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LPU WORKING PAPER No. 7

The economic implications of the beef pricing policy in Zimbabwe

GIL RODRIGUEZ

MAY 1985

INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA (ILCA)
ADDIS ABABA, ETHIOPIA

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ERRATA

1. On ABSTRACT page third paragraph, "Purusing" should be "Pursuing".

2. Page 5 bottom paragraph, "11,300" should be "111,3000".

3. Page 6, "subsudy" should be "subsidy".

4. Page 6, "the retail price for beef...." should be "...the domestic retail price for beef...".

5. Page 9 (4.1), "period to" should be "period t".

6. Page 15 first paragraph, "DW" should be "W".

7. Page 16 second paragraph, "H contends" should be "He contends".

8. Table 8, "Caraces" should be "Carcasse".

9. Table 9, "Colde" should be "Cold" in the footnote.

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ABSTRACT

Livestock products play a crucial role in the economy of Zimbabwe. It is a major source of foreign exchange earnings, employment, food, and farm income. Seventeen to thirty one percent of the total value of primary production in the large scale sector during the period 1965-82 was contributed by beef, cattle and dairy products.

This paper has the following tasks:

(a) Analysis of the price structure confronting beef producers and consumers.

(b) Estimation of the quantitative response of producers and consumers to changes in the beef prices.

Using the nominal protection index (which is the ratio of the domestic prices to border prices), it was shown that there is an increasing trend to subsidize beef producers during the period 1965 to 1982. Purusing the same quantitative basis of price comparisons, it was proven that beef consumers' subsidy declined during the period 1966 to 1981. Consumers were in fact taxed in 1977 and 1978. A rationale for such policy bias can be attributed to the government's objectives of generating exportable beef surplus and to boost beef producers' income mainly at the expense of urban beef consumers. High-income urban consumers spend on the average seventy eight percent more than the lower urban income class on beef consumption.

On the other hand, through the use of an aggregate demand model, it was empirically illustrated that a ten percent rise in beef retail prices will induce a decline in per capita beef consumption of 4.8% to 5.1%. Also, fitted (finite price lag) cattle slaughter models gave an estimate of a producers' price response for the commercial and communal areas. Communal beef producers will cut the slaughter levels by 3.4% if producer prices are increased by 10%. For the same increase, commercial producers will also reduce slaughtering levels by 4.9% to 6.2% percent. Such behavior of both producers is consistent with economic theory since they have to maintain a bigger herd to enable them to take advantage of future price increase.

CONTENTS

		Pages
1.	INTRODUCTION	1-2
2.	THE STRUCTURE OF PRODUCTION	3-5
3.	BEEF CONSUMPTION PATTERN AND THE FACTORS AFFECTING IT	5-9
4.	PRICING POLICY TOWARDS BEEF PRODUCERS	9-16
5.	CONCLUSION	17
6.	BIBLIOGRAPHY	18
7.	FOOTNOTES	19

The Economic Implications of the Beef Pricing Policy In Zimbabwe*

Introduction

The livestock sector has always played a pivotal role in the economy of Zimbabwe as a domestic food supplier, as a generator of export earnings or a major source of domestic farm income; and as an employer. Livestock products in the form of beef cattle and dairy accounted from 17% to 31% of the total value of primary production in the large scale sector (Table 1) for the period 1965-82.

Livestock products are produced on three types of livestock enterprises, i.e. large- and small-scale commercial farms and communal areas' peasant holdings. A large scale unit satisfies at least one of the following criteria:-

i) 5 or more permanent employees
ii) 25 or more hectares under crops (all crops)
iii) 350 or more livestock (cattle sheep, and pigs)

Both large- and small-scale units are characterized by modern farm technologies. On the other hand, communal areas' peasant holdings will be characterized by a lower form of technology and a higher home-consumption levels of the farm products. Labour in such places will in majority of cases be supplied by family members.

The government's participation in the beef sector started in the late twenties. In 1927, confronted with a surplus of cattle in the domestic market, the government entered into an export agreement with the Imperial Cold Storage of Cape Town. The export contract was between the latter and the Rhodesian Cold Storage and Supply Ltd. which was then owned by a private group. The agreement provided a subsidy to the Rhodesia Cold Storage and the provision of a pre-emptive right to the government to expropriate the former after ten years.

In 1937, the government assumed the management and ownership of the Cold Storage Commission. The Commission have factories in Harare (established in 1943), Umtali (1946), Fort Victoria (1951), Gatooma (1970), Marandellas (1975), Sinoia (1976), and small cold stores at Que Que (1946) and Gwelo (1947). In 1976, a major cold store complex was build in Gwelo.

* Significant comments on this paper have been provided by S. Sandford.

In 1967, the Cold Storage Commission (CSC) was placed under the authority of the Agricultural Marketing Authority (AMA). The AMA is the agency which conducts the initial hearings with the farmers' associations in the process of gazetting producer prices. The CSC is considered by the government as the institution which will permit it to accomplish the following objectives:-

i) To attain self-sufficiency in beef products.

ii) To achieve an exportable surplus of beef.

As such, the operating policy of CSC is to support producers' prices on the basis of the cost of production incurred within alternative commercial farming systems. The cost data are partly furnished by the Commercial Farmers' Union and partly by the extension service unit of the Ministry of Agriculture. Both sources rely on the use of case studies of particular farming units to generate their cost of production statistics. The CSC's trading activities are financed heavily by government advances and loans.

This paper aims to accomplish the following:

a) To depict the price structure, resulting from government interventions, confronting beef producers and consumers.

b) To attempt to estimate the quantitative response of producers and consumers to changes in the beef prices.

The first section describes the production structure of the beef sector. The second provides the trend in beef consumption and initial estimates on an aggregate beef demand. The third part gives the producers' price structure (vis-a-vis world prices), aggregate supply response parameter, and discussions on the beef grading scheme and on its implications for beef producers in communal areas.

The Structure of Production

The number of cattle on large farms had an increasing compounded annual growth rate till 1977 as evidenced by:

Period	Annual growth rate
1920-30	1.5%
1935-45	2.2%
1945-55	2.2%
1955-65	2.7%
1965-77	5.0%
1977-81	-7.2%

The decline in the period after 1977 can be attributed to the effect of drought in 1979 and the internal security situation. The communal areas' herd, on the other hand, grew by 5.2% annually in the period 1965-77. It also showed a decline of 4% per year between 1977 and 1981.

For the period 1966-1983 as a whole, the beef herd in the large scale sector rose by 1.5% per annum. A large part of this increase can be attributed to the growth of the average farm herd size of 3.62% per year (from 358 to 655) while the number of beef farms declined by 2.01% per year (from 4379 to 3070). The bulk of the beef herd of the large scale sector is situated in the Matabeleland, Mashonaland (North and South), and Midlands areas. For example, in 1983, these areas accounted for 86% of the total stock.

In terms of changes in the herd structure of the large scale sector for the period 1965-83, the trends were as follows:-

Type	Annual growth rate of number of animals
Calves	3%
Breeding females	1.5%
Other females	2.3%
Bulls	2.6%
Other males	.2%

There was a pronounced decline in the breeding female component from 1,028,000 heads in 1976 to 733,000 heads in 1980.

The average slaughter offtake rate for the large scale sector for the period 1964/65 to 1982/83 was 14% (with a standard deviation of 4%). In the case of the small scale farms, offtake rates ranged between 10 and 15% during the period 1974-78. The average death rate (large scale) was 3% for the same period. The average calving rate (large scale) was 58% (with a standard deviation of 6%) for the period 1965-83. Magnitudes of calving rate are affected partly by the stocking rate as indicated by experimental results obtained at the Matopose Research Station for a fixed area of 1044 hectares:

	Light Stocking (1LU/HA)	Heavy Stocking (8LU/HA)
Calving percentage	69	53

A substantial portion of the mature cattle slaughterings is undertaken at the Cold Storage Commission (Table 4). In 1983, the CSC accounted for 87% of the total. For the period 1965-83, the CSC's share averaged 82% (± standard deviation of 5%).

Except in the communal areas (where CSC purchase cattle on a live-mass basis), the CSC since its inception has always adopted a carcass oriented buying policy. In general, it is known that pricing cattle on the basis of carcass and grade has the following advantages:-

i) It enables the pursuance of a pricing policy based on the characteristics of an animal. As such, the consumer (both domestic and foreign) is assured of a wide array of easily identifiable food products with varying qualities.

ii) It eliminates marketing costs arising from any asymmetry in the information regarding the animal being sold that is available to the producer and marketing agents respectively.

The three ingredients necessary for a carcass grading scheme are accuracy,objectivity, and feasibility. On July 1, 1977, in order to assure the proper payment for a particular cattle quality and to eliminate a high degree of arbitrariness on the part of the graders, carcasses were grouped according to age, flesh development (based on length to mass ratios) and fat cover. Corresponding prices were paid for the various quality combinations. Data on the cattle slaughtered according to the age attributes considered in the pricing scheme are provided in Table 5. A contraction in almost all the female class

slaughterings has occurred from 1978 to 1981. Part of the reason for the contraction is the constant revision of prices paid to the producers. For example:

(1) In January 1, 1979, the basic beef price was raised by 12½% and a 5% premium was incorporated in all price schedules. In addition, the pricing scheme introduced separate prices for 0-2 tooth and 4-6 tooth animals.

(2) In May, 1979, it was decreed that producer prices were to be increased by an additional 10% retrospective to the January 1, 1979 pronouncement.

(3) Producer prices were further increased by 15% on January 1, 1980.

(4) In 1981, the government increased beef cattle prices by 30% with retrospective effect to March 2, 1981.

(5) For the period 1982-83, the average beef producer price was again increased by 22%.

Beef Consumption

Export sales (as a proportion of total beef sales) ranged from 44% to 68% during the period 1965-79. In terms of the total value of meat products exported during the period 1970-81, beef (in frozen and canned forms) contributed 50% to 93% of the total. Most of the exports were destined for South Africa prior to 1978. By 1980, beef exports manifested a sharp decline. The unstable peace and order conditions in the previous years (1977-79) led to the deterioration of veterinary services and destruction of dipping facilities. These factors resulted in a significant drop in the domestic availability of beef and deterioration of beef quality suitable for export demand. In fact, a beef rationing scheme was pursued in the domestic market during the period 1979 to 1981.

Beef consumption on the domestic scene has grown from 48,050 tons in 1965 to 11,300 tons in 1983. This represented an annual growth of 7%. Beef represented 70% of total meat consumption in 1983. The possible substitutes for beef, such as pig and poultry meat, grew annually by 3% and 9% respectively in the period 1970-82. Although poultry meat had a higher growth than beef (7%), its share

in meat consumption is quite low. For example in 1982, its share was only 10%.

During the period, 1976/77 to 1981/82, budgetary "subsidies" for beef were (quoted by Jansen (1982)):

Year	Beef Subsidy (Zimbabwe $ (000)	Total Subsidy (Zimbabwe $ (000)
1976/77	6338	9458
1977/78	11265	14483
1978/79	20516	42173
1979/80	12920	26302
1980/81	9319	50568
1981/82	25730	121650

A subsidy scheme is usually pursued either to stimulate an exportable surplus or to encourage the domestic consumption of the commodity (for say nutritional reasons such as obtaining protein from beef). To examine the consumption aspects of the beef subsudy scheme, the retail price for beef was compared with its border price. If the domestic retail price is above (below) the border price, consumers face implicit taxes (subsidies) whenever they purchase beef. Table 6 shows that the domestic retail price for beef has been increasingly aligned with the equivalent border price. This is shown more clearly by the following averages:

Period	Average domestic retail border price ratio for beef
1966-69	.72
1970-72	.95
1973-75	.75
1976-81	1.16

In fact in 1977 and 1978, the consumer was taxed rather than subsidized.

Nevertheless, despite the insight provided by Table 6 on the domestic consumer beef price policy, use of the various price ratios cited must be treated with caution. Firstly, the degree of under- or over-valuation of the exchange rate has not been considered. To the extent that there is an over-valuation of the exchange rate, then the estimated ratio can be over-stated. Secondly, the marketing margin (35%)

utilized in adjusting the border price to the equivalent domestic marketing level is largely dominated by the CSC operations which may include either some monopoly profits or additional costs arising from potential marketing inefficiencies.

An aggregate beef demand was estimated for the period 1970-83. In linear and log form, the demand relationships are respectively:

$$(3.1)\quad q_{bt} = 17.46 - \underset{(.09)}{.17} P_{bt} - \underset{(.61)}{.26}\, d_{rt} \quad R^2 = .27 \quad DW = 1.71$$

$$(3.2)\quad q'_{bt} = 4.16 - \underset{(.25)}{.48}\, P'_{bt} - \underset{(.05)}{.02}\, d_{rt} \quad R^2 = .25 \quad DW = 1.62$$

Where q_{bt} is the beef per capita consumption in period t.

P_{bt} is the real retail beef price in period t.

d_{rt} is a dummy variable equal to 1 in the presence of a rationing scheme and O otherwise.

Variables with primes represent log transformation to the base e.

Numbers in parenthesis are standard errors.

The fit obtained for the two demand equations is not satisfactory. However, the price coefficients are statistically significant (as evidenced by its value being approximately equal to 2) and have the correct signs. Furthermore, serial correlation problems were not encountered (i.e. the Durbin Watson (DW) values are reasonable).

The demand price elasticities obtained ranged from -.48 to -.51 (computed at the means). Rather than focus on the level of significance of the elasticity coefficients (which can be easily undertaken for 3.2), we opted to compare the confidence intervals of the elasticity parameters generated by (3.1) and (3.2). This side steps the appropriateness of using the null hypothesis that the price elasticity or regression coefficient equals zero which is commonly pursued in most regression softwares in undertaking a test of the level of significance. In the case of (3.1), the confidence interval of the elasticity coefficient involves obtaining the roots of the following expression:

$$(3.3)\quad P\left(\frac{(k_1 - Rk_2)}{Var(k_1) - 2R\,cov\,(k_1, k_2) + R^2\,var\,(k_2)} \leq t^2\right) = g$$

Where g is the confidence coefficient

k_1 is the product of the regression coefficient (b) and the mean price (P_b)

k_2 is the mean quantity

R is the ratio between the expected values of k_1 and k_2 respectively t is the usual student value.

The respective confidence intervals at g =.95 of the price elasticity coefficient (in absolute terms) for (3.1) and (3.2) are:

(i) $.35 < .51 < .72$

(ii) $.36 < .48 < 1.33$

Ideally, the "best" confidence interval is the one endowed with minimum expected length. It is clear that the elasticity estimate of the log form is inferior as compared to the elasticity coefficient estimated at the means for the linear demand equation if the confidence interval criteria is invoked.

In terms of substitutes for beef, the terms of trade (ratio of the retail price of substitute to the retail price of beef) seem to be in favour of beef with respect to consumption. The empirical evidence partly supporting such a hypothesis is the terms of trade for meat products in Harare:

Year	Mutton/Beef	Pork/Beef	Chicken/Beef
1973	2.06	1.80	1.46
1974	2.05	1.70	1.43
1975	1.94	1.64	1.39
1976	2.75	1.76	1.30
1977	2.59	1.67	1.29
1978	2.43	1.58	1.47
1979	2.29	1.73	1.40
1980	2.55	1.82	1.60

It is to be noted that mutton prices at the retail level are not controlled by the government. A favourable terms of trade for the beef sector will dampen any expansion of demand of meat substitutes such as mutton, pork, and chicken. It

is difficult to assess whether the government's policy is to preserve a large share of the domestic meat market for the beef producers. Nevertheless, part of the reason for the higher prices of pork and chicken relative to beef can be their higher feed and other input costs.

Pricing Policy Towards Beef Producers

An index which can be used to monitor the ex-post impact of a given price policy is the nominal protection coefficient (NPC):

(4.1) $NPC = P_d/P_w$

where P_d is the domestic producer price in period to

P_w is the border price in period t

In the case of beef the border price (Pw) is defined as:

(4.2) $P_w = \pi P_x - M + R$

where π is the exchange rate

P is the border price in foreign denomination per kg

M is the marketing margin

R is the revenue of relevant cattle by-products.

If NPC is greater or less than one, then the producer is either subsidized or taxed respectively.

The NPC for beef for the period 1965-82 is given in Table 7. The NPC was estimated under various assumptions pertaining to the marketing margins (incurred by CSC) and the revenue contributions of offals and hides as follows:

	Marketing margin	Revenue contribution of offals and hides
NPC_1	40%	25%
NPC_2	30%	25%
NPC_3	30%	30%
NPC_4	30%	35%

The main rationale in estimating alternative values for NPC was to see how sensitive the ratio is to possible changes in the latter elements.

Nevertheless, a single trend which emerges is the growing subsidy provided to domestic producers during the period 1965-82. The average nominal protection coefficients (together with their standard deviations) in particular sub-periods tend to support each hypothesis:

	1965-69	1970-74	1975-82
NPC_1	1.14 (.08)	1.25 (.10)	1.64 (.20)
NPC_2	.98 (.06)	1.07 (.09)	1.40 (.16)
NPC_3	.91 (.06)	1.00 (.08)	1.32 (.16)
NPC_4	.85 (.06)	.92 (.07)	1.22 (.15)

If subsidies on beef consumption are correctly estimated to be on the decline, then this represents an attempt by the government to boost rural incomes (mostly mmercial farmers) at the expense of urban consumers. Comparison of the various mean ratios also indicates:

(a) Overstating the marketing margin by 25% causes the ratio to be higher by 17%.

(b) Overstating the revenue contribution of the by-products to the tune of 17% lends to an understatement of the ratio by 8%.

An alternative way to look into the pricing policy of the government with respect to livestock producers is to consider the following relationship:

(4.3) $P_d = a + bP_w$

P_d is the expected producer price in period t
P_w is the expected world price in period t

If b = 0, this means that the government have completely insulated livestock producers' prices from the international market price movements. A possible reason for the government to undertake such strategy is to prevent the transmission of international market fluctuations into the domestic market in the short run. It is further noted that as b approaches zero, substantial variation in the nominal

protection coefficient will occur (1). This simply means that variations in government policies will be large if a price insulation policy is pursued.

The empirical estimate of (4.3) is:

(4.4) $P_d = 15.64 + .77\ P_w - 1.02\ t$ $\quad R^2 = .89 \quad DW = 1.28$

(.12) (.57)

Numbers in parenthesis are standard errors

Period of fit was 1965-82.

P_d and P_w are in cents per kg of beef (bone in) of average quality

The magnitudes of the coefficients of (4.4) ($b \neq 0$) indicate that the government permits the domestic beef producers' price to be responsive to changes in international market conditions.

As mentioned previously, to effect the appropriate payments for the beef sold to the CSC a carcass grading scheme has been pursued. However, despite the apparent objectivity in the 1981-82 price schedule, some grey areas still existed under the former arrangements. Van Vliet (1982), using the 1981/82 price schedule, illustrated that the price difference between two similar carcasses can be as high as 44%. As a result the flesh class component of the pricing (1981/82) schedule was further subdivided into very finite intervals to minimize ambiguity with respect to such quality (Tables 8-9). Also, there was a shift in the product quality weights (with respect to the carcass pricing policy) from age to the flesh class component in the 1981/82 to 1982/83 schedules.

In the 1984/85 price schedule, an additional provision for a primary component (residual quality adjustment) was provided. For example, the producer price is computed as follows:

(a) Primary price is 80 cents per kg during the whole period.

(b) Age price according to:

Age class (teeth)	Cents per kg.
0	44
2	44
4	44
6	40
Full mouth	30

(c) Fleshing prices varying by month and by class.

Although the main purpose of the carcass grading scheme is to transmit price signals with respect to the cattle mix which commercial producers intend to sell, the said price policy instrument may need to be supplemented with equity oriented tools. For example, the distribution of inputs, fixed farm assets, and technological knowledge will likely be in favor of the commercial producers as compared to the communal ones. As a result, the incidence of the benefits of a pricing policy will be biased towards the commercial farms.

Slaughter price response models were fitted for the period, 1965-82. In terms of R^2 and statistical significance of regression coefficients, the finite lag expectation approach outperforms the infinite one. These lag structures are defined as follows:

Type of Lag	Weighting scheme with respect to lag variables
Fisher (arithmetic lag)	$a_i = (k + 1 - i)a \quad 0 \leq i \leq k$ $a_i = 0 \quad i > k$
Almon Lag	$a_i = c_o + c_1 i + c_2 i^2 + .. + c_n i^n$

In the case of the Almon lag, an end-point constraint was imposed, i.e. $a_k = 0$. As a result of this constraint (given k = 3), the two almon price-transformed independent variables are:

$V_{t_1} = \sum_{T=0}^{k} (T-k) P_{t-T}$ and $V_{t_2} = \sum_{T=0}^{k} (T^2 - k^2) P_{t-T}$ (where P_{t-T} is the price variable). Note that the end-point constraint is imposed to set a terminal point for the impact of the independent price variables.

The empirical estimates of the Fisher and almon lag models are:

$$(4.5) \quad S_t = 437.69 - \underset{(2.06)}{2.31}\, Z_{t_1} - \underset{(6.47)}{2.34}\, Z_{t_2} + \underset{(10.08)}{43.88}t \qquad R^2 = .67 \quad n = 17 \quad DW = 1.37$$

$$(4.6) \quad S_t = 347.07 - \underset{(3.82)}{11.92}\, V_{t_1} + \underset{(1.08)}{3.09}\, V_{t_2} + \underset{(8.05)}{40.76}t \qquad R^2 = .75 \quad DW = 1.71 \quad n = 17$$

Where S_t is the slaughter level (in thousand heads)

Z_{t_1} equals $2P_t$ (P_t is the weighted average producer price in Zimbabwe cents per kg. of carcass weight across classes in period t)

Z_{t_2} equals P_{t-1}

Numbers in parenthesis are standard errors
t is the time variable
DW is the Durbin Watson estimated value
n is the number of observations.

The models fit the data moderately well (as indicated by the R^2). There is also no serious autocorrelation encountered (as supported by the DW values). Nevertheless, the standard errors of the price coefficients, particularly for (4.5), is relatively large. This indicates the possible existence of severe multicollinearity among the transformed independent variables. A measurement of the degree of multicollinearity is the eigenvalues corresponding to the independent variable vectors. The rationale for such criterion follows from the symmetry of the product matrix of the independent variables, i.e. X'X (where X is a Txk matrix of the independent variables). Since X'X is symmetric, we can always convert it into a diagonal matrix by pre- and post-multiplying it by C (where C is an orthogonal matrix). The resulting matrix (obtained from C'X'XC) is = diag (λ_1, ..., λ_n). λ_1, ..., λ_n, the diagonal elements, are the eigenvalues corresponding to C'X'XC. It is clear that the inverse of C'X'XC is simply the inverse of the diagonal elements of λ. Hence λ will be difficult to invert if λ_i is close to zero. As an operational rule of thumb, an eigenvalue between .1 and .3 indicates moderate multicollinearity while an eigenvalue less than .1 indicates a high multicollinearity. The eigenvalues corresponding to C' (V_{t_1}, V_{t_2},t)' (V_{t_1}, V_{t_2},t) C are 2.87, .0004, and .1268. To minimize the degree of multicollinearity and to preserve consistency with the theoretical structure of the lag models, ridge regression was utilized to re-estimate the models. The ridge approach basically involves adding a scalar, k, to the elements of λ. The optimal k is obtained usually by minimizing the mean square error. Details of the ridge methodology are given in Rodriguez (1984). Ridge regression normally yields biased regression coefficients but efficient estimators. An estimate of the Almon relationship at the optimal ridge parameter, k = .0001, is:

$$(4.7)\quad S_t\ (k = .0001) = 373.16 - 9.07\ V_{t_1} + 2.28\ V_{t_2} + 41.22t$$

At k = .001, the sum of the variance inflation factor (the ith variance inflation factor of the jth regressor is the ith diagonal element of the correlation matrix) is 1413.56 as compared to 2508.22 (when k = 0) for the Almon relationship. Substantial reduction has been achieved with respect to the impact of multicollinearity.

In the short run, the price elasticity obtained through the use of an expected producer price equals to twice the expected value of P_t and the coefficient of Z_{t_1} is -.59. In the case of (4.6),re-expressing it in terms of the price variables, we get:

$$(4.8)\quad S_t = 636.72 - 7.95\, P_t + .88\, P_{t-1} + 3.53\, P_{t-2}$$

The elasticity expression of (4.8) for the period t-2 to t calculated at the means of S_t and P_t is:

$$(4.9)\quad \sum_{i=-2}^{0} S_{t-i} dP_{t-i}\; P/S = E$$

The elasticity estimated is -.49 (as derived from (4.8) and (4.9). Pursuing the same steps, the ridge regression (Almon model) yield a short-run price elasticity of -.51 to -.63. In terms of sign, the elasticity parameters obtained are consistent with economic theory. Producers will hold back animals from slaughter because they need a larger herd to obtain higher slaughter offtake levels if they anticipate prices to increase. The absolute magnitudes of the elasticities are comparable with those obtained elsewhere such as in Brazil (-.113 to -.575); Argentina (-.668 to -.962); and Columbia (-.058 to -1.20).

The previous supply elasticity estimates largely reflect the behavior of commercial livestock producers to price changes. Hence, to determine the direction magnitude of the price response of livestock producers in the communal areas, a supply relationship defined below was fitted to the period 1965-1983 (Appendix Table 2);

$$(4.10)\quad S_{ct} = 7.37 - \underset{(.21)}{.34\, P_{t-1}} + \underset{(.12)}{.41\, S_{CT-1}} + \underset{(.11)}{.10\, T} + \underset{(.10)}{.25\, D} - \underset{(.16)}{.97\, W} \qquad R^2 = .90 \quad DW = 2.07$$

All (dependent and independent) variables except D and W are in logarithm (base e).

Numbers in parenthesis are standard errors.

S_{ct} is the total number of heads sold at official auctions in the communal farming areas in period t.

D is a binary variable (representing the presence of drought conditions).

It is equal to one for the years 1968, 1970, 1979, 1982, and 1983.

DW is a binary variable (representing the internal security situation).

It is equal to 1 for the years 1978 and 1979 and zero otherwise.

The model (4.9) is the empirical estimate of the reduced form of the Koyck lag model. Such framework assumes that the weights attached by communal farmers on prices decline geometrically as the price information gets "older".

The sign of the price coefficient coincides with previous estimates. Doran, Low, and Kemp (1979) argue that a priori, it should be negative since livestock producers in communal areas will sell fewer higher priced animals to meet their cash requirements. However, in absolute terms the magnitude of the short-run supply elasticity (.34) is less than those calculated for the commercial livestock sector, but statistically significant at the .10 level.

Previous short-run cattle slaughter price elasticities are -1.05 DLK (Doran, Low, and Kemp (1979)) for Swaziland and 1.10 to 1.15 KS (Khalifa and Simpson (1972)) for Sudan. The period of fit for the first parameter was 1950-76 while it was 1919-35 and 1946-65 for the second parameter. The DLK figure was estimated at the means while that of KS was derived from a logarithmic form.

A common conceptual difficulty encountered in both the DLK and KS models arose from the definition of the dependent (endogenous) variable. Doran defined it as:

(i) $$\frac{TS + (EXP-IMP) - 14\% \, POLC}{SNLC} \times 100$$

Where TS = total slaughterings

EXP = number exported for slaughter

IMP = number imported for slaughter

POLC = privately owned land cattle

SNLC = Swazi nation land cattle.

Fourteen percent is the offtake rate in privately owned lands and assumed to be insensitive to price changes. To the extent that such assumption is not true, then the response of TS and EXP to price changes will include those of the commercial producers in privately owned lands (which is expected to be high). This may partly explain the high absolute magnitude of the Doran elasticity estimate.

On the other hand, Low (1975) noted that the dependent variable in Khalifa and Simpson model may reflect only the slaughter of animals in a "premium priced and demand determined market". H contends that once producers sell in a premium market A, they will sell less in market B (where they get lower prices per animal unit as compared to market A) provided they have already met their minimum cash income targets. The price differentials existing between markets A and B mean that given a price increase in market A, the increased sales in market A will be less than the reduction in sales in market B. The overall response then to an increase in the price will be negative.

The cattle sold at official auctions in the communal areas largely purchased by the CSC who accounted on the average, for 65% of total sales (with a standard deviation of $\pm$ 12%). Such policy reflects partly the objective of CSC to effect a guaranteed producer price for the livestock products of communal farmers. During periods of drought, a substantial portion of the CSC purchase is in the form of young cattle stocks. For example in 1970, close to 32% of total CSC market acquisition belongs to the latter. The young stocks are usually placed on grazier agreements with other farmers or held in the CSC cattle pens. By minimizing the drastic effect of drought on the cattle herd, the CSC is in effect trying to stablize the availability of beet to the domestic market and to preserve export capabilities.

Some of the implications arising from the nature of our elasticity estimates are:

(a) In the short-run, an increase in the price received by domestic producers will result in lower levels of slaughterings. Coupled with rising beef demand, this will result in a lower exportable surplus which might affect the foreign exchange contribution of the beef sector.

(b) Since the earlier price transmission relationship indicates that the government do not insulate the domestic market from international price changes, then international cattle cycles can be experienced by domestic beef producers.

This means that in periods of high international prices, the number of domestic animals slaughtered by producers can decline resulting in lower exports.

(c) A higher producer price will induce an increase in cattle inventories. An increase in the cattle inventories will require an increase in the usage of domestic resources such as land, labor, coarse grains, etc. If the increase in the livestock activity reduces resources in crop activities wherein Zimbabwe enjoys a comparative advantage, then the producer price increase will incur an efficiency cost. On the other hand, if the increase in livestock inventories induces the consumption of, say, grain by-products which have zero opportunity costs, then some indirect benefits are realized.

Conclusion

The Beef sector contributes, on the average, about 22% of the total output orginating from the primary sector. It is also an export earner for the Zimbabwe economy. Cattle productivity among commercial farmers seems to be satisfactory with average slaughter offtake rates of 14% and an average annual growth rate for the breeding female animals of 1.5% for the period 1965-83. Productivity in the communal areas will likely be lower.

Current trends in the government's pricing policy indicate more towards declining subsidies on beef consumption and a higher nominal protection rates accorded to beef producers. The implicit objective then behind such move might be to boost the farm income (mostly of commercial farmers) at the expense of high-income urban consumers. The latter spends on the average 78% more than the lower urban income class on beef consumption. Initial estimates indicate that both commercial farmers and communal areas' peasant producres respond to changes in producer prices in the same way as producers in other countries.

Bibliography

Khalifa A H, and Simpson M C. 1972. "Perverse Supply in Nomadic Societies". Oxford Agrarian Studies, Vol. 1, pp. 47-56.

A R C Low. "Cattle Supply Response in Sudan and Swaziland: Motivational Inferences and Overgrazing Implications". Oxford Agrarian Studies, Vol. 7, 1978, pp. 62-73.

Doran M H, Low A R C, and Kemp R L. "Cattle as a Store of Wealth in Swaziland: Implications for Livestock Development and Overgrazing in Eastern and Southern Africa". American Journal of Agricultural Economics, Vol 61, No. 1, February 1979, pp. 41-47.

Jansen Dorris. "Agricultural Prices and Subsidies in Zimbabwe: Benefits, Costs, and Tradeoffs". Unpublished 1982 report.

Rodriguez G. The Usefulness of the Ridge Regression Approach to Supply Function Estimates". Unpublished LPU paper, 1984.

van Vliet C A. "A Review of the Beef Carcasse Classification Scheme". Unpublished paper, 1982.

Footnotes

1/ The variance of the nominal protection coefficient is:

(1) $$\mathrm{Var}(NPC) \frac{1}{\bar{P}^2_w} \mathrm{var}\, P_d - 2\frac{(\bar{P}_d)}{\bar{P}^3_w} \mathrm{Cov}(P_d, P_w) + \frac{(\bar{P}_d^{\,2})}{\bar{P}^4_w} \mathrm{Var}(P_w)$$

Denote further:

(2) $$\frac{\mathrm{Cov}(P_d, P_w)}{\mathrm{Var}(P_w)} = b_1$$

(3) $$\frac{\mathrm{Cov}(P_d, P_w)}{\mathrm{Var}\, P_d} = b_2 = b_1^{-1}$$

Hence (1) can be re-expressed as:

(1') $$\mathrm{Var}(NPC) = \left(\frac{1}{\bar{P}^2_w}\right) b_1 \mathrm{Cov}(P_d, P_w) - 2\frac{(\bar{P}_d)}{\bar{P}^3_w} b_1 \mathrm{Var}(P_w) + \frac{(\bar{P}_d^{\,2})}{\bar{P}^4_w} \frac{\mathrm{Cov}(P_d, P_w)}{b_1}$$

b_1 is the regression slope of P_d with respect to P_w. As b_1 approaches Zero, Var (NPC) approaches infinity.

Table 1. The Contribution of Beef Cattle and Other Major Agricultural Commodities to the Total Value of Agricultural Primary Production in the Large Scale Sector (In Percentages)

Year	Beef Cattle	Tobacco	Maize	Sugar	Cotton	Dairy Produce	Others
1965	13	48	12	8	2	4	13
1966	17	38	14	10	3	4	14
1967	15	32	21	8	4	5	15
1968	18	24	16	9	8	6	19
1969	16	17	25	7	13	5	17
1970	19	16	21	10	8	5	21
1971	19	16	23	10	9	4	19
1972	22	14	23	10	10	4	17
1973	27	16	12	10	12	4	19
1974	17	18	21	14	11	3	16
1975	17	17	17	16	9	4	20
1976	18	21	15	10	10	4	22
1977	22	18	16	8	9	3	24
1978	20	20	14	8	10	4	24
1979	20	21	10	9	11	5	24
1980	15	18	15	14	10	5	22
1981	12	18	34	11	11	5	9
1982	19	20	22	10	11	6	12

Notes: Beef refers to cattle slaughterings only
The drought years were 1968, 1970, 1973, 1979

Source: Central Statistical Office

Table 2. National Cattle Population

Year	Large and Small Scale Sector			Communal	National
	Beef Herd	Dairy Herd	Total	Areas	Total
1965	1519	111	1630 (47)	1844 (53)	3474 (100)
1966	1635	114	1749 (51)	1714 (49)	3463 (100)
1967	1649	108	1757 (45)	2183 (55)	3940 (100)
1968	2148	112	2260 (53)	2036 (47)	4296 (100)
1969	2367	120	2487 (52)	2315 (48)	4802 (100)
1970	2616	123	2739 (53)	2451 (47)	5190 (100)
1971	2819	123	2942 (53)	2600 (47)	5542 (100)
1972	2785	125	2910 (52	2691 (48)	5601 (100)
1973	2665	129	2795 (50)	2847 (50)	5642 (100)
1974	2668	128	2796 (49)	2936 (51)	5732 (100)
1975	2882	127	3009 (49)	3123 (51)	6132 (100)
1976	3007	126	3133 (50)	3183 (50)	6316 (100)
1977	3103	123	3226 (49)	3388 (51)	6614 (100)
1978	2960	117	3077 (51)	2950 (49)	6027 (100)
1979	2600	109	2709 (49)	2860 (51)	5569 (100)
1980	2304	106	2410 (46)	2869 (54)	5179 (100)
1981	2287	104	2391 (45)	2900 (55)	5291 (100)
1982	2352	102	2454 (43)	3240 (57)	5694 (100)
1983	2207	103	2310 (44)	2900 (56)	5210 (100)

Notes: (1) All numbers except those in parentheses are in thousands. The numbers in parenthesesare percentages.

(2) For 1965, and 1967, the numbers reported for the first three columns refer only to the large scale sector.

Source: Central Statistical Office.

Table 3. Cattle Owned By Large Scale Farmers
(Numbers of head)

Year	Beef	Dairy	Total
1920	*	*	772891
1925	*	*	1006086
1930	*	*	901343
1935	*	*	807416
1940	*	*	826268
1945	*	*	1001269
1955	*	*	1246254
1956	*	*	1344136
1957	*	*	1434115
1958	*	*	1506199
1959	*	*	1552380
1960	*	*	1552097
1961	1473560	112292	1585852
1962	1498976	117384	1616360
1963	1502326	115674	1618000
1964	1514231	112965	1627196
1965	1519307	111299	1630606
1966	1568826	114384	1683210
1967	1648910	107743	1756653
1968	1922691	112055	2034746
1969	2149235	119642	2268877
1970	2391434	122739	2514173
1971	2586019	122978	2708997
1972	2559308	124647	2683955
1973	2443742	129068	2572810
1974	2446868	128056	2574924
1975	2653688	127042	2780730
1976	2776092	125667	2901759
1977	2836272	123147	2959419
1978	2695029	117179	2812208
1979	2368983	108725	2477708
1980	2102113	105623	2207736
1981	2084922	103819	2188741

* Figures not available according to classification.
Source: Central Statistical Office.

Table 4. Mature Cattle Slaughterings
By Market Sector (Thousand heads)

Year	Cold Storage Comission	Butchers in Prescribed Areas	Butchers Outside Prescribed Areas	Farm Slaughterings	Total Kill
1965	281.4	34.5	28.0	24.6	368.5
1966	317.8	37.1	32.9	23.2	411.0
1967	258.7	29.8	26.1	17.0	331.6
1968	264.5	35.7	30.8	18.5	349.5
1969	287.0	37.8	26.3	18.3	369.4
1970	342.9	48.3	26.5	19.3	437.0
1971	428.2	69.7	17.9	21.7	537.5
1972	545.2	65.2	35.9	24.8	671.1
1973	596.9	56.1	47.6	23.5	724.1
1974	457.3	20.7	45.2	22.9	546.1
1975	444.4	11.4	40.4	23.8	520.0
1976	558.4	14.8	40.8	27.2	641.2
1977	649.0	14.4	32.8	27.8	724.0
1978	644.2	21.3	30.7	28.8	725.0
1979	560.0	31.8	27.0	25.7	644.5
1980	455.2	20.6	26.9	19.8	522.5
1981	350.3	42.9	26.5	21.3	4410.0
1982	450.5	35.3	2.50	20.0	530.8
1983	485.0*	28.0*	25.0*	20.5*	558.5*

* Estimate

Notes: (1) Excludes slaughterings for subsistance consumption in communal areas.

(2) Large and Small Scale Sector farm slaughterings excluding an estimated number of calves.

Source: Central Statistical Office and Cold Storage Commission.

Table 5. Total Cattle Slaughtered By Sex and Age (Thousand heads)

Sex	Age	1978	1979	1980	1981	1982	1983
BU	0	1345	2532	3051	624	593	1667
BU	2	1051	1002	1173	680	588	928
BU	4	918	761	1007	706	622	745
BU	6	974	955	1007	1052	938	1040
BU	FM	663	658	792	1143	1316	1225
BU	FA	4077	3568	3627	3666	4600.5	6268
Total Bulls		9028	9476	10279	7871	8657.5	11873
CO	0	26522	20973.5	15273	5784	8382	6107
CO	2	40349	28678	21792	9298	12394	11668
CO	4	33481	24958	20773	10558	15212	12649
CO	6	25503.5	23223	16696	11929	15110	15190
CO	FM	18466	15616	11765.5	8[illegible]	15716	18337
CO	FA	156537.5	134938.5	98551	71244.5	99509	116630
Total Cows		306859	248387	184850.5	117505.5	166323	180581
OX	0	37856.5	38697	27814	17931	24570	24570
OX	2	66690.0	63763	51513	37202	43190	44773
OX	4	78249.0	70222	62181.5	46955	61547	51829
OX	6	77534.0	68604	54294.5	54588	63226	51593
OX	FM	42836	37590	33623.0	34429	41738	38311
OX	FA	17539	9365	20251.5	23769	25200.5	34283
Total Oxen		320704.5	288741	249677.5	214874	259171.5	245359
Inferior		5689.0	6083	3365.5	3295	3777	7249
Sub-Total		636280.5	552687	448622.5	343545.5	438229	445059
Detained		6001	5278	5042	5403	10501	9960
Condemned		1939.5	2002	1497.5	1303.5	1808	2247
Total		644221	559967	455162	350252	450538	457266

Source: Cold Storage Commission

Table 6. Comparison of Domestic Retail Price of Beef with Border Price (1966-81. All Prices in Cents/kg)

Year	Domestic Beef Retail Price*	Border Price Equivalent**	Ratio of Domestic to Border Price
1966	33.20	49.95	.67
1967	35.52	48.60	.72
1968	38.00	52.65	.72
1969	40.67	52.65	.77
1970	43.51	48.60	.90
1971	46.56	47.25	.99
1972	49.82	51.30	.97
1973	53.31	64.80	.82
1974	57.04	89.10	.64
1975	61.03	76.95	.79
1976	65.30	64.80	1.00
1977	69.88	54.00	1.29
1978	74.77	51.30	1.46
1979	80.00	75.60	1.06
1980	86.00	78.30	1.10
1981	114.00	110.20	1.03

* The domestic beef retail price series was contructed by assuming an annual 7% growth rate in retail prices. The latter growth rate represented the trend for the wholesale beef prices for the period 1970-81. It was assured that the same trend persisted for retail prices for the above period.

** The export realized price was adjusted by 35% which represented the marketing margin. Jansen (1982) utilized the same margin for previous work.

Table 7. Nominal Protection Rates
Confronting Domestic Beef Producers (1965-82)

Year	NPC_1	NPC_2	NPC_3	NPC_4
1965	1.020	.874	.816	.757
1966	1.148	.984	.919	.853
1967	1.232	1.060	.986	.915
1968	1.160	1.000	.929	.862
1969	1.152	.991	.922	.845
1970	1.242	1.068	.993	.917
1971	1.313	1.129	1.050	.967
1972	1.328	1.143	1.063	.985
1973	1.271	1.093	1.017	.939
1974	1.076	.926	.861	.800
1975	1.293	1.112	1.034	.906
1976	1.484	1.277	1.188	1.096
1977	1.810	1.557	1.488	1.347
1978	1.882	1.552	1.505	1.395
1979	1.573	1.353	1.258	1.174
1980	1.748	1.504	1.398	1.330
1981	1.556	1 339	1.245	1.160
1982	1.755	1.510	1.404	1.305

Note: For explanation of NPC_1 - NPC_4 see text.

Table 8. Beef Producer Prices
(Zimbabwe Cents Per Kg. of Cold Dressed Mass)
(MID-MONTH PRICES)

	Age Class				Fleshing Class					Fat Class			
1981/82	0-2T	4-6T	FM	FA	A	B	C	D	E	1	2	3	9
Mar	97	96	85	79	15	12	8	-4	-7	8	5	-3	-6
Apr	93	92	82	77	13	10	5	-4	-7	8	5	-3	-6
May	93	92	82	77	13	10	5	-4	-7	8	5	-3	-6
Jun	95	93	85	81	14	11	7	-4	-7	8	5	-3	-6
July*	97	94	87	82	14	11	7	-4	-7	8	5	-3	-6
Aug*	97	95	88	82	14	11	8	-4	-7	8	5	-3	-6
Sept*	97	95	88	82	15	13	8	-4	-7	8	5	-3	-6
Oct*	98	96	89	83	15	13	8	-4	-7	8	5	-3	-6
Nov*	100	98	91	85	17	15	8	-4	-7	8	5	-3	-6
Dec*	102	101	92	86	18	18	9	-4	-7	8	5	-3	-6
Jan*	102	101	91	86	21	19	10	-4	-7	8	5	-3	-6
Feb*	101	100	90	84	19	16	9	-4	-7	8	5	-3	-6

*Incentive Prices: Incentive prices apply to the following classifications 0 - 6-tooth: A1, A2, B1 and B2 only and in the given month as follows: July 5c/kg; August 15c.kg; and September to February 17c/kg.

Bull Beef: Caraces of young bulls (BY) are paid for as detailed in the Schedule while caraces of other bulls (BU) are subject to a discount of 16c/kg c.d.m.

Inferior Class: Any carcase classed as Inferior does not enter the classification scheme and receives a price of 52c/kg.

Table 9. Beef Producer Prices

(Zimbabwe Cents Per Kg. of Cold Dressed Mass)

(Mid-month prices)

	Age Class						Fleshing Class										Fat Class			
1982/83	0	2	4	6	FM	FA	A+	A-	B+	B-	C+	C-	D+	D-	E+	E-	1	2	3	9
Mar	43	43	43	38	34	27	60	52	45	38	30	23	16	10	6	3	0	0	-6	-8
Apr	"	"	"	"	"	"	47	40	33	28	23	19	14	6	4	2	"	"	"	"
May	"	"	"	"	"	"	41	36	31	26	22	17	12	6	4	2	"	"	"	"
June	"	"	"	"	"	"	45	39	33	29	24	18	12	8	5	2	"	"	"	"
July	"	"	"	"	"	"	50	44	36	32	27	21	14	8	5	2	"	"	"	"
Aug	"	"	"	"	"	"	57	49	42	36	29	23	15	9	5	3	"	"	"	"
Sept	"	"	"	"	"	"	61	53	45	39	32	24	16	10	6	3	"	"	"	"
Oct	"	"	"	"	"	"	67	58	49	41	34	25	17	11	6	3	"	"	"	"
Nov	"	"	"	"	"	"	73	64	54	45	36	27	20	13	7	3	"	"	"	"
Dec	"	"	"	"	"	"	80	70	60	50	40	30	22	14	8	4	"	"	"	"
Jan	"	"	"	"	"	"	80	70	60	50	40	30	22	14	8	4	"	"	"	"
Feb	"	"	"	"	"	"	80	70	60	50	40	30	22	14	8	4	"	"	"	"

Notes:

Bull Beef: Carcasses of young bulls (BY) will be paid for as detailed in the schedule, and will not be subject to any discount.

Carcasses of all other bulls (BU) will receive a price equal to the ruling price for FA category less 19c/kg. Penalties and premiums for fat cover and fleshing will apply.

Inferior Class: Any carcass classed as Inferior will not enter the classification scheme, and will receive the inferior grade price of 63c/kg.

Source: Colde Storage Commission

Appendix Table 1. Demand Data Used in Beef Regression Runs (1970-83)

Year	Per Capita Beef Consumption (in kgs)	Deflated Retail Beef Price (Cents/kg)	Dummy Variable for Rationing
1970	9.74	39.14	0
1971	9.77	37.59	0
1972	11.03	37.47	0
1973	11.53	37.41	0
1974	10.94	38.08	1
1975	10.90	37.53	0
1976	11.45	36.11	0
1977	11.78	33.55	0
1978	11.98	32.17	0
1979	11.75	34.38	1
1980	12.43	32.03	1
1981	11.25	28.16	1
1982	12.43	29.67	0
1983	13.74	35.46	0

Source of Basic Data: Cold Storage Commission

Appendix Table 2.

Cattle Sales at Official Auctions in the Communal Farming Areas

Calendar Year	Total Cattle Sold (number of head)	Average Price on Live Mass Basis (c/kg and in Zimbabwe $)
1965	130488	10.51
1966	95448	12.09
1967	67469	13.40
1968	87089	12.62
1969	85060	13.16
1970	101961	12.55
1971	90915	12.35
1972	68324	14.22
1973	97025	14.93
1974	108261	19.73
1975	79532	22.71
1976	67641	20.61
1977	48196	20.39
1978	23899	19.88
1979	21615	22.29
1980	42910	27.35
1981	58576	35.23
1982	76690	40.70
1983	77142	43.54

Source: Ministry of Agriculture (Communal Cattle Marketing Section)