricultural Output (percent)	Share of Total Rural Credit (percent)
1964	39	18.5
1965	37	20.5
1966	33	23.1
1967	32	26.1
1968	32	37.1
1969	31	36.8
1970	34	34.3
1971	n.a.	35.3

Source: Agricultural product,by sectors, was obtained from EAPA/SUPLAN, Ministry of Agriculture, Brasilia. Total rural credit is taken from Boletim do Banco Central do Brasil, Brasilia, various issues.

The increase in the relative position of the livestock sector was also accompanied by a large increase in the absolute amount of credit extended to the sector. This is shown in Table A.6, where the data indicate that the total value of credit extended to the livestock sector increased three times in nominal terms over the period 1969 to 1972.

Table A.6. New Loans Granted to Livestock Sector, 1960-72, by Source (Cr $ Millions)

Year	Source of Credit				
	Total Official Banks	Banco do Brasil, CREAI	Banco Amazonia	Banco Nordeste	CONDEPE
	(1)	(2)	(3)	(4)	(5)
1960	-	11.39	-	-	-
1961	-	11.74	-	-	-
1962	-	30.28	-	-	-
1963	-	25.93	-	-	-
1964	-	62.01	-	-	-
1965	-	64.69	-	-	-
1966	-	186.00	37	-	-
1967	-	245.00	283	-	-
1968	-	416.00	357	-	-
1969	978	575.00	394	133	12
1970	1149	726.00	-	125	77
1971	1585	1345.00	-	175	235
1972	2870	1967.00	-	338	213

- indicates that the data are either not available or were insignificant in amount.

Source: (1) GECRI, Banco Central do Brasil, Credito Rural.
(2) Banco do Brasil, Relatorio (in 1970 the farm lending functions were removed from CREAI).
(3) Banco da Amazonia, relatorio.
(4) Banco do Nordeste, relatorio.
(5) CONDEPE, relatorio.

Note: The figures may add up to more than the total because CONDEPE does lend some finance through private banks.

The large increase in credit-use by the livestock sector was facilitated by four major factors. First, the new attitude towards rural lending adopted by the government in the period 1965-69 meant an automa ic increase in the availability of credit from official banks. Thus, for example, the Banco do Brasil greatly increased its loans to the livestock sector through its rural lending department, CREAI.

The second factor was the policy of extending the fiscal incentive program[18] to cattle production in the North and Northeastern regions of the country. This program is the main reason for the large increases in credit offered by the Banco da Amazonia and Banco do Nordeste since the totals for these institutions reflect the investments in this program through the governmental development projects SUDENE (Superintendencia do Desenvolvimento do Nordeste) and SUDAM (Superintendencia do Desenvolvimento da Amazonia), respectively.

Table A.7. Credit Use in Livestock Sector, by Lending Agency (End of Period Balances, Cr $ millions)

Lending Agency	Year 1971	1972	1973[a]
Monetary Authorities			
Banco Do Brasil	2239	3543	3750
Official Banks			
Federal	416	677	731
State	483	687	682
Total Official Credit	3138	4907	5163
Private Banks	1081	1386	1463
Percent Official Credit	74	78	78

[a] Refers to March, 1973.

Source: Banco Central do Brasil, Economics Department.

The third factor which had a major influence on the availability of credit was the formation of a special credit fund for the development of the cattle industry. This fund, FUNDEPE (Fundo Para o Desenvolvimento

[18] In the period since 1964 the government has used fiscal incentives in the form of tax rebates to influence the direction of economic activity. (These incentives really became effective only after 1967). One goal of these incentives has been to reduce regional imbalances by encouraging the investment of capital from the South in the North and Northeast.

da Pecuaria), was formed in 1967 and administered by CONDEPE, a department of the Ministry of Agriculture. The initial funds for this scheme were provided equally from the Central Bank and two foreign loans, one of U.S. $40 million from the World Bank and two others of U.S. $26 million from the Interamerican Development Bank. CONDEPE began lending money in 1969 to establish cattle producers in the Central and Southern regions of Brazil. These loans were intended for development programs designed to increase carrying capacity and animal productivity through the use of artificial pastures, fencing, improved water supplies, and improved management techniques.

The fourth factor is that private banks also appear to have been caught up in the act as well. Table A.7 shows that over the last two years, when livestock credit has expanded the fastest, the private banks have let their relative position shift only slightly. Correspondingly, they have also increased their lending to the livestock sector by a considerable amount.

Milk Policy

It has been estimated[19/] that 35 percent of the cattle in Brazil are of breeds suitable for both milk and beef production (mainly Gir and other Zebu crosses). The cows of these breeds may (and often are) used for both milk and beef production. Furthermore, it is generally understood[20/] that a considerable production of the total milk supply comes

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19/ Cunha (16).

20/ This is only an estimate, as there are little data available to prove the point.

from these dual purpose herds, and though exact figures are difficult to obtain, the most common estimate is about 35 percent. However, this type of estimate probably refers only to milk channeled through official markets, and the proportion may in fact be considerably higher than that.

For the most part, milk and milk products have not been exported from Brazil in large quantities, so export policy has not been an issue for this product, except in as much as imports have seldom been permitted. However, the government has pursued an extremely vigorous price control policy, and this has resulted in numerous supply crises. Over the period 1947-73 milk prices have been subject to retail price controls and controls on allowable profit margins by SUNAB and its two predecessor bodies. In this sense milk prices have been (and still are) more politically sensitive than beef prices.

A list of the legislation covering changes in milk prices is given in Table A.8 for the state of Guanabara. The table shows that intervention in the milk sector has a long history, and gives some notion of the frequency with which changes in policy were made.

There were two periods, however, when milk prices were freed from controls: one in 1962 and again for the period 1966-69. In the first period, however, price controls were put back only four months after their removal. In 1966 the removal of price controls resulted in a dramatic increase in milk supply and subsequent downward pressure on the milk price. This effect brought complaints from traditional milk suppliers that their incomes were being reduced, and the government reinstated price controls in November,1969.

Table A.8. Regulations Governing the Price of Milk, State of Guanabara, 1945-1971.

Year	Controlling Agency	Producer Price Cr$ /liter
	PORTARIAS - RESOLUCOES	
1945	Coordenacao da Modillzacao Economica Resolucao No. 102 29/03/45	0.90
1946	Comissao Central de Precos Officio No. 1.467 9/08/46	1.60
1949	Comissao de Precos do Distrito Federal Portaria No. 11/49 de 21/10/49	1.90
1952	Comissao Central de Precos Portaria No. 1 16/01/52	2.20
	COMISSAO FEDERAL DE ABASTECIMENTO E PRECOS	
1952	Portaria No. 62 10/10/52	--
1953	Portaria No. 95 29/09/53	--
	Portaria No. 124 19/11/53	2.80
	Portaria No. 135 12/12/53	2.80
1954	Portaria No. 160 6/02/54	--
	Portaria No. 271 5/11/54	--
1955	Portaria No. 362 23/05/55	3.80
	Portaria No. 362 23/05/55	--
1956	Portaria No. 559 17/08/56	4.90
1958	Portaria No. 328 11/07/58	6.70
1959	Portaria No. 261 19/08/59	8.00
1960	Portaria No. 647 5/08/60	12.90
1961	Portaria No. 660 23/06/61	15.20
1962	Portaria No. 336 18/04/62	--
	Portaria No. 702 8/08/62	26.50
1963	Portaria No. 276 8/03/63	36.50
	SUPERINTENDENCIA NACIONAL DO ABASTECIMENTO (SUNAB)	
1963	Portaria No. 37 8/08/63	43.50
	Portaria No. 39 16/08/63	44.90
	Resolucao No. 32 19/12/63	61.90
1964	Resolucao No. 82 2/06/64	84.50
	Resolucao No. 152 9/11/64	104.90
1965	Portaria No. 252 26/02/65	105.00
	Resolucao No. 240 14/10/65	--
1966	Resolucao No. 267 18/03/66 (Producer price freed) Price ruling on 21/06/66	190.00

(Continued)

Table A.8. (Continued)

1967	Portaria No. 330 2/03/67.	0.220
1968	Portaria No. 675 23/05/68	0.262
1969	Portaria No. 49 14/05/69.	0.316
1970	Portaria No. 23 20/05/70.	0.380
1971	Portaria No. 13 28/05/71.	0.450

Source: O Produtor de Leite Ano 2, No. 10 (Jan-Fev, 1972).

Note: 1. From 1945-66 the price is quoted in old cruzeiros and from 1967-71 in new cruzeiros (1 new cruzeiro=1000 old cruzeiros)

2. The date system in this table is day/month/year.

One explanation of this phenomenon is that milk supply is relatively elastic with respect to price over the range in which mixed milk-beef farmers enter or leave the sector. When controls were lifted, price expectations rose and a large number of small producers increased production. This brings out the point made in the text concerning the importance of milk price policy on the stock of cows on farms, and in turn on the production of beef, both in the short and long run.

APPENDIX B

Appendix B

Description of the Data Used to Estimate the Econometric Model

The purpose of this Appendix is to describe the data used in the econometric analysis and to evaluate the correspondence between the data used and the economic variables postulated in Chapter Two to enter the economic relationships. Before going into detail on each of the data concepts, however, there is one general comment which applies to most of the data series used.

Due to the lack of good communication links, regulatory agencies, and a host of other factors (including the sheer size of Brazil and the length of her land borders) many researchers do not have a great deal of confidence in the accuracy of the secondary data on the beef cattle sector in an absolute sense. That is, they think that the reported data often overstate or understate the real situation. This is complicated by the fact that the various kinds of data available may be subject to different types of errors.

In this regard, there are three data series which merit special comment. The official data on prices[1/] are considered for our purposes to be subject only to random error. This assumption is made because the author was unable to find any evidence showing the existence of a bias in the data. Indeed, the official price data appear to be consistent with independent price series which are available for some individual states for the period under study.[2/] Thus, these data are not expected

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1/ These data are published by EAGRI, Ministerio da Agricultura.

2/ For example, crop and meat prices for the State of Sao Paulo have been published by the Instituto de Economia Agricola of the State Secretariat of Agriculture for the period 1948 to the present.

to bias the statistical results, since the random error may be accounted for by the error term and attributed to omitted variables.

For other data series, however, the situation appears to be more complex. The data on official cattle slaughter are believed to be biased downwards. The evidence for this is that in 1971, an independent agency, CEPEN, using a larger sample than the Ministry of Agriculture (EAGRI) estimated that total cattle slaughter in Brazil was 6.3 percent higher than the official estimate. However, it is now known whether this bias has changed over time. In the absence of such information, it is assumed for purposes of the present study that the bias has been constant. This may be useful in the interpretation of the statistical results.

On the other hand, the official data on the stock of cattle appears to contain an upward bias which has changed over time. If the Census data on cattle stocks are assumed to closely approximate reality, then the percentage error in the official stock data appears to have risen from 18 percent in 1950 to 33 percent in 1960, and fallen again to 24 pefcent in 1970 (See Table 2.1). If this inference is correct, the use of the official stock data would create considerable problems in the statistical analysis. This is the main reasons why an alternate source of data has been used in this study for measuring the stock of cattle on farms.

In the remainder of this Appendix the data on individual variables are discussed under the heading of the variable which they represent.

Table B.1. Cattle Stocks, Beef Slaughter, Consumption, and Exports, Brazil, 1947-1971 (thousands of head).

	Cattle Stocks (beginning of year t)		Cattle Slaughter		Beef Consumption	Beef Exports
Year	Male	Female	Steers	Cows		
1947	11684	36954	3816	1371	4902	302
1948	12053	38186	4165	1690	5420	408
1949	12280	38941	4225	1813	5790	232
1950	12461	39632	4275	1689	5801	163
1951	12294	40366	4566	1886	6386	66
1952	12378	40790	4278	1725	5970	33
1953	12563	41593	4425	1820	6224	21
1954	12861	42382	4446	1725	6162	9
1955	13616	43583	4345	1689	5976	55
1956	14005	44774	4736	1841	6490	84
1957	14059	45501	4887	2146	6837	196
1958	13756	45959	5210	2647	7439	318
1959	13447	45799	5180	2603	7258	525
1960	13397	45612	4811	2396	7059	148
1961	13349	45699	4899	2242	6871	270
1962	13853	46291	4704	2285	6791	198
1963	14375	46858	4745	2320	6908	157
1964	14768	47429	4931	2592	7301	222
1965	15395	48297	5224	2619	7380	463
1966	16541	49565	5104	2504	7325	283
1967	17501	50979	5397	2413	7639	171
1968	17899	52435	5958	2774	8230	502
1969	17924	53541	6347	3133	8695	785
1970	18218	54428	6281	3279	8637	923
1971	18584	55219	6329	3063	8289	1104
1972	19028	56206				

Source: See text.

Table B.2. Cattle Slaughter, Brazil, 1940-71.

Year	Cattle Slaughtered (thousands head)			
	Total	Steers	Cows	Calves
1940	4,595	3,976	511	108
1941	4,752	3,379	1,178	195
1942	4,979	3,247	1,542	190
1943	4,592	3,068	1,306	218
1944	4,036	2,819	1,000	217
1945	4,203	3,057	911	235
1946	4,875	3,420	1,192	263
1947	5,204	3,544	1,369	291
1948	5,829	3,881	1,689	259
1949	6,023	3,953	1,813	257
1950	5,964	4,034	1,689	241
1951	6,452	4,337	1,886	229
1952	6,003	4,074	1,725	204
1953	6,245	4,233	1,820	192
1954	6,171	4,262	1,725	184
1955	6,031	4,170	1,686	175
1956	6,574	4,522	1,836	214
1957	7,033	4,574	2,146	313
1958	7,857	4,907	2,647	303
1959	7,783	4,886	2,603	294
1960	7,207	4,577	2,396	234
1961	7,141	4,672	2,242	227
1962	6,989	4,488	2,285	216
1963	7,065	4,516	2,320	229
1964	7,523	4,679	2,592	252
1965	7,843	4,987	2,619	237
1966	7,608	4,925	2,504	179
1967	7,810	5,200	2,413	192
1968	8,732	5,715	2,774	243
1969	9,480	6,119	3,133	228
1970	9,560	6,066	3,279	215
1971	9,392	6,148	3,063	181

Source: EAGRI, Ministerio de Agricultura, Rio de Janeiro.

The Stock of Cattle

Since 1940 the Brazilian Ministry of Agriculture has published under the name of the various agencies,[3/] an annual estimate of the stock of cattle on farms. However,as noted in the previous section there have been serious discrepancies between these data and the data from the agricultural Censuses which have been made every ten years.[4/] For this reason these data were not used for the present study and instead data series developed by Dias (19) was used.

This alternative series has been constructed from the slaughter data which are also published by the Ministry of Agriculture.

The Dias data are produced by a model designed specifically to construct such a set of stock data, using a simplified version of a technique used by Yver (77) and Nores (56). Dias provides an estimate of the stock of male and female cattle for the period 1949 to 1966. In order to arrive at his estimate, he made the following assumptions:

1. That Brazil can be divided into three relatively autonomous regions: (a) the South, (b) Central-South, and (c) the North-Northeast.[5/] As a result, the reported slaughter data for each of these regions comprises mainly cattle born and raised within the region, and the flows of feeder and fat cattle between these regions is small enough to be ignored.

[3/] The data are currently published by EAGRI. Formerly it was published by ETEA and SEP.

[4/] See Table 2.1.

[5/] The South region is comprised of the States of Rio Grande do Sul and Santa Catarina; the Central-South of the States of Mato Grosso, Goias, Bahia, Minas Gerais, Espirito Sasnto, Rio de Janeiro, Guanabara, Sao Paulo and Parana; and the North-Northeast of the remaining states.

2. That all steers are slaughtered at four years of age in the Southern and North-Northeastern regions, and that in the Central-South region, 50 percent are 3.5 years and 50 percent are 4.5 years.
3. That the mortality rates of male and female cattle are equal for a given age group and have remained constant over the period 1947-70.
4. That all reported calves slaughtered have been males less than one year old.
5. That the 1950 Census estimate of the stock of adult cows was an accurate estimate for the farm production year 1949.

Table B.3. Transformation Coefficients to Convert Beef Products to Equivalent Carcass Weight.

Product	Transformation Coefficient
Fresh, frozen or chilled beef, bone-in	1.05
Fresh, frozen or chilled beef, boneless	1.50
Processed beef	2.50

Source: Norés, Gustavo, "Structure of the Argentine Beef Cattle Economy--A Short Run Model, 1960-70", Unpublished Ph.D. thesis, Purdue University, 1972, Appendix E, Table 19.

Dias derived a set of mortality rates, by region, from a series of farm management studies conducted by CEPEN (13). These rates were increased by an amount to account for on-farm slaughter[6/] so as to produce a set of

6/ These corrections were designed to account for slaughter not subject to federal inspection. The data used to make these adjustments were obtained from the 1950 Agricultural Census.

rates of disappearance of cattle by age group, sex and region. On the basis of these parameters Dias constructed the stock of cattle implied by the slaughter data on steers, cows and calves[7] by the same groupings for the period 1949 to 1966.

The data series was extended by the author back to 1947 using the same procedure as in the original study. Furthermore, since the Dias study was published, another year of slaughter data (1971) became available, which permitted the extension of the series to 1967. In order to extend this data to 1971 it was assumed that the calving rate in each region remained constant from 1968 to 1970 at the average rate for the previous four years. With these two extensions, the data were aggregated over all classes and regions to produce the stock of male and female cattle given in Table B.1.

Slaughter

As indicated in the previous section, the Ministry of Agriculture reports the official annual slaughter data, by State, in three categories: steers, cows and calves. These data are based on statistics collected at registered slaughter houses (Federal, State, and Municipal), plus an estimate of the so-called unregulated slaughter, which includes on-farm slaughter.[8] It is believed that these data underestimate total slaughter, especially the unregulated portion, but the size of the error is not known over the whole period. For purposes of the present study, steer and calf slaughter are combined, because the investment decisions of producers

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[7] The slaughter data are the official EAGRI data.

[8] A set of this slaughter data by class of stock (steers, cows, and calves) and by State for the period 1940-71 is on file in the Krannert Library, Purdue University.

with respect to calves is postulated to more closely match those for steers than for cows.

The data for the model are presented in Table A.1 and the source data are given in Table B.2.

Exports

The volume of beef exports (fresh, frozen, chilled and processed) is reported on a product weight basis by the Ministry of Finance.[9/] In addition, cattle exports on foot are also reported. However, exports on foot are ignored here because it is believed that the data seriously underestimate the actual flow and that, despite this bias, they comprise a small proportion of total exports.

It should be noted that the reported exports of live cattle tend to be breeding animals, and that failure to include these would not affect the results since the focus of the study is beef for consumption purposes. The marketing of cattle across borders, however, is largely for slaughter purposes.

In order to convert beef exports on a product weight basis to an equivalent number of slaughter animals, two calculations were made. First, exports were expressed on a cold carcass weight basis by a series of transformation coefficients taken from Nores (1972)(see Table B.2). Although these coefficients were estimated for Argentine beef, the evidence available suggests that they are applicable in Brazil as well. For example, a recent study (15) showed that the average meat yield of beef carcasses from a sample in the State of Sao Paulo was 71.8 percent.

9/ The agency is CIEF, Ministry of Finance.

Table B.4. Beef Exports, by Product Type, Brazil, 1947-1972 (Thousands of Tons.

Year	Beef Exports Total	Fresh, Frozen, Bone-in	Dried and Chilled Boneless	Processed Beef	Beef Export Total (equivalent carcass weight)
		(product weight)			
1947	31.6	14.8	2.0	14.8	55.5
1948	41.3	17.8	2.4	21.1	75.1
1949	30.5	21.3	2.9	6.3	42.6
1950	17.6	8.6	1.3	7.7	30.0
1951	7.6	4.3	0.6	2.7	12.2
1952	3.5	1.7	0.2	1.6	6.1
1953	2.4	1.4	0.2	0.8	3.8
1954	1.2	1.0	0.1	0.1	1.6
1955	4.5	0.9	0.1	3.5	9.9
1956	11.1	7.6	1.0	2.5	15.8
1957	29.1	23.3	3.2	2.6	36.1
1958	41.9	29.3	4.0	8.6	58.6
1959	51.3	20.6	2.8	27.9	95.6
1960	14.1	5.3	0.7	8.1	26.9
1961	28.1	12.3	2.4	13.4	50.0
1962	21.9	10.3	2.7	8.9	37.2
1963	18.4	9.4	3.2	5.8	29.2
1964	26.4	13.3	5.7	7.4	41.1
1965	52.6	23.6	12.2	16.8	85.1
1966	31.3	12.8	8.0	10.5	51.7
1967	19.0	6.5	5.0	6.5	30.6
1968	59.4	23.2	21.1	15.1	93.9
1969	98.0	39.3	42.7	15.9	145.2
1970	115.9	42.8	56.0	17.1	171.7
1971	123.9	34.6	54.2	35.1	205.4
1972	191.8	60.7	95.0	36.1	297.0

Source: SEEF, Ministerio da Fazenda and calculations by the author.

When shrinkage is taken into account, this yield corresponds to a transformation coefficient for boneless beef of 1.45. This is very similar to the figure of 1.50 in Table B.3. The processed beef products of both countries are very similar (mainly corned and canned beef), and hence the transformation coefficients for manufactured products are assumed to be equal.

Unfortunately, the export statistics do not distinguish between beef in boneless and bone-in form. Hence, an approximation was used. In 1970 an agency of the Ministry of Agriculture (DIPOA) began reporting the volume of beef inspected for export in boneless and bone-in form. In the fiscal year 1970-71, 61 percent of Brazil's fresh, frozen, and chilled exports were in boneless form, which is close to the corresponding figure for Argentina of 55 percent in the same year. Furthermore, since Argentina has traditionally been the world's largest beef exporter and her markets are very similar to those of Brazil, it is reasonable to assume that the product mix of beef exports from Brazil has closely resembled that of Argentina.

In 1960, 12 percent of Argentina's fresh, frozen and chilled exports were in boneless form, with the fraction being fairly stable prior to that date. However, after 1960 the proportion increased monotonically to the level reported above in 1970. On the basis of these considerations the proportion of Brazil's fresh, frozen, and chilled beef exports in boneless form is assumed to have been 12 percent from 1947 to 1960, and thereafter to have increased linearly to a value of 61 percent in 1971.

Table B.5. The Real Price[a/] of Beef, Crops, Milk, and Pork, Brazil, 1947-71.

Year	Price of Beef	Milk Price	Crop Price Index	Price Pork
	Cr$ per ton c.w.	Cr$ per liter	1965/67=100	Cr$ per ton
1947	761	188	115	1263
1948	652	176	127	1028
1949	678	168	132	1028
1950	736	192	137	1061
1951	727	170	134	999
1952	807	176	149	1030
1953	822	151	159	1043
1954	888	141	146	1117
1955	989	160	141	1135
1956	929	131	137	1100
1957	865	146	127	1057
1958	883	129	110	1095
1959	860	118	104	1114
1960	1043	111	114	1232
1961	1125	133	104	1219
1962	1129	103	120	1091
1963	1126	138	94	1194
1964	1049	132	115	1155
1965	1151	130	92	1276
1966	1309	192	100	1222
1967	1242	182	110	1269
1968	1 147	170	106	1204
1969	1070	173	117	1051
1970	1117	172	120	1066
1971	1352	166	120	1064

Source: EAGRI, Ministerio de Agricultura and calculations by the author.

[a/] The indices of prices in nominal terms were deflated by index 2 of the Conjuntura Economica. See column (1) of Table A.6.

The second step in the calculation consisted of translating beef exports on a cold carcass weight basis into an equivalent number of slaughter animals. This was achieved by dividing by the average cold carcass weight of cattle slaughtered. The cold carcass weight was obtained by deducting a correction factor of 5 percent from the average hot carcass weight reported by EAGRI.[10/] The corrected volume of beef exports on a cold carcass weight basis is presented in Table B.4, and in terms of an equivalent number of slaughter animals in Table B.1.

Domestic Demand

Estimates of the quantity of beef consumed in Brazil are given in Table B.1. The estimates were made by taking the difference between total slaughter and exports and expressing it in terms of the equivalent number of slaughter animals.

The Prices of Beef, Pork and Crops

The Ministry of Agriculture (EAGRI) also reports the value of beef pork and crops, together with the appropriate quantity data for each State. These data refer to the value of production at the point of purchase from the farmer, not at the farm level, which for our purposes would be preferable.[11/] However, since these are the only price data available on a national basis for the period under consideration, they were used despite this limitation.

10/ The shrinkage factor can vary from as low as three percent under ideal conditions to more than five percent under less than ideal conditions. This latter figure is assumed to be average for Brazil.

11/ The point of purchase is either the slaughterhouse, the crop warehouse or some off-the-farm market.

Table B.6. Price Indices and the Rate of Inflation, Brazil, 1947-1971.

	Brazil: Index of General Prices 1965/67=100	Wholesale Price Indices		Rate of Inflation
		Brazil 1965/67=100	United States 1965/67=100	(percent)
Year	(1)	(1)	(2)	(3)
1947	0.86	0.86	77.4	11.7
1948	0.91	0.92	79.1	5.8
1949	0.98	0.96	79.6	7.7
1950	1.09	0.98	82.8	11.2
1951	1.27	1.19	92.2	16.5
1952	1.41	1.34	89.6	11.0
1953	1.63	1.55	88.4	15.6
1954	2.07	1.93	88.6	27.0
1955	2.41	2.31	88.9	16.4
1956	2.88	2.81	91.7	19.5
1957	3.29	3.23	94.4	14.2
1958	3.73	3.69	95.8	13.4
1959	5.14	5.27	95.9	37.8
1960	6.64	6.92	96.0	29.2
1961	9.10	9.72	95.7	37.0
1962	13.8	14.6	95.9	51.6
1963	24.2	25.7	95.7	75.4
1964	46.1	46.6	95.8	90.5
1965	72.3	71.6	97.8	56.8
1966	99.7	101.0	101.0	37.9
1967	128.0	128.0	101.2	28.3
1968	159.0	157.0	103.7	24.2
1969	192.0	187.0	107.8	20.8
1970	230.0	223.0	111.2	19.8
1971	277.0	271.0	114.9	20.4

Source: (1) Conjuntura Economica, indices 2 and 12, respectively.
(2) Bureau of Labor Statistics, Washington, D. C.
(3) See text.

The unit price of these products was calculated from the data on value and quantity of production by state. The price of beef was then calculated as the weighted average for the country, with the weights being the respective quantities produced in each State. The crop price index was the weighted average price of six principal crops which are thought to compete with beef production. These crops are corn, coffee, cotton, beans, wheat and soybeans. Average prices for the country as a whole were used for each crop, and the weights used for aggregation were the areas planted to each crop.

The price of pork facing consumers was approximated by the "farm level" price. These data were used in the absence of an alternative price series for close substitutes of beef at the retail or wholesale level.

Each of these prices were expressed in real terms by deflating with the index of general prices given in Table B.6. The data on real prices are presented in Table B.5.

There are two other major sources of data on the price of beef in Brazil but since they refer to two individual States they are not used in this study. These data are given in Table B.7.

The Price of Milk

For most years in the period under consideration the farm price of milk has been controlled by the Government. The agencies responsible for these controls[12/] announced a new price for the milk supply under each quota[13/] at least once a year, and sometimes as many as four times

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12/ These agencies are Commissao Central de Precos, COFAP, and SUNAB.

13/ Each farmer is allotted a quota for which he is paid the quota price. The quota is allocated on the basis of his historical production.

Table B.7. Beef Prices by Independent Agencies for Two States, 1946-71.

Year	Price of Steer Beef	
	Sao Paulo[a] (Cr$/Kg. c.w.)	Rio Grande do Sul[b] (Cr$/Kg liveweight)
1946		0.0019
1947		0.0024
1948		0.00266
1949		0.00270
1950		0.00270
1951		0.00350
1952		0.00370
1953		0.00480
1954	0.021	0.00650
1955	0.027	0.00800
1956	0.030	0.00870
1957	0.029	0.0105
1958	0.033	0.0110
1959	0.050	0.0151
1960	0.090	0.0310
1961	0.131	0.0440
1962	0.200	0.052
1963	0.319	0.0999
1964	0.534	0.176
1965	0.851	0.297
1966	1.62	0.400
1967	1.70	0.410
1968	1.88	0.460
1969	2.09	0.660
1970	3.09	1.004
1971	4.21	1.420

a/ Instituto de Economia Agricola (IEA), Sao Paulo.

b/ Instituto Sul Rio Grandense de Carnes, Porte Allegre.

a year. For this reason it was hypothesized that farmers with dual purpose herds react to this announced milk price, rather than the average price received in the previous year, for example.

One problem is to identify the price announcement within the year on which the farmers base their production decisions. The convention adopted here is that farmers react to the milk price announcement which immediately precedes the onset of the dry season (or winter). This period corresponds to the period of maximum cow slaughter, when the majority of calves are being weaned. The series of announced milk prices given in Table B.5 are the prices in effect prior to June each year. However, where no new price was announced before this date of a given year, the price used was the last price announcement in the previous year.

In four years during the period of interest, the price of milk was freed from direct controls. In those years the price used was the quota price actually paid by milk processing companies. All the prices used refer to the price paid to producers supplying the State of Guanabara (City of Rio de Janeiro). This includes the largest milk producing State of the Federation (Minas Gerais), which is also the State with perhaps the greatest substitution possibilities between beef and milk production. This price is also deflated by the general index of prices (Index 2 of the Conjuntura Economica).

The Rate of Inflation

The rate of inflation that influences policy makers and beef producers is assumed to correspond to the current rate of increase of the general price level. This assumption is made in part because the exogenous variables in the equations on the supply side of the model include cattle stocks with a one period lag, which should include the effects of past

Table B.8. The Volume and Value of Beef Exports, Brazil 1947-71.

Year	Fresh, Frozen, Dried, Chilled (1) Volume 1000 tons	Value NCr.	Value U.S.$	Processed (2) Volume 1000 tons	Value NCR.	Value U.S.$	Total (3) Volume 1000 tons	Value NCr.	Value U.S.$
1947	16.8	130.010	7,073	14.8	159.439	3,616	31.6	289.449	15,749
1948	20.2	154.572	8,410	21.1	256.270	13,943	41.3	410.842	22,353
1949	24.2	199.293	10,843	6.3	86.032	4,681	30.5	285.330	15,524
1950	10.9	71.072	3,867	7.7	76.466	4,269	17.6	147.540	8,136
1951	4.9	38.072	2,071	2.7	38.213	2,079	7.6	76.285	4,150
1952	1.9	19.500	1,061	1.6	22.183	1,207	3.5	41.683	2,268
1953	1.6	16.263	873	0.8	13.971	750	2.4	30.234	1,623
1954	1.1	13.832	462	0.1	1.641	548	1.2	15.473	1,010
1955	1.0	21.748	453	3.5	123.008	2,481	4.5	144.756	2,934
1956	8.6	206.182	3,241	2.5	118.567	1,790	11.1	324.749	5,031
1957	26.4	633.563	9,612	2.7	107.058	1,608	29.1	740.621	11,220
1958	33.2	1.130.07	12,571	8.7	541.183	5,664	41.9	1,671.25	18,235
1959	23.4	987.834	9,873	27.9	2,569	20,490	51.3	3,351.83	30,363
1960	5.0	576.749	3,204	9.1	1,148	6,506	14.1	1,724.75	9,710
1961	14.7	1,872.45	7,202	13.4	3,099	11,724	28.1	4,971.45	18,926
1962	13.0	1,742.10	5,457	8.9	2,471	6,898	21.9	4,213.10	12,355
1963	12.6	3,033.17	5,344	5.8	2,297	3,970	18.4	5,330	9,314
1964	19.0	13,573	11,566	7.4	6,534	5,388	26.4	20,407	16,954
1965	35.8	44,110	24,352	16.8	22,200	12,354	52.6	66,310	36,706
1966	20.8	28,002	12,932	10.5	17,431	8,062	31.3	45,433	20,994
1967	11.6	18,109	6,723	6.5	15,312	5,687	19.0	33,421	12,410
1968	44.3	87,767	26,675	15.1	48,822	14,659	59.4	136,589	41,334
1969	82.1	189,272	47,321	15.9	63,347	15,820	98.0	252.619	63,141
1970	98.8	318,121	70,229	17.1	86,329	18,617	115.9	404,450	88,846
1971	88.8	517,379	93,707	35.1	304,280	57,339	123.9	821,659	156,060

Source: SUEF, Ministry of Finance, Comercio Exterior.
(1) Includes categories 4.10.01, 4.10.05 and 4.10.08.
(2) Includes category 4.12.24.

Note: The export categories refer to those used prior to 1971. The corresponding new codes from 1971 are 02.01.01, 02.01.02, 16.02.11 and 16.03.01.00.

inflation. The model is thus an attempt to explain only current adjustments in the endogenous variables. In addition, Brazil has experienced inflation over a long period of time and Brazilians can therefore be expected to adapt to changes in the rate of inflation very quickly.

The current rate of inflation is represented by the percentage increase in the index of general prices (Index No. 2 of the Conjuntura Economica). This data is presented in Table B.6.

The World Price of Beef

There are no published data on the unit prices of beef exported from Brazil over the period under consideration. In the absence of such data the only alternative appears to be the average FOB price of exports in each category. The official data on the volume and value of beef exports is given in Table B.8, and the implied average FOB price per ton on an equivalent carcass weight basis is presented in Table B.9.

An alternative indicator of the world price of Brazilian beef is an index of the price of Argentine beef on the London market, which is published by the International Monetary Fund. An index of these prices is also given in Table B.9. The index is the average price of beef sides and corned beef, weighted 50:50.

It can be seen from the table that there is a wide divergence between the two price series. In most years this is not a serious problem because the units of each differ. One refers to volume on an equivalent carcass weight basis, and the other to a product weight. However, in some years the average FOB price moves in the opposite direction to the London price. For example, in 1954 the average FOB price rose 47 percent, while the London price fell 2 percent. The reason for this appears

Table B.9. The World Price of Beef and Net Internal Product, Brazil, (Real Terms[a]).

Year	Average FOB Price of Beef, Brazil, US$ per ton e.c.w. (1)	Index of the Price of Argentine Beef in London (2)	Net Internal Product Tens of Millions Cr$ (3)
1947	367	685	1879
1948	377	703	2029
1949	457	765	2178
1950	327	615	2304
1951	369	603	2394
1952	415	656	2479
1953	483	715	2609
1954	712	700	2660
1955	333	668	2846
1956	347	543	3047
1957	329	511	3191
1958	325	533	3485
1959	332	623	3452
1960	376	663	3382
1961	396	653	3714
1962	346	553	4009
1963	333	571	4139
1964	431	686	4139
1965	441	780	4170
1966	402	724	4304
1967	402	660	4529
1968	424	738	4923
1969	404	666	5400
1970	465	718	5821
1971	661	975	6211

[a] Columns (1) and (2) are deflated by the U.S. Wholesale Price Index, and Column (3) is deflated by the Brazilian index of general prices.

Source: 1. See text.
2. International Financial Statistics, various issues.
3. Anuario Estatistico do Brasil, various issues.

to be that the transformation coefficients do not adequately reflect the equivalent carcass weight of the wide variety of processed products that are exported. Normally this doesn't create problems since the coefficients are intended to be averages. However, in 1954 the volume of beef exports fell to only 1200 tons, and it appears that this was made up of a greater than usual proportion of these high priced cuts.

Due to the above considerations, the London price of Argentine beef is used in the analysis as a proxy for the world (or export) price of Brazilian beef.

Consumer Income

The disposable income of domestic consumers is represented by the Net Internal Product, expressed in real terms by deflating with the index of general prices. This data is presented in Table B.9.

Balance of Payments

Data on the balance of payments and other related data are presented in Table B.10. The data on balance of payments refer to the overall position, including the influence of capital flows. This variable was chosen, in contrast to the trade balance, because the Government has always made use of foreign borrowing over the period covered, and thus policymakers are hypothesized to react to the situation in the foreign sector accounts net of the impact of capital flows in that year.

Intervention in the Beef Export Market

As described in Chapter II, the level of intervention in the beef export sector is calculated as in Equation B.1.

$$I_t = p^w_{\$} \cdot \pi^e - p^b \qquad (B.1)$$

where,

I_t = the level of intervention in year t measured in cruzeiros per ton.

$P^w_\$$ = the world price of beef, dollars per ton.

π^e = the real free trade exchange rate, Cr$ per U.S.$.

P^b = the domestic beef price, Cr$ per ton.

The data on the world beef price and the domestic price have already been discussed. All that remains is to construct a series on the real free trade exchange rate. This is calculated in the following manner. In 1970 Bergsman published a study in which he calculated the free trade exchange rate for Brazil by estimating the elasticities of export supply and import demand and measuring the displacement of the average market exchange rate by the weighted average tariff in each year for the period 1954 to 1967. However, the 1967 estimate refers only to the period from April to December, and so for our purposes is excluded from the series. In addition, Gudin and Kingston (35) estimated the rate for 1950, and Bacha et al. (4) made a similar calculation for 1967 and 1970. These estimates are all shown in Table A.10 as the free trade rate in nominal terms.

In order to complete the series three different procedures were used for each of three individual time periods. First, Bacha found that the degree of overvaluation of the cruzeiro was approximately the same in 1967 and 1970. Hence, because there does not seem to have been any major policy reversals between these dates, it was assumed that the degree of overvaluation remained constant from 1967 to 1971. Accordingly, the market rate was adjusted by a constant fraction (24 percent)

Table B.10. Free Trade Exchange Rates, Balance of Payments and the Level of Intervention in Trade, Brazil, 1947-1971.

	Free Trade Exchange Rate (Cr$/U.S.$)		Overall Position Balance of Payments	Level of Intervention
	Nominal	Real[b/]	(U.S. $ millions)	(Cr$ of 1965/67 per ton)
Year	(1)	(1)	(2)	(1)
1947	26.6	2.40	-182	883
1948	20.9	1.80	- 24	613
1949	24.0	1.99	- 74	844
1950	26.1	2.20	52	617
1951	29.1	2.26	-291	636
1952	32.1	2.15	-615	603
1953	35.1	2.00	16	608
1954	38.0	1.74	-203	330
1955	57	2.20	17	481
1956	71	2.32	194	331
1957	81	2.37	-180	346
1958	95	2.47	-253	434
1959	160	2.91	-154	953
1960	210	2.92	-410	893
1961	350	3.43	-115	1115
1962	550	3.63	-346	878
1963	830	3.07	-244	627
1964	1700	3.57	4	1400
1965	2500	3.50	331	1579
1966	2.800[a/]	2.80	153	918
1967	3,320	2.62	-245	487
1968	4.435	2.93	32	1015
1969	5.024	2.91	549	868
1970	5.659	2.83	545	915
1971	6.514	2.74	555	1320

[a/] The new cruzeiro was created in 1966 equal to 1000 old cruzeiros.

[b/] Deflated by multiplying the nominal rate by the ratio of the wholesale price index in the U.S. to the wholesale price index in Brazil, both indices having a common base 1965-67=100.

Source: (1) See text.
(2) Conjuntura Economica, Nov.1972.

for 1968, 1969 and 1971.[14/]

Second, the values of the free trade rate from 1951 to 1953 were estimated by taking a linear interpolation between the 1950 and 1954 estimates in the Table. There is no apparent evidence to suggest that this does great violence to reality.

The period 1947 to 1949 is a far more difficult period to deal with, because the Brazilian economy was severely disrupted by the after-effects of World War II, and there does not appear to be a quantitative estimate of the degree of overvaluation in the immediate post-war period.[15/] For these reasons a formula derived by Bacha and Taylor (3) was used to project the free trade rate back from the base in 1950 to 1947. This formula is given as Equation B.2:

$$r'' = H'' + \frac{(1 + \eta m)\ \pi_m'' - (1 + E_x)\ D\pi_x'' - (1 - D)\Delta''}{DE_x - \eta_m} \qquad (B.2)$$

where:

r'' = the rate of change of the equilibrium exchange rate.

H'' = the rate of change of the domestic price index.

D = the ratio of the value of exports to imports expressed in foreign currency.

Δ'' = the rate of change of capital movements.

η_m = the elasticity of import demand.

E_x = the elasticity of export supply.

π_m'' = the rate of change of the foreign price of imports.

[14/] This was the degree of overvaluation calculated by Bacha for 1967 and 1970.

[15/] However, many researchers, including Bergsman and von Doellinger (1973), have stated that the cruzeiro must have been overvalued by 1945 because the government followed a policy of holding the market exchange rate constant in the face of rapid inflation vis-a-vis Brazil's trading partners.

π''_x = the rate of change of the foreign price of exports.

This formula is basically a parity calculation, but also includes adjustment factors for changes in capital flows and the trade balance. These modifications are important when considering this particular period. The formula has been simplified by assuming that technical progress was neutral and the elasticities of import demand and export supply are assumed to be -2 and +2, respectively.[16/] The price indices used are the wholesale indices of Brazil[17/] and the United States,[18/] Brazil's largest trade partner. The free trade rate in nominal and real terms, and the level of intervention are given in Table B.10.

Policy Variables

A set of four dummy variables (D_1-D_4) was included in the discrimination equation to distinguish between the various eras in post-war Brazilian trade policy. These were zero-one variables, with "one" for the years in the particular period and zero in all others:

D_1 = 1, 1947-52: 0 otherwise

D_2 = 1, 1953-59: 0 otherwise

D_3 = 1, 1960-63: 0 otherwise

D_4 = 1, 1964-71: 0 otherwise

16/ These values are taken from Bergsman (1970).

17/ Index No. 12, Conjuntura Economica.

18/ The Bureau of Labor Statistics wholesale price index.

APPENDIX C

Table C.1. Matrix of Simple Correlation Coefficients Between the Variables.

	Trend	Income	Price Beef	Price Pork	Level Discrim-ination	World Beef Price	Infla-tion	Stock Males t+1	Stock Males t	Stock Males t+1	Stock Females t	Male Slaughter
Trend	1.0	.975	.914	.348	.492	.298	.470	.933	.928	.981	.983	.900
Income		1.0	.862	.211	.487	.373	.359	.942	.948	.980	.983	.942
Price Beef			1.0	.536	.465	.338	.501	.854	.814	.880	.865	.698
Price Pork				1.0	.356	.088	.464	.285	.228	.266	.242	.065
Intervention					1.0	.601	.509	.432	.371	.409	.403	.395
World Price Beef						1.0	-.053	.463	.409	.341	.304	.339
Inflation							1.0	.270	.201	.324	.327	.142
Stock Males t+1								1.0	.989	.968	.947	.893
Stock Males t									1.0	.974	.960	.928
Stock Females t+1										1.0	.997	.939
Stock Females t											1.0	.951
Male Slaughter												1.0
Female Slaughter												
B.O.P.												
Demand												
Price Milk												
Price Crops												
D_1												
D_2												
D_3												
D_4												

Appendix C. Matrix of Simple Correlation Coefficients Between the Variables.

	Female Slaughter	B.O.P.	Demand	Price Milk	Price Crops	D_1	D_2	D_3	D_4
Trend	.915	.522	.936	-.136	-.590	-.740	-.259	.151	.809
Income	.931	.607	.938	-.053	-.518	-.655	-.284	.089	.803
Price Beef	.707	.413	.739	-.126	-.578	-.726	-.280	.286	.710
Price Pork	.132	-.032	.136	-.132	-.672	-.374	-.222	.307	.315
Intervention	.517	.440	.394	-.129	-.551	-.153	-.557	.122	.581
World Price Beef	.276	.524	.222	.339	-.044	.017	-.364	-.270	.546
Inflation	.341	.000	.290	-.497	-.554	-.472	-.225	.430	.311
Stock Males t+1	.830	.652	.868	.164	-.463	-.586	-.300	-.113	.914
Stock Males t	.854	.634	.899	.169	-.446	-.578	-.264	-.129	.886
Stock Females t+1	.902	.592	.943	-.029	-.491	-.714	-.196	.014	.831
Stock Females t	.926	.573	.961	-.080	-.503	-.728	-.173	.043	.800
Male Slaughter	.947	.639	.972	.002	-.437	-.586	-.169	-.091	.770
Female Slaughter	1.0	.547	.972	-.163	-.580	-.617	-.226	.052	.742
B.O.P.		1.0	.525	.228	-.181	-.312	-.115	-.290	.624
Demand			1.0	-.130	-.498	-.676	-.151	.014	.753
Price Milk				1.0	.200	.538	-.354	-.559	.288
Price Crops					1.0	.366	.394	-.337	-.449
D_1						1.0	-.350	-.245	-.385
D_2							1.0	-.272	-.428
D_3								1.0	-.299
D_4									1.0

APPENDIX D

Appendix D

Some Legislation Governing the Beef Sector, 1960-72

Table D.1. Legislation Governing the Beef Sector Administered by COFAP and SUNAB, 1960-72.

NO.	DATE	SUMMARY OF REGULATIONS[1/]
120	02/03/60	Extends regulation No. 742.
945	11/21/60	Rescinds regulation No. 120.
604	05/27/61	Same as the previous one.
700	06/27/61	Contains specification of how prices of meat have to be displayed at markets.
1315/62	12/18/61	Intervenes in following slaughter plants: Perrha Goulart S/A, Santa Cruz to check on their profit margins. (If further rises in price occur, other plants will be investigated.)
092	02/01/62	Establishes maximum selling price of fresh meat to consumers. Issues mandatory use of official receipt containing name of firm or slaughterhouse--confirming date, signature, type and price of meat sold.
Res 10	10/28/62	The counties where selling has been forbidden on Sundays--it will be possible to sell on Tuesdays--the meat may be sold by slaughterhouses on Mondays from 2 p.m. on.
1021	12/05/62	Establishes selling prices in the State of Guanabara at the average levels of the first week of July/62. Starting 15 days from now, ASCOAPS will put in effect acts fixing prices for main cities and consuming centers, according to the local conditions, without going beyond the maximum levels established by this resolution.
140	17/01/63	To remove the control over prices of beef, established by regulation 1021.

1/ The original Portuguese language version of these regulations has been deposited in the Krannert Library, Purdue University.

Res. 6	09/19/63	Establishes maximum price for beef in Central Brazil. Denies use of newspapers to wrap meat and establishes other requirements concerning the selling of beef to consumers. Establishes selected days for exclusive selling of goat meat, fish, sheep meat, pig meat and poultry. Exports of beef suspended temporarily--Authorizes distribution of stored meat from 1st week of October till end of November and puts sanctions into effect against increases in price.
Res. 07	10/10/63	Authorizes local agencies to set regulations for selling of all other kinds of meat not mentioned in Res. 6. Also assigns them the control over the distribution of meats to hospitals, schools, etc.
Res. 31	12/19/63	Prohibits the exports of beef, starting on 1/1/64. But allows for unlimited exports of preserved forequarters.
Res. 51	02/17/64	Establishes in all the National Territory, maximum profit margins of 10 percent at wholesale and 20 percent at retail.
Res. 26	06/04/64	Allows for the export of frozen veal, up to the maximum limit of 500 tons.
Super 82	06/12/64	Establishes for the State of Rio Grande do Sul a limit of 5,000 tons of exports of meat.
Super 132	07/17/64	Establishes maximum selling prices of meat for the States of Minas Gerais, Guanabara, Rio de Janeiro and Sao Paulo.
Res. 106	07/23/64	Same as previous one.
Res. 128	08/24/64	Releases for consumption the meat financed by the Bank of Brazil and stored in slaughter houses in Guanabara, Rio de Janeiro and Sao Paulo, and sets the maximum selling prices for this meat. Also reduces by one the number of days per week when slaughtering takes place.
Res. 153	08/28/64	Requires the use of price displays on canned and packed meats.
Res. 144	10/06/64	Releases the control over prices of fresh and chilled beef at all stages of marketing. Establishes maximum prices for frozen stored meat.

Super 262	11/20/64	Excludes some selected states from the regulations stated in Resolution 144.
Res. 159	11/26/64	Confirms port. No. 262 and makes ineffective Article 2.
Res. 188	02/01/65	Allows the export of 60,000 tons of beef meat, 40,000 tons from Rio Grande do Sul state, and of forequarters from Central Brazil. Sets up regulations for special export permits. Credit for storage to be financed through Bank of Brazil (from 02/15 up to 06/30/65). Export tax fixed at 30% of value in foreign currency. Sanitary inspection required.
Res. 190	02/24/65	Establishes maximum selling prices for meat from several states at price levels prevailing at 12/1/64. through all marketing steps.
Super 505	04/27/65	Intervenes in slaughter plants T. Maia, S. Carlos Pirrhal, Minerve and Cruzeiro. This shall be executed by SUNAB.
Res. 223	05/20/65	Rescinds Res. 133.
Super 754	07/22/65	Establishes specifications about the display of prices at all market places, for all types of meat.
Res. 232	07/23/65	Establishes selling prices for cattle for slaughter.
Res. 236	09/14/65	Requires the daily notification of account of meat received and delivered for consumption, specified by type. (This holds for Guanabara, Minas Gerais, Rio de Janeiro, and Sao Paulo).
Res. 235	09/14/65	Rescinds confiscation of stock, but prices remained fixed.
Super 949	09/28/65	Establishes maximum selling prices for fresh, chilled and frozen beef meat in all States, to be in effect up to December 31, 1965. Regional differences in price levels to be established by the local agencies of SUNAB.
Res. 238	09/30/65	Confirms previous Resolution and makes ineffective Article 2.
Res. 241	10/14/65	Extends intervention period on T. Maia, Cruzeiro, Industrial Minerve and Sao Carlos do Pirrhal slaughterhouses.

Res. 245	11/04/65	Establishes a limit of up to 20 percent of the total weight of beef for delivery. (Note: Meaning of Portuguese original not clear.)
Super 1070	11/16/65	Reduces by 20 percent the maximum price levels of beef (fixed by Super 949) for the states of Maranhao and Piaui exclusively.
Super 1071	11/16/65	Establishes minimum prices for meat in the states of Alagoas, Pernambuco, Paraiba, and Rio Grande do Norte.
Super 1264	12/22/65	Includes the states of Ceara and Sergipe under the price regulations established by Super 1071.
Res. 253	12/29/65	Extends for 90 days, starting on 1/1/66, the dead line for the request of the services of SUNAB interventors (refers to intervention on slaughterhouses T. Maia, Sao Carlos do Pirrhal and others).
Res. 254	12/29/65	Maintains previously fixed price levels for the states of Piaui, Maranhao, Sergipe, Alagoas, Pernambuco, Ceara, Paraiba and Rio Grande do Norte.
Res. 255	12/29/65	Rescinds Resolution 232 and art. of Resolution 235.
Res. 258	01/06/65	The firms that act as meat wholesalers are required to present daily to the SUNAB agencies of GB, MB, RJ and SP the amounts of meat delivered (up to 12 hrs. after delivery has occurred).
Res. 279	04/22/66	Rescinds Res. 263, and emphasizes item IV, art. 3 of Res. 261.
Res. 280	04/22/66	Allows the export of 20 tons of frozen boneless veal meat from Central Brazil.
Res. 284	05/26/66	Allows the export of 5 tons veal.
Res. 285	05/26/66	Creates the Executive Sector of Meat Production.
Res. 292	07/14/66	Gives a new editing to Res. 258, art. 1, with a greater discrimination of the article for hindquarters, "boi casado", and the rump.
Res. 294	07/23/66	Refers to Res. 254 and establishes a new selling price for second quality meat....at all stages of marketing in States of Para, Maranhao, Sergipe,

		Alagoas, Pernambuco, Ceara, Paraiba, Rio Grande do Norte, Distrito Federal and Territorios.
Res. 295	08/04/66	Authorizes the superintendent of SUNAB to establish regulations on slaughter, according to local conditions.
Res. 297	09/01/66	Ratifies agreements between SUNAB and the following Unions: Industry of Sao Paulo, Society of Slaughterhouses of Cattle and others. Also establishes regulations on slaughter quotas for all slaughterhouses of Central Brazil, according with Res. 295.
Res. 748	10/26/66	In addition to Res. 297: a) Authorizes Slaughterhouse Contricho S.A. to complement quota previously granted of 160 heads of cattle per month for the Jewish Community b) Grants quotas to other slaughterhouses.
Res. 764	11/08/66	Includes "Coop. Central de Pecuaria Brazil" among the slaughterhouses of Central Brazil whose slaughter quotas have been stabilized. Slaughter house Bordon granted share of quota, granted at COPEBRAS.
Super 782	11/17/66	Includes other slaughterhouses among list of firms granted slaughter quotas. Allows for sharing of the quotas between "Frigoirfico Jaudiro S/A and Coop. Central Alto Noroeste de Agricultura e Pecuario.
Super 720	11/23/66	Allows Frig. Prudenfina S/A and Coop. Agropecuaria Pirabirringe to share slaughter quota granted to Frig. Piracicaba S/A.
Super 791	11/24/66	Grants sharing of slaughter quota between Coop. Agropecuaria Paulista and Frig. Botia S/A.
Super 813	12/05/66	Grants slaughter quota of 237 head to the Slaughterhouse Corchense Ltda.
Super 819	12/26/66	Grants the sharing of slaughter quota between Coop. Guararahs Ltda. and Frig. Nordestrino S/A.
Super 850	12/26/66	Grants the sharing of slaughter quota between Frig. Cotia and Coop. Central Agropecuaria Paulista, up to the limits established by Res. 297.

Res. 327	01/09/67	Reduces slaughter in all slaughterhouses of Central Brazil: August-25; September-35; October-40; November-40; and December-25.
Res. 328	01/09/67	Rescinds Res. 294, maintaining unchanged art. 3, 4, 5, and 6.
Super 464	06/07/67	Forbids selling to consumers of sinewy meat. Bones cannot be sold beyond the limit of 20 percent of total weight of meat.
Super 549	08/14/67	Cattle farmers required to answer questionnaires.
Super 1397	11/09/67	Establishes marketing margins (per kilo) for several types of boneless meat in the cities of Sao Paulo and Rio de Janeiro. States that these margins will be based on a percentage of the value of forequarters and hindquarters. All supermarkets, slaughterhouses of CADEP and others will not be submitted to the marketing margins now set.
Super 126	02/03/68	Forbids the inclusion in the official receipt of items such as cost of transportation or broker's fee charged on meat delivered. Establishes a fixed amount for transportation. Assigns to the SUNAB of Sao Paulo the responsibility for establishing the amount to be charged by transporters of meat.
Super 992	08/23/68	Cattle farmers required to answer informal questionnaire. A daily bulletin to be distributed except on Saturdays and Sundays and sent to SUNAB agencies of GB, SP, MG, RJ, GO and DF(before 5 p.m. of the following work day). Forbids the selling of sinewy meat to consumers and establishes specifications on wrapping of meat, requiring plastic or non-coloured paper.
Super 1019	09/03/68	Gives the list of Sao Paulo counties for the purposes of art. 8 of Super 992.
Super 13	02/06/69	Creates the "Grupo Executivo de Abastecimento de Carnes (GEAC) SEPROC. The main responsibility of the new sector is to advise the Comissao Nacional de Abastecemento and supply it with information to help control the flow of meat in order to avoid scarcity. The new sector will have official representation in the following institutions: Ministerio da Fazenda, Ministerio da Agricultura, Banco Central, Banco do Brasil, and Couselho Nacional do Desenvolvimento do Pecuaria.

Super 76	07/29/69	Questionnaire required. Daily distribution of bulletin. Real value and taxable value corresponds to the reduction in ICM. Sale of tallow prohibited. (Counter-weight-bone not to be more than 20 percent). Packaging--plastic or uncolored paper. Prices visibly posted. Classification of No.2 meat, GB, SP, & RJ. Marketing margin starting 8/19/69, in GB, SP, and RJ. Transportation costs on separate bill, by the wholesaler. Meat of the type "kosher" or "kasker" excluded from marketing article 8 (Colonia Israelita Artodom).
27/70	06/16/70	Decides that all slaughterhouses, merchants, warehouses, co-operatives, deliverers, butchers and all other agents that act as wholesalers or retailers of meat beef are required to keep the official receipts referring to the origin and destination of meat. The receipts must specify the type of meat received and must be always available to the SUNAB agents.
42/70	09/03/70	Establishes a 50 percent maximum monthly limit for cattle slaughter, calculated over the average slaughters during the months of April, May and June of the current year. This refers to all slaughterhouses that did not sign the "Term of Liability" with the Federal Government.
01/71	01/20/71	Rescinds Super No. 42.
05/71	02/04/71	Establishes regulations for the marketing of beef and meat products in all states.
31/71	07/22/71	Establishes the "National Program for Limiting Cattle Slaughter" beginning on August 1st, 1971.
02/71	12/22/71	Rescinds Super No. 31.
28/72	07/21/72	Same as 31/71.
29/72	07/24/72	Establishes ceiling prices of Cr$4.20 (four cruzeiros and twenty cents) per kilo for hindquarters and Cr$3.20 (three cruzeiros and twenty cents) per kilo for forequarters for beef sold at retail in the states of GB, RJ and SP.
60/72	12/07/72	Rescinds Super No. 28.
63/72	12/26/72	Rescinds Super No. 29.

VITA

VITA

Ralph Gerard Lattimore was born in Christchurch, New Zealand on August 23, 1945.

He graduated Bachelor of Agricultural Science in Farm Management from Lincoln College of the University of Canterbury, New Zealand in 1968 and worked with the Farm Advisory Division of the New Zealand Department of Agriculture that year.

Entered Massey University in 1969 and graduated Master of Agricultural Science in Farm Management in 1971. In September 1970, he began the Ph.D. program at Purdue University. He spent 14 months at Escritorio de Analise e Politica Agricola (EAPA) of the Brazilian Ministry of Agriculture from July 1972 to September 1973 as part of the thesis research program.

Completed the requirements for the degree of Doctor of Philosophy in August 1974.

He married Jillian Jane Larsen of Westport, New Zealand on December 10, 1966 and has three children: Ralph, Jane and Michael.

He is a citizen of New Zealand.