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DISTORTIONS OF AGRICULTURAL INCENTIVES
An Analysis of the Effects of Government Policy on the Brazilian Beef and Dairy Sectors.

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1. Introduction

In recent years there has been renewed interest in studying the effects of government policies in agriculture in both the developed and less developed countries. The basic theme underlying most of these studies is that government intervention distorts the price and other incentives prevailing in agriculture. As noted by Schultz (1978), it is rarely the case that government policy is neutral with respect to agricultural production; high-income countries tend to overvalue agriculture, the less developed countries tend to undervalue it. The economic implications of these distortions are serious. In particular, where agriculture is undervalued, producer incentives are below optimum and the unrealised economic potential of the agricultural sector may be large.

This study examines agricultural policy in Brazil and the effects of distortions in economic incentives in the beef and dairy sectors in the post-war period. Since these sectors account for more than 20 per cent of total agricultural production and receive more attention from policy-makers than any other sector, the orientation of the study seems appropriate. Moreover, to date little empirical work on these important sectors has been attempted.

The basic focus of the study is econometric, with the estimated model being used as the tool for policy evaluation. The general policy setting is reviewed in the next section, followed by an outline of the econometric model. Since the model is quite complex, the discussion here cannot be comprehensive, but nevertheless it is hoped that the salient features of the model are conveyed. Policy analysis is the subject of the next sections, in which the impact of government intervention on production and consumption in the beef and dairy sectors is evaluated and some measure of the welfare losses and their distribution is attempted. Finally, a summary of the main findings and some concluding remarks are presented.

2. Brazilian Government Policy in the Beef and Milk Sectors

The beef and milk sectors have received more attention from policy-makers than any other sector of Brazilian agriculture. An attempt has been made to select from the myriad of policies adopted since 1947 those measures which have had a significant impact on aggregate output, consumption, external trade and prices. Table 1 summarises the main developments in this area in the 1947/1979 period. Here government policies are classified according to their point of impact on the three cattle products: beef, liquid milk and dairy products. In addition, three market levels or zones of impact are distinguished. The frontier level is that zone of activity in which goods are traded between regions with recognisable economic boundaries. Examples of measures at this level are tariffs, export/import duties, health regulations etc. The production level is that area of activity which is directly concerned with inputs and the technical process of production. Measures here include grants and subsidies to producers, input and credit subsidies, tax allowances, wage regulation etc. Finally, the marketing level denotes the zone in which a saleable price for domestic output is determined. In this zone, there are domestic price support measures, price intervention at the retail level, marketing boards, consumer taxes and subsidies, buffer stock schemes etc.

Despite the frequent changes in policy, often as spontaneous responses to balance of payment crises, domestic supply shortages or inflationary pressures, some systematic features of government intervention on the beef and dairy sectors are apparent. With regard to the beef sector, policy-makers have used the domestic market and external trade to hold down the price of beef to consumers and to increase supply in the off-season. The most significant aspect of this policy occurred at the frontier level where exchange rate policy has had a marked influence on supply, demand and price in the domestic market, as well as on beef exports. Intervention in the fluid milk market has been concentrated on the production and marketing

TABLE 1 : GOVERNMENT POLICIES TOWARDS THE BEEF AND DAIRY SECTORS AND THEIR POINTS OF IMPACT, 1947/79

<table>
<tr><th>PRODUCT
LEVEL</th><th>BEEF</th><th>FLUID MILK</th><th>DAIRY PRODUCTS</th></tr>
<tr><td rowspan="2">FRONTIER</td><td colspan="3">EXCHANGE RATE POLICY - fixed (1947/53); multiple rates (1953/60); unstable system (1961/64); crawling-peg system (1965 onwards)
TRADE POLICY - Import Quantitative Control (1947/53; 1961/64; 1974/79), Tariff-1957 (ad-valorem system); 1966 (tariff reform)
Export Quantitative Control (1947/53); Export Incentives (1964 onwards)</td></tr>
<tr><td>Export Quotas - 1954,59/60,63/65, 67,71,73/74
Export Taxes - 65/67, 73
Export Incentives - 1968 onwards
Imports at preferential rates - 58,70,74 onwards</td><td></td><td>Import under special conditions (dried milk) - PL480 (60/72), Tax exemption (73)
Import Quotas (dried milk for reconstitution) - 1974/79</td></tr>
<tr><td rowspan="2">PRODUCTION</td><td colspan="3">Rural credit at preferential rate , Fiscal Incentives, Health Animal Program, Agricultural Research and Extension</td></tr>
<tr><td>Special Credit and Assistance Program - 1969/77
Price Control of Fat Steer - 59, 63/67, 70/71, 73/76
Slaughter Control - 1968 onwards
Direct Confrontation and Intervention - 1959,65,73</td><td colspan="2">Special Credit and Assistance Program - 1945/53; 1965/70; 1973/76
Input Subsidies - 1974 onwards
Price control of raw milk - Class I 1945/66,69 onwards
Class II 1945/66, 69 onwards
Supply control and incentives (quota-excess scheme) - 52,63,69/72,73, 75/59</td></tr>
</table>

TABLE 1 (continued)

PRODUCT / LEVEL	BEEF	FLUID MILK	DAIRY PRODUCTS
MARKETING	Federal Sanitary Inspection Regulation for the Processing Industry Subsidized Credit for the Meat and Milk Processors - 1965 onwards		
	Retail Price Control of Beef - 43/53,55,59/60,63/65,72/74 Marketing Margin Control - 69/71, 78 onwards "Gentlemen's Agreement" - 1970/73 Slaughter Control/Seasonal Storage Program - 64/66,67/73 74/79 Direct Intervention/Confrontation 59,63,73 Buffer Stock Scheme - 1974 onwards	Retail price of fluid milk - 45/66, 69 onwards Marketing Margin Control - 1966/69 Supply Intervention Scheme (Reconstitution of Dried Milk) 1973 onwards Grading Scheme (Price Differentiation - 73/79 Consumption Subsidy - 1975/80	Retail Price Control - 62/63 Buffer Stock Program - 75/79

levels: i,e. control of the price of raw milk at the farm level and, at the marketing level, retail price control and supply intervention by means of the reconstitution of imported dried milk. These measures have been used to tax the producer to the benefit of urban consumers. It should however be added that, as partial compensation to the beef and dairy producers, the government provided, from the mid-1960's onwards, rural credit at a subsidised rate, together with a technical assistance programme.

In the econometric model of the beef and dairy sectors which follows, government intervention is represented in a number of ways. Firstly, policy prices, in the form of regulated milk prices and a subsidised loan rate on rural credit, appear as explicit explanatory variables where appropriate. In those cases where it is difficult to construct a quantitative variable to characterise a particular policy or set of policies, dummy variables are introduced. Five dummy variables are utilised, each taking either a value of zero when the policy in question is "off" or of unity when it is "on". Furthermore, the impact of government policy (e.g. foreign exchange rate policy) is implicit in the whole domestic price regime, which clearly differs from that which would prevail in an alternative policy setting such as free trade. The policy evaluation exercise conducted in this study will focus on a comparison of the actual performance of these sectors over the post-war period with the predicted performance if the government had not interfered with the market.

3. An Outline of the Econometric Model

The econometric model comprises a set of dynamic, simultaneous structural equations designed to capture the operation of the Brazilian beef and dairy sectors at the national level, on an annual basis, over the period 1947 to 1979. In a short paper it is not possible to discuss the theoretical or empirical justification for each equation specification. Rather this section will endeavour to introduce the principal logic of the model's con-

struction; the complete model and the estimated results are presented in the Appendix.

Figure 1 depicts the general structure of the model. For the purpose of discussion, it is convenient to divide the system into two sub-models, corresponding to the beef and dairy sectors, although the inter-dependence of these sectors should not be overlooked.

3.1 The Beef Sector Sub-Model

In this sub-model, an attempt is made to explain economic behaviour in four aspects of the beef market: a) investment and supply behaviour, b) price formation in the intermediate sector, c) domestic demand for beef, and d) external trade, market equilibrium and price formation at the farm level.

The supply side of the model focuses on the decision concerning the sale of steers and cows for slaughter and, through accounting identities, the stock of cows, steers and other categories.[1] An adaptation of the dynamic model of profit maximisation developed by Carvalho (1972) is taken as the theoretical underpinning of the supply equation for cows for slaughter. It is hypothesised that the latter will depend on the price of fat steers, the price of feed and the stock of cows, all with a lag of one period, together with the expected prices of milk and fat steers. The supply of steers for slaughter is determined by the lagged feed price and steer stock, with the expected price of fat steers again entering as an explanatory variable. Two additional exogenous variables are introduced: a policy dummy variable, to account for the effect of strong government intervention in the sector during three periods of market crisis, and the inflation rate, since cattle

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1. Lack of data precluded a more comprehensive approach. Here cattle stock categories are related by technical coefficients (mainly birth and death rates) and it is assumed that the sale of animals for slaughter originated from the stock of cows (females over 3 years old) and steers (males over 2 years old).

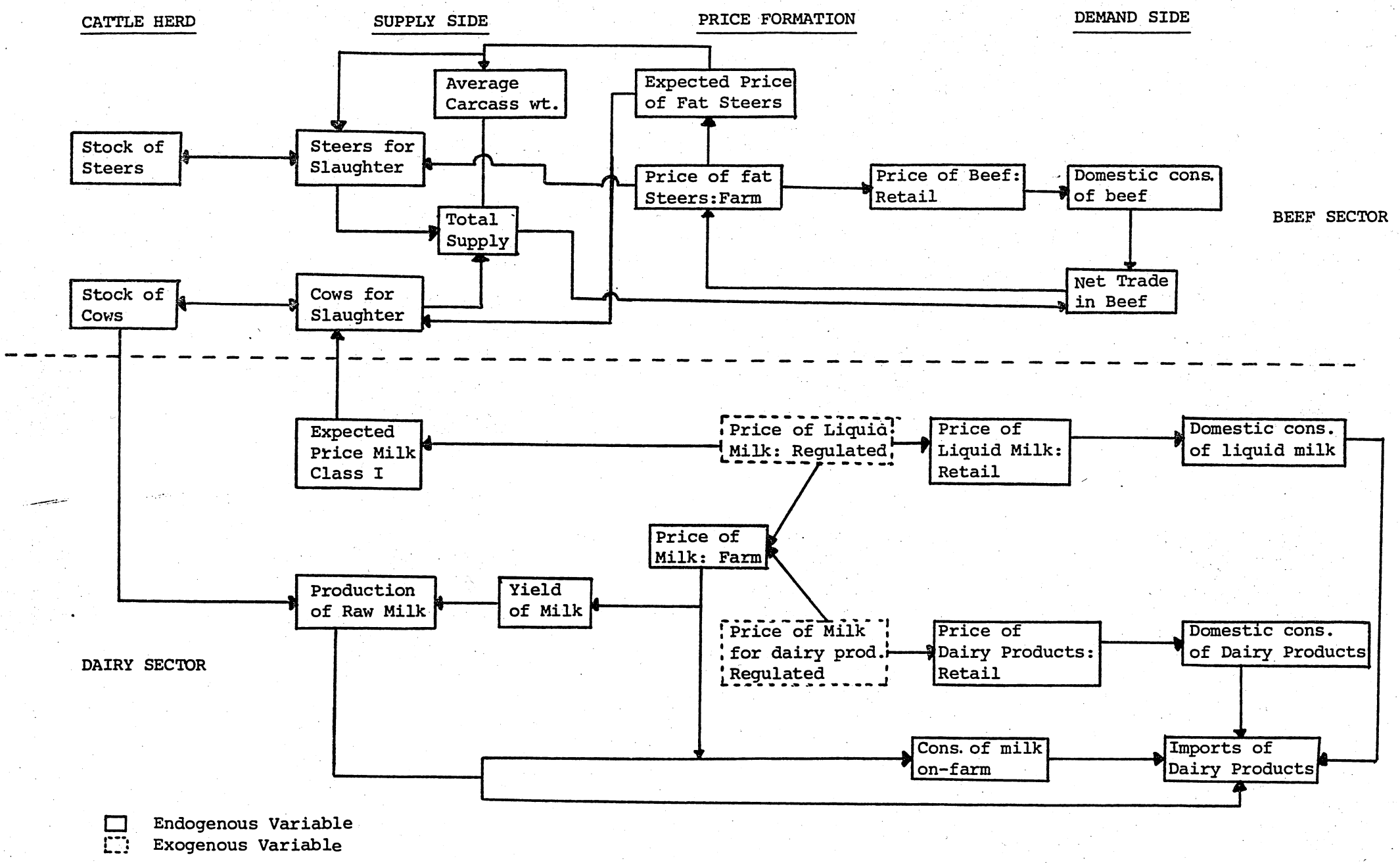

FIGURE 1 : Structure of the Beef and Dairy Model

are retained not only for productive purposes but also for their value as a hedge against inflation.

In order to eliminate the unobserved anticipated prices entering the supply equations, the quasi-rational expectations approach is adopted. Thus expected values of the price variables are replaced by their minimum square error predictions generated by univariate (ARIMA) models.[1]

$$EP_{t+1/t} = E(P_{t+1}/P_t, P_{t-1}, \ldots, P_{t-p})$$

Turning to the pricing mechanism in the intermediate sector, the retail price equation is specified as a simple mark-up which includes the beef price and a policy dummy variable. The latter is included to represent the adoption of a seasonal buffer stock scheme. Although simple in form, this type of specification has produced satisfactory results in a number of studies of agricultural commodity markets.

Beyond stressing the importance of prices and income, economic theory has little to contribute to the specification of the consumer demand equation for a single commodity. The estimating equation is typically ad hoc, particularly with regard to the choice of price variables to be included. This study is no exception; per capita demand for beef at the retail level is assumed to depend on the retail prices of beef, pork and poultry and per capita disposable income in the private sector. To account for consumer inertia in adjusting to market stimuli, the partial adjustment hypothesis is maintained and so a lagged dependent variable is incorporated into the analysis.

The final component of the beef sub-model concerns the market equilibriating mechanisms. Two equations are utilised for this purpose. The internal price of beef, it is assumed, depends on excess demand (represented by net external trade[2]) , the external price and government intervention

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1. See Wallis (1980).

2. Since annual carry-over is insignificant, excess supply is reflected in exports. Indeed the "exportable surplus approach" has formed the basis of Brazilian government's trade policy in the post-war years.

through export quotas and prohibitions. In turn, the net external trade of beef, which closes the sub-model, is determined as a residual of total supply when domestic needs have been met.

3.2 The Dairy Sector Sub-Model

For ease of exposition, three blocks of structural relationships can be distinguished in the dairy sector: a) price formation at the farm level, raw milk supply and market equilibrating conditions, b) price formation in the intermediate sector, and c) domestic demand for fluid milk and dairy products.

At the farm level the main instrument of government intervention, as in many other countries, has been price differentiation whereby the price of milk used in the liquid milk industry (Class I) is set higher than the milk for use in manufacturing dairy products (Class II). While these relative prices will reflect the respective elasticities of demand, the criteria used by the public authorities in setting the particular levels go beyond market conditions of demand and supply but will include, inter alia, producers' and processors' market power. As the criteria are complex and have changed over time, the prices of milk Class I and II are assumed to be exogenous for present purposes. The price of milk received by the farmer is a blended price, based on these two exogenous prices but, because of additional payments, cannot be simply taken as a weighted average.

Raw milk production is based on two decision variables: the yield of milk per cow and the stock of cows. The latter is specified in the beef sub-sector and constitutes one of the connecting links between the two sectors. The milk yield per cow is hypothesised to depend on the current blended price, feed cost and a lagged dependent variable, reflecting partial adjustment. In addition,the subsidised rural credit rate, granted to the cattle producer and stimulating investment in this sector, is introduced.

Finally the dairy sector sub-model is closed by imports of dairy products, mainly dried milk. Again,the external trade variable is determined residually.

As the intermediate market segment of the dairy sector exhibits an oligopolistic structure, this should be reflected in the price formation mechanisms. While the development of a complete oligopoly model is beyond the scope of the present study, some aspects of imperfect competition may be incorporated by assuming that price formation in the retail segment is based on the mark-up marketing approach, including the profit rate in the processing industry as an additional explanatory variable. Thus the retail price of fluid milk is not only a mark-up on the price of raw milk Class I but is also influenced by the profit rate in the milk processing industry, the cost of living index (due to the importance of milk in the consumer budget and the government's preoccupation with controlling inflation), and subsidies to milk consumers in the metropolitan areas (measured by a dummy variable). The retail price of dairy products, on the other hand, is determined as a mark-up on Class II raw milk, the profit rate in the dairy products industry and a dummy variable for government intervention in the form of the buffer stock scheme.

The third and final block of the dairy sub-model concerns the domestic demands for fluid milk and dairy products. The model further distinguishes between the per capita consumption of raw milk on-farm and of fluid milk in urban areas. Because of data limitations, the former is assumed to depend upon the per capita income from milk production (i.e. the per capita value of production), a time trend (to represent the improvement in transport and the process of commercialisation) and lagged consumption (reflecting consumer inertia). By contrast, the urban demand for fluid milk and the demand for dairy products are specified along more conventional lines, each depending on the respective retail price, per capita disposable income and a lagged

dependent variable. In addition the fluid milk equation contains a dummy variable marking government intervention in the market after 1975.

3.3. Econometric Procedures

The model consists of 28 endogenous variables, 31 exogenous and pre-determined,and 5 policy dummy variables. For estimation purposes, the complete system can be viewed as 4 inter-related blocks:(i) the cattle herd, which is composed of a set of identities and so does not require econometric estimation, (ii) the beef market, comprising a simultaneous sub-system, estimated by 2SLS, (iii) the dairy market, which may be treated as a recursive block and hence is estimated by OLS[1], and (iv) the price expectations formation block, consisting of two equations whose parameters and expected values were generated by ARIMA models, following Box-Jenkins procedures, applied to the real annual price of fat steers in the period 1937/80 and of milk Class I in the period 1940/80.

By most criteria the overall statistical results for the stochastic equations are reasonably good. Corrected $\bar{R}^2$ and F statistics indicate satisfactory fits, while the Durbin-Watson statistics suggest the absence of serial correlation in all but one equation and then the test was inconclusive at the 1 per cent level. Using the Durbin h statistic where appropriate, the null hypothesis of no serial correlation again cannot be rejected. Finally, the Box-Pierce statistics for the ARIMA models are low and the models cannot be rejected on the χ^2 criteria.

In order to evaluate the fitted model as a whole, a set of validation statistics (not presented) was calculated from the dynamic simulation of the model over the sample period. The model performed poorly only in respect of the net trade variables which are determined residually and so may cumulate errors from the rest of the system. But even in these cases, the errors may be judged unimportant since they represent on average 2 and 4

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1. Generalised least squares was also applied but with little change in the estimated parameter values.

per cent of the domestic consumption of milk and beef respectively.

4. The Impact of Price Distortions on the Beef and Dairy Sectors

The economic effects of government intervention in the beef and dairy sectors can be measured using dynamic simulations of the fitted econometric model over the 1948/79 period.[1] In conducting this exercise, two important assumptions are made: a) that without government intervention, free trade would operate in the agricultural sector and domestic prices would tend towards external prices evaluated at the free trade equilibrium exchange rate; b) that even with the removal of price distortions the structure of the beef and dairy sectors is reasonably well represented by the estimated model.

The policy evaluation proceeds as follows. First, the model without modification is simulated over the 1948/79 period. It should be noted that in this run, prices of raw milk received by farmers are fixed by the government, the policy dummy variables are all in operation and preferential rates on rural loans are granted. Hence this simulation indicates the performance of the sectors with government intervention. In the second simulation run all market distortions brought about by government policy are removed: the price of beef at the farm level, the price of Class II milk and the price of crops composing the feed price are all exogenously determined by the respective external prices[2] and, in addition, policy dummy variables and preferential interest rates are excluded from the analysis. It is also necessary to re-estimate the equations which generate the expected prices of beef and milk at the farm level, using ARIMA models of both prices without

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1. For a similar approach to policy evaluation see Heien (1977).

2. If P_i denotes the distorted domestic price, then the 'corrected' price is given as $(1/(1-r_i))P_i$, where r_i is the rate of nominal implicit tax incidence. For details of this calculation, see Da Silva (1984).

market distortions. Given these modifications, the second run depicts the market without government intervention.

The impact of price distortions resulting from government intervention can be estimated by comparing the results of the two simulation runs. The comparison can be made by calculating for each of the dependent variables the following indices:

$$EF_i = \left(1 - \left(\frac{rwd}{rrd}\right)_i\right)$$

where EF_i denotes the effect of market distortions on variable i, rwd represents the simulated result with market distortions, and rrd is the simulated result removing market distortions. Table 2 provides, in percentage terms, the results of this comparison. For ease of exposition, the data period is divided into six sub-periods, corresponding to the cattle cycle, and the average impact in each cycle is presented. The interpretation of the sign on each coefficient perhaps requires some elaboration. A positive sign on prices at the farm level denotes implicit taxation, whereas on prices at the retail level, it denotes implicit subsidies. Where a positive sign appears on beef and milk production, the cattle herd and external trade, government intervention has had a disincentive effect.

At the farm level, beef and raw milk prices were effectively taxed by government policy throughout most of the post-war period and the rate of implicit taxation increased after the 1960s, as a consequence of the new trade policies. The average rates of taxation for the whole period were 33 per cent for beef and 38 per cent for raw milk. As a consequence of these disincentives at the farm level, beef and milk production were markedly lower (about 20% lower) than the expected free trade levels. Also reflecting the discouragement to farmers to produce cattle, the supply of cows for slaughter was higher than the free-trade level. As cows are mainly capital goods in the beef and dairy sectors, this result can be interpreted as a contraction of capital stock and consequently a reduced capacity for future

TABLE 2 : ECONOMIC EFFECTS OF PRICE DISTORTIONS ON THE BEEF AND DAIRY SECTORS - 1948/79 (IN %)

VARIABLES \ PERIODS	1948/50	1951/55	1956/62	1963/66	1967/74	1975/79	1948/79
1. PRICES AT FARM LEVEL							
Beef (PFS)	-13	2	7	44	49	34	31
Raw Milk (PM)	3	12	23	35	49	43	36
2. PRICES AT RETAIL LEVEL							
Beef (RPB)	-11	2	7	34	39	26	24
Fluid Milk (PRI)	-19	-1	15	39	49	49	32
Dairy Products (RPDP)	12	12	16	26	40	38	28
3. BEEF AND MILK PRODUCTION							
Slaughter of Steers (M)	-1	-4	-5	-3	13	31	11
Slaughter of Cows (F)	15	-11	-22	-85	-49	20	-17
Cattle Production (CP)	-4	-3	0	11	26	35	20
Beef Supply (TS)	4	-6	-10	-18	2	30	7
Milk Production (MP)	-6	-8	-3	8	28	26	17
Carcass Weight (WT)	0	0.5	0.5	2	4	3	2
Yield per Cow (AMP)	-3	-4	-1	0	7	-13	-1
4. TOTAL CONSUMPTION							
Beef (TCB)	5	0	-4	-26	-30	-18	-15
Fluid Milk (TCFM)	7	2	-6	-15	-19	-37	-19
Dairy Products (TCDP)	-6	-8	-8	-14	-16	-12	-12
Milk on Farm (HC)	-1	0	4	14	34	38	23
5. EXTERNAL TRADE							
Beef Export (NT)	-29	-70	-58	34	74	90	82
Dairy Products Import (IM)	182	58	-12	-92	-209	-95	-206
6. CATTLE HERD							
Cows (SF)	-4	-3	0	11	26	35	19
Steers (SM)	-1	-1	0.5	12	27	39	23
Total (RBT)	-3	-3	0.5	10	25	35	19

beef and milk production.

At the retail level, prices of beef, milk and dairy products were considerably lower than would have been the case in the absence of government intervention and as a result of this consumer subsidy, demand for these products expanded (on average by 16 per cent for beef, 21 per cent for milk and 13 per cent for dairy products). Brazilian consumers enjoyed the benefits of these implicit subsidies throughout the post-war period but consumer gains were more significant after the mid-1960s. The consumption of milk on-farm decreased (17 per cent on average) as a consequence of the disincentive to milk production. This result also implies that the main beneficiary from agricultural policy was the urban consumer.

The effects of production disincentives and consumer subsidies were also apparent in the external trade variables. However these results must be interpreted with some caution. Since net trade is estimated as a residual in the model, measurement errors in the other components of the system will be concentrated here. Moreover, as net exports of beef and imports of dairy products are small in proportion to the total quantities transacted in the market, small errors in the simulated values represent large percentage errors for these variables. Nevertheless, the direction of the effects of price distortions is quite clear. Exports of beef would have been higher without the price distortions induced by government policy and Brazil could have been an exporter of dairy products rather than an importer.

5. Measurement of Welfare Losses from Government Intervention

The aim of this section is to use the simulation results in a context which would allow the measurement of the overall economic costs and welfare effects of agricultural policy in the beef and dairy sectors.

The standard approach to the measurement of allocative and distributive effects of market intervention utilises the concepts of consumers' and

TABLE 3 : MEASURING THE ECONOMIC COSTS AND WELFARE EFFECTS OF MARKET DISTORTIONS: MAIN FORMULAE

Effects	Formulae
A. Economic Costs	
1. Net Economic Loss in Production (NELp)	$NELpB = \frac{1}{2}(TSc-TSd)(PFSc-PFSd)$
	$NELpD_o = \frac{1}{2}(MPc-MPd)(PMc-PMd)$
	$NELpD_1 = \frac{1}{2}(MPc-HCc-MPd+HCd)(PMc-PMd)$
2. Net Economic Loss in Consumption (NELc)	$NELcB = \frac{1}{2}(TCBc-TCBd)(RPBc-PRBd)$
	$NELcD = \frac{1}{2}(TCFMc-TCFMd)(PRIc-PRId) + \frac{1}{2}(TCDPc-PTCPd)(RPDPc-RPDPd)$
3. Net Economic Loss (NEL)	$NELB = NELpB + NELcB$
	$NELD_o = NELpD_o + NELcD$
	$NELD_1 = NELpD_1 + NELcD$
B. Welfare Effects	
1. Welfare loss of Producers	$WLPB = (PFSc-PFSd)TSc-NELpB$
	$WLPD_o = (PMc-PMd)MPc-NELpD_o$
	$WLPD_1 = (PMc-PMd)(MPc-HCc)-NELpD_1$
2. Welfare Gain of Consumers	$WGCB = (RPBc-PRBd)TCBc+NELcB$
	$WGCD = (PRIc-PRId)TCFMc + (RPDPc-RPDPd)\ TCDPc + NELcD$
3. Government Revenue	$GRB = TSd(PFSc-PFSd)-TCBd(RPBc-RPBd)$
	$GRD_o = MPd(PMc-PMd)-TCFMd(PRIc-PRId)-TCDPd(RPDCc-RPDPd)$
	$GRD_1 = (MPd-Hcd)(PMc-PMd)-TCFMd(PRIc-PRId)-TCDPd(RPDPc-RPDPd)$

Notes: c denotes corrected values, that is, removing market distortions; d denotes distorted values; B refers to the beef sector; D_o, D refers to the dairy sector; D_1 refers to the dairy sector excluding consumption of raw milk on-farm; the other symbols have the same interpretation as before.

producers' surplus. While this approach is well known and widely adopted, its theoretic foundation and empirical application have been challenged.[1] A review of the major issues in the debate seems inappropriate in a paper which already threatens to be considered too long. At worst, the calculations performed here provide some indication of the welfare gains and losses generated by agricultural policy. However it should be further stressed that the effects of government intervention in the beef and dairy sectors in Brazil are so striking that theoretical and empirical problems with the methodology are unlikely to change the social costs incurred radically.

The dynamic simulations of the estimated model with and without government intervention provide the basic data for the quantification of the welfare effects. The basic formulae used in this context are displayed in Table 3, while the main results evaluated at the average values for 1948/79 are presented in Table 4.

The economic loss in production in both sectors amounts to 3.5 billion per year and some two-thirds of this is borne by the dairy sector. The loss in consumption is 3.9 billion Cr$ per year but the beef sector accounts for most of this figure. The net economic loss of 7.4 billion represents about 6 per cent of the value of production in both sectors or 1.4 per cent of the agricultural output. The annual welfare loss from government intervention also appears quite large in comparison to the calculations for other LDCs in Bale and Lutz (1981). The loss of producers' surplus was also large in terms of the value of production (some 52 per cent of the aggregated output of both sectors), whilst the gain in consumers' surplus was 33 per cent of the total value of actual expenditures on both products.

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1. See Currie et al. (1971), Scandizzo and Bruce (1980) and Willig (1976).

TABLE 4 - Measure of Overall Welfare Effects and Economic Costs of Price Distortions on the Beef and Dairy

(average of 1948/79)

EFFECTS \ SECTORS	BEEF	DAIRY	LIQUID MILK	DAIRY PRODUCTS	TOTAL
A. ECONOMIC COSTS					
1. Net Economic loss in Production (NELp) - Cr$ thousand millions	1.1	2.4			3.5
2. Net Economic Loss in Consumption (NELc) - Cr$ thousand millions	2.3	1.6	0.8	0.8	3.9
3. Net Economic Loss (NEL)-Cr$ thousand millions	3.4	4			7.4
4. NEL/Value of Production (%)	5	10			6
B. WELFARE EFFECTS					
1. Welfare Loss of Producers (WLP)-Cr$ thousand millions	-34.5	-25.4			-59.9
2. Welfare Gain of Consumers (WGC)-Cr$ thousand millions	32.5	23.5	9.3	14.2	56
3. Government Revneue (GRD)-Cr$ thousand millions	-1.4	-2.1			-3.5
4. WLP/Value of Production (%)	47	61			52
5. WGC/Value of Expenditures (%)	30	39	43	37	33

The results of Table 4 reinforce the previous findings with regard to the transfer of resources from the beef and dairy producers to other sectors. As the change in government revenue is not significant, clearly the major beneficiaries from government policy have been consumers of beef and dairy products. However, the benefits to consumers and the costs to producers are not evenly distributed within these broad categories. Unfortunately lack of suitable data precludes a complete analysis of the distributional consequences of government policies but some broad conclusions may be inferred. Firstly, since more than 60 per cent of the Brazilian active population earn less than twice the minimum wage[1] per month and less than 15 per cent receive more than 7 times the minimum wage rate, the major beneficiaries of the large consumer subsidies embodied in agricultural policy were the middle and upper income groups.[2] By contrast, on the production side, the burden of producer losses and implicit taxation was borne by the small scale milk producers (less than 100 hectares) and the medium and large beef producers (more than 500 hectares).[3] However, as the large producer had easier access to subsidized rural credit, the large beef farmers' losses were offset to some degree. Hence, the costs of agricultural policy were chiefly borne by the small and medium scale beef and milk producers.

The conclusion that the price distortions induced by government policy should benefit the higher income consumers at the expense of small and medium size farmers is in direct contradiction to the conventional view that

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1. In Brazil, the national minimum wage is commonly taken as the base from which income class is defined.

2. In 1975 the low income groups accounted for about 11 per cent of beef and milk consumption and only 8.5 per cent of the consumption of dairy products.

3. In 1975 farms in the 100-500 ha category accounted for 31.5% of beef production; 42.4% of beef came from farms over 500 ha. On the other hand 48.1% of milk production occurred on farms of less than 100 ha.

artificially low agricultural prices result in a more egalitarian distribution of income.[1] In the Brazilian case, government policy in the beef and dairy sectors tended to reinforce the skewed income distribution prevailing in the country.

Conclusions

This study has attempted to measure the economic effects of Brazilian government policies on the beef and dairy sectors in the post-war period, with particular attention being given to the consequences of market distortions induced by government intervention. The analysis was facilitated by the construction and estimation of a dynamic, econometric model of the two sectors, which could be simulated with and without the policy-makers' interference.

The yardstick for comparison of the past performance of the sectors is the price regime which would be expected to prevail under free trade and, on this basis, it is apparent that Brazilian agricultural policy has had a significant, and not entirely benign, influence on the beef and dairy markets. Throughout the sample period, a high rate of implicit taxation was imposed on beef and dairy producers; farm level prices were over 30% below free trade levels. It is not therefore surprising that the disincentive effects of these price signals in terms of reduced beef and milk production and the distortion of the pattern of external trade were striking features of the analysis. In contrast, urban consumers were confronted with retail prices which were highly subsidised, and responded by increasing consumption of beef and dairy products. However, when the effects of price distortions and production disincentives are combined, large economic losses are seen to be the result of government policy to date.

While the economic losses which may arise from undervaluing the agricultural sector in developing countries are recognised, it is sometimes

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1. See Brown (1978).

argued that the adoption of this approach to agricultural policy may nonetheless produce a more egalitarian society. This would be the case if the higher farm prices following the removal of distortions were to benefit chiefly the large-scale producers and the main group to be adversely affected by higher retail prices were low-income consumers. However, our results do not support this conclusion. The main beneficiaries of government policy in Brazil have been the middle and upper income groups and the burden has been borne by the small and medium-scale beef and milk producers. Thus, a more even distribution of income would result, not from the maintenance of the *status quo*, but rather from the removal of price distortions in these sectors.

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APPENDIX : ECONOMETRIC MODEL OF THE BRAZILIAN BEEF AND DAIRY SECTORS

1. PRICE FORMATION IN THE FARM SECTOR

1.1 BEEF PRICE

$$PFS_t = \underset{(1.05)}{48.3144} + \underset{(6.53)}{5.57845}\ CWPIB_t - \underset{(3.52)}{0.99933}\ NT_t/1000 - \underset{(1.25)}{39.7647}\ D_3 + \underset{(3.21)}{0.38448}\ PFS_{t-1}$$

1.2 RAW MILK PRICE

$$PM_t = \underset{(1.78)}{-0.85651} + \underset{(5.43)}{0.41153}\ PI_t + \underset{(10.37)}{0.65431}\ PII_t$$

1.3 EXPECTED PRICE OF BEEF

$$(1-\underset{(117.3)}{0.9889}L)(1+\underset{(10.7)}{0.9829}L^3)PFS_t = (1+\underset{(1.02)}{0.1718}L-\underset{(1.36)}{0.2474}L^2)(1+\underset{(3.14)}{0.6399}L^3)a_t$$

1.4 EXPECTED PRICE OF MILK

$$(1-\underset{(139.0)}{0.9803}L)(1+\underset{(2.17)}{0.8314}L^2)PI_t = (1+\underset{(2.70)}{0.8596}L^2)a_t$$

2. PRICE FORMATION IN THE INTERMEDIATE SECTOR

2.1 BEEF PRICE

$$RPB_t = \underset{(2.57)}{7.55661} + \underset{(17.9)}{1.31904}\ PFS_t/15 + \underset{(4.0)}{9.87695}\ D_2$$

2.2 FLUID MILK PRICE

$$PRI_t = \underset{(2.80)}{-3.30509} + \underset{(12.2)}{1.51439}\ PI_t + \underset{(8.11)}{27.80204}\ Lfm_t - \underset{(2.97)}{0.01332}\ ICV_t - \underset{(1.85)}{1.00841}\ D_4$$

2.3 DAIRY PRODUCTS PRICE

$$RPDP_t = \underset{(1.40)}{4.18251} + \underset{(7.73)}{1.60011}\ PII_t + \underset{(1.52)}{12.51369}\ Ldp_t - \underset{(2.46)}{1.7316}\ D_5$$

3. SALES FOR SLAUGHTER, SUPPLY OF BEEF AND MILK PRODUCTION

3.1 SALE OF COWS FOR SLAUGHTER

$$F_t = \underset{(2.89)}{1115} + \underset{(7.82)}{0.14857}\ SF_{t-1} - \underset{(4.06)}{2.67368}\ EPFS_{t/t-1} - \underset{(1.83)}{101.70434}\ EPI_{t+1/t}$$

3.2 SALE OF STEERS FOR SLAUGHTER

$$M_t = \underset{(10.56)}{1579.1} + \underset{(14.73)}{0.38281}\ SM_{t-1} - \underset{(3.04)}{1.4788}\ EPFS_{t/t-1} + \underset{(2.63)}{10.58578}\,(PFS/PS)_{t-1}$$

$$- \underset{(3.05)}{7.55247}\ P_t + \underset{(1.97)}{301.29791}\ D_1$$

3.3 AVERAGE CARCASS WEIGHT

$$WT_t = \underset{(92.62)}{178.43286} + \underset{(2.44)}{0.18685}\ EPFS_{t/t-1}/15 + \underset{(4.07)}{0.47716}T$$

3.4 BEEF SUPPLY

$$TS_t = (WT_t)(M_t + F_t) + CS_t$$

3.5 YIELD OF MILK PER COW

$$AMP_t = \underset{(3.16)}{55.71513} + \underset{(2.18)}{33.72234}\,(PM/PS)_t + \underset{(2.72)}{0.11024}\ CA_t + \underset{(4.42)}{0.57278}\ AMP_{t-1}$$

3.6 MILK PRODUCTION

$$MP_t = (AMP_t)(SF_{t-1})$$

4. DOMESTIC DEMAND FOR BEEF, MILK AND MANUFACTURED DAIRY PRODUCTS

4.1 BEEF

$$CB_t = \underset{(5.79)}{11.18513} - \underset{(3.86)}{2.07361}\,(RPB/DI)_t + \underset{(4.93)}{0.40634}\,(RPPC/DI)_t + \underset{(5.65)}{0.5301}\ CB_{t-1}$$

4.2 FLUID MILK

$$CFM_t = \underset{(3.18)}{22.53529} - \underset{(2.40)}{12.64036}\,(PRI/DI)_t + \underset{(2.24)}{4.6258}\ D_4 + \underset{(3.21)}{0.50183}\ CFM_{t-1}$$

4.3 MANUFACTURED DAIRY PRODUCTS

$$CDP_t = \underset{(3.09)}{14.36236} - \underset{(2.40)}{6.93345}\,(RPDP/DI)_t + \underset{(4.17)}{0.5757}\ CDP_{t-1}$$

4.4 MILK ON FARM

$$PcHC_t = \underset{(6.64)}{21.78854} + \underset{(7.05)}{11.56737}\ VP_t - \underset{(1.77)}{0.09957}\ T + \underset{(3.96)}{0.36539}\ PcHC_{t-1}$$

5. EXTERNAL TRADE AND MARKET CLEARING CONDITIONS

5.1 NET EXPORT OF BEEF

$$NT_t = TS_t - (CB_t)(POP_t)$$

5.2 DAIRY PRODUCTS IMPORT

$$IM_t = (PcHC_t)(PA_t) + (CFM_t)(PU_t) + (CDP_t)(POP_t) - MP_t$$

6. CATTLE HERD

6.1 STEER

$$SM_t = 0.98\ [SM_{t-1} - M_t] + 0.9667\ M2_{t-1}$$

6.2 YOUNG STEER

$$M2_t = 0.9677\ [M1_{t-1} - AV_t]$$

6.3 MALE CALVES

$$M1_t = 0.23764\ SF_t$$

6.4 BULLS

$$TOU_t = 0.05\ SF_t$$

6.5 COWS

$$SF_t = 0.90\ [SF_{t-1} - F_t] + 0.977\ F3_{t-1} + 0.19334\ F2_{t-1}$$

6.6 HEIFERS 3 YEARS

$$F3_t = 0.77336\ F2_{t-1}$$

6.7 HEIFERS 2 YEARS

$$F2_t = 0.9677\ F1_{t-1}$$

6.8 FEMALE CALVES

$$F1_t = 0.23294\ SF_t$$

6.9 TOTAL CATTLE HERD

$$RBT_t = M1_t + F1_t + M2_t + F2_t + F3_t + SF_t + SM_t + TOU_t$$

Note: Numbers in parentheses below each estimated parameter are Student t-values

DEFINITION OF VARIABLES

Endogenous Variables

PFS	-	real fat steer price: farm level, Cr$/15 kg.
PM	-	real price of milk: farm level, Cr$/litre.
RPB	-	real price of fresh and chilled beef: retail level, Cr$/kg
PRI	-	real price of liquid milk: retail level, Cr$/litre
RPDP	-	real price of cheese and dried milk: retail level, Cr$/litre equivalent
F	-	number of cows sold for slaughter, 1000 head
M	-	number of steers sold for slaugher, 1000 head
WT	-	average carcass weight of cows and steers slaughtered, kg/head
TS	-	domestic supply of beef, tons of carcass wt. equivalent
AMP	-	average yield of milk per cow, litre/head
MP	-	production of raw milk, milk litres
CB	-	per cap. domestic consumption of beef, kg
CFM	-	per cap. domestic consumption of liquid milk (urban areas), litres
CDP	-	per cap. domestic consumption of dairy products, litre equivalent
PcHC	-	per cap. consumption of raw milk on farm, litres
NT	-	net trade (exports less imports) in beef, tons
IM	-	imports of dairy products, null litres equivalent.
SM	-	stock of steers over 2 years old, 1000 head
M1,M2	-	stock of male calves up to 1 year old, stock of young steers, 1000 head
TOU	-	stock of bulls, 1000 head
SF	-	stock of cows and heifers over 3 years old, 1000 head
F1,F2,F3	-	stock of female calves up to 1 year, heifers up to 2 years, heifers up to 3 years respectively, 1000 head
RBT	-	total cattle stock, 1000 head
$EPFS_{t/t-1}$	-	real expected price of fat steer: farm level, for period t, Cr$/15 kg
$EPI_{t+1/t}$	-	real expected price of milk Class I: farm level, for period t+1, Cr$/litre

Exogenous Variables

CWPIB	-	price of beef received by exporters, Cr$/ton
PI	-	real milk price received for milk used in liquid milk market, Cr$/litre
PII	-	real milk price received for milk processed in the dairy industry, Cr$/litre
P	-	rate of increase of general price index, in percent
T	-	time trend, 1947=1
CS	-	beef production from male calves, tons of carcass wt.
PS	-	real price of crops (maize, soybeans, cotton and wheat), Cr$/kg
CA	-	real balance of loan granted to the cattle sector, Cr$/million
ICV	-	rate of increase of cost of living index, in percent
Lfm	-	gross profit rate in the milk processing industry, in percent
Ldp	-	gross profit rate in the dairy processing industry, in percent
DI	-	disposable income in the private sector, Cr$/millions
POP,PA,PU	-	total population, rural population, urban population respectively, 1000 head.

AV - number of male calves sold for slaughter, 1000 head
D1=1; 1959,65 and 73 , periods of strong government intervention in beef sector
D2=1;1964-79 , period of buffer stock scheme and supply restrictions in beef sector
D3=1;1954,59/60,63/65,67,71,73/74 - periods of export quotas and prohibitions
D4=1; 1974/79 - periods of reconstitution of milk, consumption subsidies and new regulatory criteria i.e. milk price
D5=1; 1964/79 - period of buffer stock scheme and control of marketing margins in the dairy sector.

TABLE 5 : MAIN STATISTICS MEASURES FOR EACH ESTIMATED STOCHASTIC EQUATION OF THE BEEF AND DAIRY SECTORS

Equations \ Statistics	R-Square		Durbin-Watson		F	Degree of Freedom	Estimator
	Normal	Corrected	D.W.	h			
1. Prices at Farm Level							
Beef Price	0.90	0.88	1.72	1.11	61	28	2SLS
Raw Milk Price	0.93	0.93	1.15		215	30	OLS
Expected Price of Beef	4.88[a]	5.67[b]				6	ML
Expected Price of Milk	4.50[a]	5.19[b]				7	ML
2. Prices at Retail Level							
Beef Price	0.94	0.94	1.80		238	30	2SLS
Fluid Milk Price	0.91	0.90	1.37		76	28	OLS
Dairy Products	0.77	0.74	1.32		32	29	OLS
3. Beef and Milk Supply							
Sale of Cows	0.76	0.73	1.54		30	29	OLS
Sale of Steers	0.96	0.95	1.47		140	27	OLS
Average Carcass Weight	0.86	0.85	2.00		90	30	OLS
Yield of Milk Per Cow	0.88	0.87	1.76	1.03	73	29	OLS
4. Demand							
Beef	0.73	0.70	1.58	1.44	26	29	2SLS
Fluid Milk	0.86	0.84	1.92	0.52	58	29	OLS
Dairy Products	0.73	0.71	2.03	-0.14	41	30	OLS
Raw Milk on Farm	0.97	0.96	1.49	1.70	314	29	OLS

Note: a) Q - Box-Pierce Statistics. b) $\bar{Q}$ - Box-Pierce Modified Statistics