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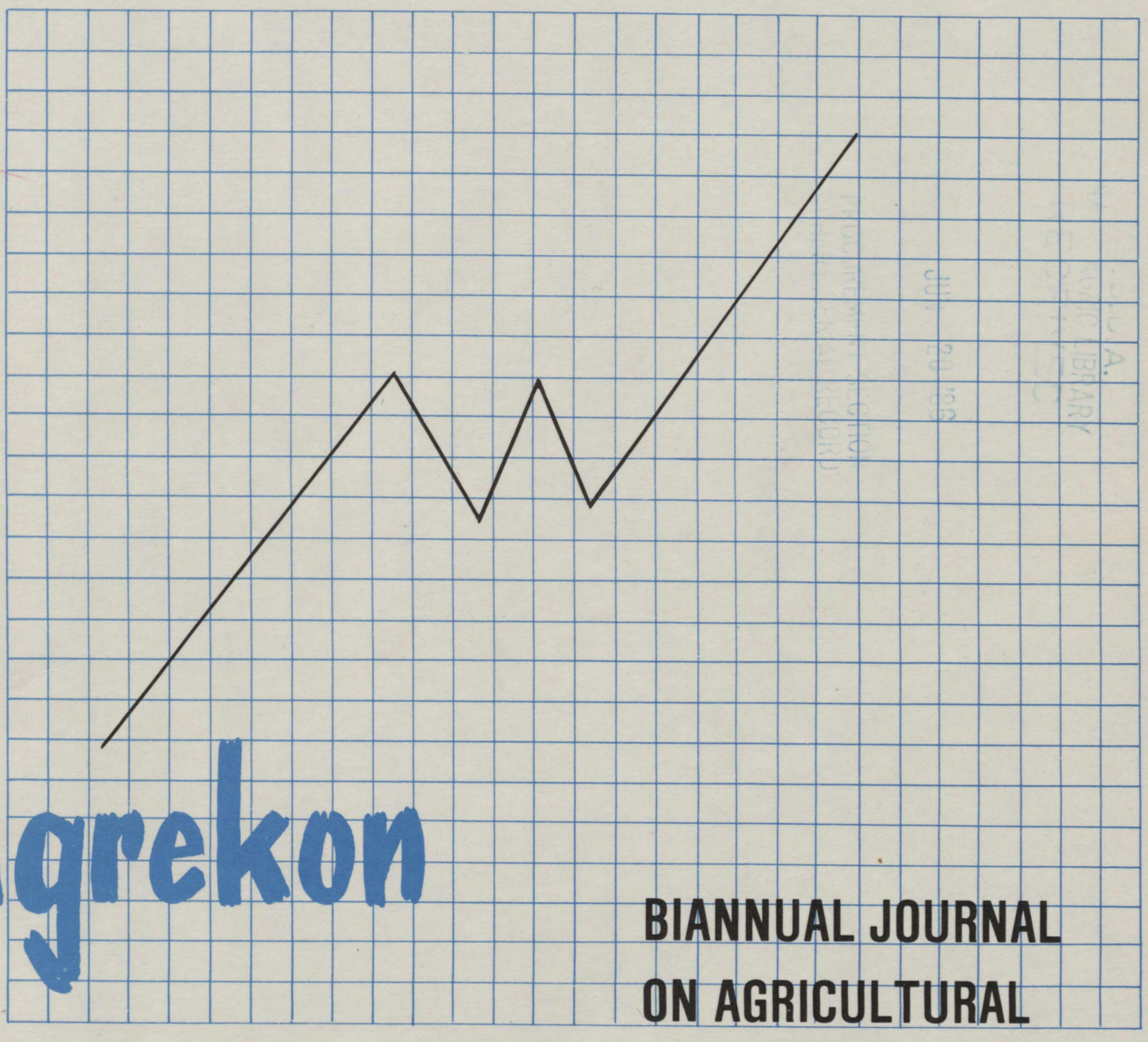

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DEMAND ANALYSIS OF MEATS IN SOUTH AFRICA*

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INTRODUCTION

In the agricultural sector beef is second only to maize in terms of gross value of production. In 1981/82 beef grossed R987 656 000, while maize fetched R1 196 949 000. The total combined value of beef, mutton, pork and poultry amounted to R2 051 681 000 in 1981/82 and accounted for 28,7% of the gross value of agricultural production (Abstract of Agricultural Statistics, 1983, p. 88).

In spite of its importance there has been a lack of research into the demand for meat. To date, only a few empirical studies have been attempted in this field. It is hoped that the results presented in this paper will help satisfy the information needs of agricultural policy-makers.

METHODOLOGY

Long-term elasticities and flexibilities were estimated using single equation models and annual data. Short-term elasticities were estimated using simultaneous equations and quarterly data.

Price-flexibility versus price elasticity of demand

Estimating direct and cross-price flexibilities may be more appropriate in agriculture than estimating price elasticities of demand (Houck, 1965). Supplies to the market are determined in advance of current prices and hence for regression purposes price should be taken as the dependent variable and quantity as an explanatory variable. The price flexibility coefficient thus shows the percentage change in price associated with a 1% change in quantity *ceteris paribus*.

According to Houck, "the reciprocal of price flexibility is absolutely less than the true elasticity if there are discernible cross effects with other commodities". Colman and Miah (1973) argue that the proof given by Houck is unacceptable because it confuses total and partial concepts of flexibilities and elasticities. They (Colman and Miah) point out that partial direct flexibilities and elasticities are inversely related "if there exists a linear relationship between two variables which can be correctly identified in both the statistical and economic senses" (p. 366). That is, the coefficient of determination (R^2) must equal one. Ortmann's (1982) empirical study supports this conclusion. Since R^2-values rarely equal one in practice, the inverses of flexibilities do not serve as good estimates of the corresponding elasticities.

Waugh (1964) recommends the use of a quantity-dependent regression equation to estimate elasticity of demand and a price-dependent equation to estimate flexibility.

The effects of time upon elasticity

Elasticity of demand measured over a very short time period (e.g. one quarter or one month) is likey to be greater than elasticity measured over a longer time period (e.g. one year). In this regard Shepherd states: "It is not surprising that the short-time price elasticities differ from the annual data elasticities; they refer to different demands. The short-time elasticities should be greater than long-time elasticities because a large part of the short-time fluctuations in supplies thrown on the market are absorbed by short-time storage operations". (p. 68)

The need for a simultaneous equations model

The concept of elasticity in traditional demand theory makes it possible to specify changes in the quantity of a good demanded with respect to changes in its price, all other commodity prices remaining constant. *Ceteris paribus* does away with all the vague qualifications concerning prices of substitutes and complements. In reality, prices of related commodities are mutually determined. The traditional concept of elasticity of demand is therefore an inadequate basis for predicting actual market behaviour (Buse, 1958). In order to estimate the effects of a price change on the quantity demanded, with all other variables interacting as the market requires, a system of simultaneous equations is necessary.

The following system of structural equations, in which quantities of beef, mutton and pork are explained in terms of their own auction prices,

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auction prices of substitutes and consumer income, was considered.

$$Qb = a_1 + b_{11} Pb + b_{12} Pm + b_{13} Pb + b_{14} Pc + b_{15} I + U_1$$
$$Qm = a_2 + b_{21} Pb + b_{22} Pm + b_{23} Pp + b_{24} Pc + b_{25} I + U_2$$
$$Qp = a_3 + b_{31} Pb + b_{32} Pm + b_{33} Pp + b_{34} Pc + b_{35} I + U_3$$

where

Qb, Qm, Qp	=	quarterly per capita consumption of beef, mutton and pork respectively.
Pb, Pm, Pp	=	deflated quarterly abattoir prices of beef, mutton and pork (base year = 1970)
I	=	quarterly income per capita
Pc	=	deflated retail price of poultry
U	=	error term

In this system of equations Pb, Pm and Pp are endogenous variables whilst variables Qb, Qm, Qp, Pc and I are exogenous because they are determined outside the abattoir. Quantities are considered to be exogenous over a three month period because:

- The decision by a farmer to market livestock is usually made at least three months prior to marketing;
- the Meat Board issues permits three months in advance so that the supply of meat to the controlled abattoirs over any three month period is fixed.

After expressing the endogenous variables as functions of all the exogenous variables, ordinary least squares may be used to estimate the endogenous variables. This is known as the reduced form. Since the above system is just identified, indirect least squares were used to estimate the structural coefficients from the reduced form. Quarterly prices and per capita consumption figures were obtained from the Meat Board, the former being the weighted average price for all grades at the non-controlled area abattoirs and the latter being total meat sales divided by the number of residents in controlled areas [Bureau of Statistics, (a)]. This implies a slight overestimation of per capita consumption since consumers residing outside controlled areas may purchase meat slaughtered in controlled areas.

Private consumption expenditure figures published in the Reserve Bank Quarterly Bulletin and population figures from the Abstract of Agricultural Statistics were used to obtain quarterly per capita incomes.

In addition to the simultaneous equations model, single-equation models were estimated using annual data and ordinary least squares. The following explanatory variables were considered in the equations with retail price as dependent variable:

- Consumption per capita of beef, mutton, pork and poultry.
- Real disposable income per capita.

Conversely, equations with consumption per capita as dependent variable included the following explanatory variables:

- Deflated retail price of beef, mutton, pork and poultry.
- Real disposable income per capita.

Retail prices relate to grade one meats [Bureau of Statistics (b)] and were deflated by the consumer price index with base year 1970. Per capita consumption figures were obtained from the Abstract of Agricultural Statistics.

Estimates of the Black population for South Africa and the independent homelands were obtained by compounding 1975 census figures at 2,8% per annum (based on the growth rate during the previous 10 years). These estimates were added to those for other population groups to arrive at annual population estimates for purposes of computing per capita income.

After transforming the data to base 10 logs, the equations were estimated using SPSS (1975).

Tests for autocorrelation were based on the Durbin-Watson d-statistic. In models where the d-test was unsatisfactory, generalised first differences were employed to negate first order autocorrelation.

Explanatory variables with low t-values were dropped from the model only after consideration had been given to the size of the t-value (Haitovsky, 1969) and the likely direction of bias in the included variables.

RESULTS

Table 1 provides a summary of retail price elasticities of demand estimated using annual data for the time period 1962 to 1981.

The own price elasticities of beef (-0,96), mutton (-1,93), pork (-1,86) and poultry (-1,66) are high. Signs of the coefficients behave as expected with the exception of that for beef in the poultry demand equation. The mutton variable in the pork demand equation was dropped on the basis of its t-value. This may result in a slight upward bias of the beef coefficient.

Little importance can be attached to the income elasticity coefficient because elasticities derived from time series include dynamic effects such as changes in income distribution, urbanisation and the structure of the population over time (Greenfield, 1974). The beef elasticity compares favourably with Laubscher's (1982) estimate of -1,00 obtained over a similar time period.

Table 2 summarises the estimates of flexibilities for the same time period. The results appear to be more stable than those obtained for the quantity dependent equations indicating the appropriateness of direct and cross-price flexibilities in agriculture. The own price flexibilities of -1,18, -0,88, -0,55 and -0,75 for beef, mutton, pork and poultry are in keeping with the elasticity estimates.

Estimates using the simultaneous technique on quarterly data are presented in Table 3. The own price elasticity coefficients are high because the estimates are based on quarterly data.

TABLE 1 - Price elasticities for various meats, South Africa, 1962 to 1981

Meat type	Constant	Elasticities					$\bar{R}^2$	d
		Beef	Mutton	Pork	Poultry	Income		
Beef	-0,53	-0,96 (4,53)**	0,66 (0,66)	0,72 (1,75)	0,19 (1,00)	0,71 (1,56)	0,85	1,81
Mutton	0,37	0,73 (2,16)*	-1,93 (5,99)**	0,53 (0,81)	0,41 (1,34)	0,44 (0,60)	0,88	1,63
Pork	-0,09	0,77 (2,66)**		-1,86 (3,63)**	0,50 (1,95)	0,73 (1,23)	0,38	1,23
Poultry	-2,16	-0,62 (1,09)	1,26 (2,32)*	0,98 (0,88)	-1,66 (3,26)**	1,12 (0,92)	0,97	1,24

Notes
1. t-values in brackets
2. ** = significant at the 1% level of probability
3. * = significant at the 5% level of probability
4. Own price elasticity estimates have been underlined

TABLE 2 - Retail flexibilities for various meats, South Africa, 1962 to 1981

Meat type	Constant	Elasticities					$\bar{R}^2$	d
		Beef	Mutton	Pork	Poultry	Income		
Beef	-2,56	-1,18 (3,42)**	-0,62 (3,25)**	-0,43 (1,41)	-0,54 (2,98)**	2,92 (4,13)**	9,92	1,29
Mutton	-0,56	-0,69 (2,08)*	-0,88 (4,76)**	-0,26 (0,89)	-0,41 (2,37)*	1,88 (2,76)**	0,86	1,41
Pork	-1,18	-0,47 (1,73)	-0,41 (2,69)**	-0,55 (2,29)*	-0,41 (2,86)**	1,89 (3,39)**	0,72	1,45
Poultry	0,67	-0,53 (1,51)	-0,47 (2,41)*	-0,68 (2,20)*	-0,75 (4,08)**	1,30 (1,81)	0,92	1,46

Notes
1. ** = significant at the 1% level of probability
2. * = significant at the 5% level of probability
3. t-values in brackets
4. Own price flexibilities have been underlined

TABLE 3 - Estimates of elasticity using the simultaneous equation technique on quarterly abattoir data, 1962 to 1981

Meat type	Elasticity				
	Beef	Mutton	Pork	Poultry	Income
Beef	-1,46	0,61	-1,6	0,55	1,64
Mutton	0,02	-1,61	0,65	0,20	1,37
Pork	-0,15	0,15	-4,2	1,13	1,85

Notes
1. Own price elasticities have been underlined
2. t- values are not presented since the indirect least squares technique does not permit their calculation

Unfortunately the pork coefficient carries the wrong sign in both the structural and reduced forms of the beef demand equations. Likewise the beef coefficient carries a negative sign in the pork demand equation.

CONCLUSION

This study was conducted in an attempt to determine response coefficients for the four major meat types in South Africa using data for the period 1962 to 1981. Long-term estimates of flexibilities and elasticities obtained using single equation models and annual data show that with the exception of beef, which has elasticity and flexibility in the region of unity, a given change in price produces a more than proportional change in quantity consumed. Short-term estimates of elasticities obtained using simultaneous equations and quarterly data were greater than unity for all red meats.

Parameter estimates derived from the price-dependent equations appear to be more reliable than those derived from the quantity-dependent equations. Nevertheless estimates of elasticities were in keeping with the estimated flexibilities.

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