DEMAND ANALYSIS OF ORANGES IN SOUTH AFRICA

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This study examines factors influencing the demand for oranges sold on the domestic market. Estimates of own-price, cross-price and income elasticity and flexibility coefficients for oranges are made. The price elasticity of demand for oranges was estimated as -1.55 and the price flexibility of demand as -0.695. The income elasticity (flexibility) was estimated as 0.407 (0.361). Significant cross-effects were present in the models.

Vraaganalise van lemoene in Suid-Afrika

In hierdie studie word faktore bestudeer wat die vraag na lemoene wat op die plaaslike mark verkoop word, beïnvloed. Ramings word gedoen van eie prys-, kruisprys- en inkomste-elastisiteits- en plooibaarheidskoëffisiënte vir lemoene. Die vraag elastisiteit vir lemoene is -1.55, en die plooibaarheidskoëffisiënt is -0.695. Die inkomste-elastisiteit (plooibaarheid) is 0.407 (0.361). Beduidende kruiseffekte is bespeur in die modelle.

1. Introduction

The Citrus Industry in Southern Africa exports to 40 countries world-wide. However, its largest market, volume-wise, is still the domestic one (Outspan International, 1993). Strict export quality controls ensure that a large quantity of good quality fruit remains available for sale on the domestic market at relatively low prices. Citrus fruits are sold mainly on the 15 national fresh produce markets. The popularity of selling fruit through these markets may be attributed to the simplicity and relatively low risk of this operation (Citrus Board, 1990/91).

This research note examines factors influencing the demand for oranges channelled through various domestic markets. Estimates of own-price, cross-price and income elasticity and flexibility coefficients for oranges will be presented. The study covers a 34-year period (1958/59 to 1991/92) and takes account of both the prices and quantities of important substitutes expected to influence the demand for oranges. Annual data are used and prices are deflated to a 1985 base using the consumer price index (CPI). Quantities are measured on a *per capita* basis. The effects of deregulation of the domestic market in November 1989 are also accounted for by using a dummy variable. Regulation by the Citrus Board in terms of distributive control (to ensure that every market in the country had a fair share of fruit) shifted to promoting citrus sales through extensive advertising.

Results from this study may be useful for policy-makers in the Citrus Industry in that the analyses should provide greater insight into orange consumption and price responses to price, quantity and real income changes.

2. Research procedure

2.1 Selection and compilation of data

Time series data for a period of 34 years, from 1958/59 to 1991/92, were used for the study. The data compiled include prices and quantities of oranges, apples, lemons, grapefruits and naartjies, all of which were obtained from the 1993 Abstract of Agricultural Statistics (Directorate Agricultural Economic Trends, 1993). Population data, which were obtained from the same source, were used to calculate real disposable income per capita as well as consumption per capita for the various fruits. Disposable income data were obtained from various issues of the South African Reserve Bank Quarterly Bulletin. The consumer price index (CPI) was obtained from the 1993 Abstract of Agricultural Statistics and was used to deflate both prices and disposable incomes to 1985 levels. The deregulation of the domestic orange market was included by using a dummy variable to distinguish between the periods of regulation (1958/59-1988/89) and a relatively free market (1989/90-1991/92). Although deregulation was only announced officially in November 1989, the 1989/90 season was included in the 'deregulated' period as it is assumed that producers and consumers were aware of the transition to a freer market and that prices had already been discounted.

2.2 Elasticities and flexibilities

By using logarithmic functions the researcher is able to determine elasticity or flexibility coefficients directly from the model. With most agricultural products, supply of the commodity is seasonal and with limited storage capacity, price is dependent upon the quantity available. By using price as the dependent variable flexibility coefficients can be estimated, whilst elasticities can be estimated using quantity as the dependent variable. The price flexibility coefficient shows the percentage change in price associated with a one percentage change in quantity of the commodity in question, *ceteris paribus*. The price elasticity coefficient, on the other hand, measures the responsiveness of quantity consumed to changes in that commodity's own price, *ceteris paribus*. The reciprocal of the direct price flexibility equals the direct price elasticity of demand only if cross effects are zero. If significant cross effects exist, then the reciprocal of the flexibility coefficient is less than the elasticity (Houck, 1965; Tomek and Robinson, 1990:49-50).

3. Demand estimation and analysis of results using elasticities

In the 'elasticity' model, orange consumption per capita was used as the dependent variable whilst the following were considered as explanatory variables: Orange price,

apple price, lemon price, grapefruit price, naartjie price, real disposable income and a dummy variable to account for the type of marketing in the industry (regulated or free).

Logarithmic demand functions were derived using the ordinary least squares (OLS) technique. The general demand function is as follows :

$$\ln ORCON_t = b_o - b_1 \ln ORPR_t + b_2 \ln APPR_t + b_3 \ln LEMPR_t + b_4 \ln GFPR_t + b_5 \ln NAPR_t + b_6 \ln YD_t - b_7 MKT + e_t$$

Where:
ln = natural logarithm
ORCON = orange consumption (kg/capita)
ORPR = real orange price (R/ton)
APPR = real apple price (R/ton)
LEMPR = real lemon price (R/ton)
GFPR = real grapefruit price (R/ton)
NAPR = real naartjie price (R/ton)
YD = real disposable income (R/capita)
MKT = type of marketing (dummy: regulated market 1958/59-1988/89 = 0;
free market 1989/90-1991/92 = 1)
e = error term
t = 34 years

The objective of such a model is to determine whether there is any logical and consistent relationship between the sale of oranges and the price of oranges, prices of substitutes, real disposable income, and (de)regulation of the market. If any relationships do exist between the independent and dependent variables the variates which have the most significant influence on the salé of oranges can be determined. Since the t-value associated with the price of lemons (LEMPR) was found to be less than unity, this variable was omitted from the final model. A table showing the correlation coefficients between variables used in this study is given in Appendix 1.

Results of the orange demand analysis with orange consumption per capita as the dependent variable are presented in Table 1. In this model the sign of the ORPR coefficient is negative in accordance with expectations. This indicates that as the selling price of oranges rises so the quantity of oranges sold declines, other factors constant. The coefficient is highly significant at the 1 percent level (t = -11.93). The price elasticity of demand (-1.55) is above unity in absolute terms indicating that the demand for oranges is relatively elastic. This can be expected since it would appear from the results obtained that there are some substitutes for oranges. Oranges could also be considered as a luxury item as it does not form part of the staple diet of most low income households. This would suggest another reason for the relatively elastic demand function. The elasticity coefficient indicates that for every 1 percent rise (fall) in the real selling price of oranges, the quantity consumed per capita will decrease (increase) by 1.55 percent, *ceteris paribus*. Thus a move by the Citrus Board of the past to artificially increase the orange price above market levels would have had a detrimental effect on the total revenue accruing to producers.

The cross-elasticity coefficients of apples, grapefruits and naartjies are positive so that these fruits can be considered as substitutes for oranges. The cross-elasticities for apples (0.45) and naartjies (0.46) are relatively high and significant at the 1 percent level. Thus, both fruits could be regarded as relatively close substitutes for oranges. An increase in the price of apples (naartjies) by 1 percent would be associated with a rise in orange consumption of 0.45 percent (0.46 percent), other factors constant. Whilst the price of grapefruit was not significant at the 5 percent level, it was still included in the final model because its associated t-value exceeded unity. The positive coefficient shows that it too may be considered as a substitute for oranges, although not a very close one.

The positive coefficient of the real disposable income variable (0.407) suggests that oranges are a normal good in consumption; as real income rises so orange demand will increase. The income elasticity coefficient, which is highly significant (t=3.9), suggests that for every 1 % increase in consumers' real disposable income, orange consumption will rise by approximately 0.4 percent.

The last result, that of the effect of the marketing approach (negative coefficient), suggests that since deregulation of the domestic market the quantity of oranges *per capita* sold on the national fresh produce markets has decreased. However, not much can be deduced from this result as the three-year 'deregulated' period considered in the model is too short to lead to any firm conclusions about the effect of deregulation on orange consumption (for example, farmers may have sold oranges through other markets or drought may have reduced sales). A longer period of analysis is required.

This model has a high R^2 value of 85.8 percent, indicating that the six explanatory variables account for 85.8 percent of the variation in the quantity of oranges sold on the major fresh produce markets in South Africa.

The model also satisfies the homogeneity condition closely. This condition states that the sum of the own-price, cross-price and income elasticities of a particular commodity, taking account of signs, equals zero (Tomek and Robinson, 1990:36). In the above model, the sum of the cross-price and income elasticities equals 1.423, which is close to the absolute value of the own-price elasticity.

4. Demand estimation and analysis using flexibilities

As noted earlier, prices of agricultural products generally depend on the quantity of the good available which is predetermined by the size of harvest. The objective of this analysis is to determine whether there is a logical and consistent relationship between the price of oranges, the dependent variable, and the quantity of oranges, quantities of substitute fruits, real disposable income and the type of marketing structure in the industry. Own-price, cross-price and income flexibilities can now be estimated. Logarithmic demand functions were derived using the OLS technique.

The general model used is as follows:

$$\ln ORPR_t = b_0 - b_1 \ln ORCON_t - b_2 \ln APCON_t + b_3 \ln LEMCON_t + b_4 \ln GFCON_t - b_5 \ln NACON_t + B_6 \ln YD_t - b_7 MKT + e_t$$

Where:
ln = natural logarithm
ORPR = Real orange price (R/ton)
ORCON = Orange quantity (kg/capita)
APCON = Apple quantity (kg/capita)
LEMCON = Lemon quantity (kg/capita)
GFCON = Grapefruit quantity (kg/capita)
NACON = Naartjie quantity (kg/capita)
YD = Real disposable income (R/capita)
MKT = Type of marketing (dummy variable: 1958/59-1988/89 = 0;
1989/90-1991/92 = 1)
e = Error term
t = 34 years

Table 1: Demand function for oranges with quantity per capita as the dependent variable, national market, 1958/59-1991/92.

	Coefficient	t-value	Significance
Constant	0.436		
ORPR	-1.550	-11.93	**
APPR	0.451	2.91	**
GFPR	O.105	1.49	
NAPR	0.460	2.81	**
YD	0.407	3.90	**
MKT	-0.212	-4.38	**
df = 27 **F = 27.139 **** **R^2 = 85.78 percent** Durbin-Watson statistic = 1.517[1]			
** Significant at the 1 percent level 1 The Durbin-Watson statistic lies in the inconclusive range			

The final model presented in Table 2 includes all variables with associated t-values greater than unity. The correlation matrix presented in Appendix 1 shows that apple quantity is closely correlated with the quantities of lemons, grapefruits and naartjies, and real disposable income. Multicollinearity could therefore be a reason for the relatively low t-values associated with APCON and NACON.

The price flexibility coefficient of -0.695, which is significant at the 1 percent level, shows that a 1 percent increase (decrease) in the quantity of oranges is associated with a 0.695 percent decrease (increase) in the price of oranges, other factors constant. The absolute value of the estimate is less than one indicating the demand for oranges to be elastic, as was shown in the previous model. The reciprocal of -0.695 is -1.439, which is close to the price elasticity estimate of -1.55. The reciprocal is lower than the elasticity estimate because of significant cross effects (Tomek and Robinson, 1990:50).

The cross-flexibilities are of interest in that lemons appear to be a complement to oranges. Apples and naartjies appear to be substitutes; however, their coefficients are not significant at the 5 percent level. Substitutes are expected to have a negative coefficient as a larger quantity of the substitute (apples or naartjies) is expected to lead to a decrease in its own price resulting in a reduced demand for oranges and hence a lower orange price, *ceteris paribus*. The positive cross-flexibility of oranges with respect to lemons is questionable if lemons are a substitute for oranges.

Table 2: Demand function for oranges with price as the dependent variable, national market, 1958/59-1991/92

	Coefficient	t-values	Significance
Constant	3.964		
ORCON	-0.695	-10.74	**
APCON	-0.110	-1.91	
LEMCON	0.293	2.37	*
NACON	-0.088	-1.25	
YD	0.361	3.68	**
MKT	-0.119	-3.33	**
df = 27 F = 27.113 ** R^2 = 85.76 percent Durbin-Watson statistic = 1.233[1]			
** Significant at the 1 percent level * Significant at the 5 percent level 1 The Durbin-Watson statistic lies in the inconclusive range			

The positive income flexibility coefficient of 0.361, which is significant at the 1 percent level, indicates that oranges are a normal good; as consumers' real disposable income rises so does the demand for oranges and with it the price of oranges. If real income increases by 1 percent the orange price is estimated to increase by 0.361 percent, other factors constant.

The negative coefficient of the marketing variable indicates that the price of oranges has declined since deregulation of the domestic market took effect. This is consistent with expectations, but the period since deregulation is too short to draw any firm conclusions.

The R^2 value of 85.8 percent shows that the six variables considered in the model accounted for 85.8 percent of the variation in orange prices.

5. Conclusions

The aim of this analyses was to estimate price and income elasticities of demand, and price and income flexibility coefficients for oranges from data derived from the national fresh produce markets. The price elasticity of demand for oranges was estimated as -1.55 and the price flexibility of demand as -0.695. The income elasticity (flexibility) was estimated as 0.407 (0.361). Significant cross-effects were present in the models. These response coefficients could be useful guidelines for policy-makers in the Citrus Industry. Flexibility coefficients may be considered more appropriate as the price of oranges is largely dependent on the availability (supply) of oranges during certain times of the year. With improved storage methods and facilities being developed for oranges, the quantity-dependent model will become more appropriate.

The results of the models were satisfactory in that the 'elasticity' model virtually satisfied the homogeneity condition, and the reciprocal of the flexibility coefficient was slightly lower than the elasticity estimate, which is expected when cross-effects are not zero. The two models estimated may also have some predictive value owing to their relatively high R^2 coefficients.

Note

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Appendix 1: Correlation matrix

ORCON	1.000										
ORPR	-0.739	1.000									
APCON	-0.025	-0.040	1.000								
LEMCON	0.484	-0.162	-0.563	1.000							
GFCON	0.419	-0.104	0.677	-0.074	1.000						
NACON	-0.146	-0.132	0.708	-0.597	0.353	1.000					
APPR	0.071	0.144	-0.913	0.563	-0.500	-0.723	1.000				
LEMPR	0.285	-0.083	0.187	-0.138	0.377	0.048	0.034	1.000			
GFPR	0.073	0.345	-0.142	0.430	0.274	-0.262	0.339	0.373	1.000		
NAPR	-0.257	0.346	-0.495	0.253	-0.478	-0.605	0.364	-0.235	0.006	1.000	
YD	0.046	0.067	0.900	-0.514	0.819	0.619	-0.718	0.327	0.041	-0.553	1.0
	ORCON	ORPR	APCON	LEMCON	GFCON	NACON	APPR	LEMPR	GFPR	NAPR	YD