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AN ANALYSIS OF THE DEMAND FOR BANANAS IN SOUTH AFRICA*

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1. INTRODUCTION

Little research has been done on marketing in relation to the kind as well as the scope of marketing control in South Africa.[1] In this study an attempt will be made to provide one of the important prerequisites for the formulation of an effective marketing strategy, namely analyses of demand.[2] The demand for bananas in two of the most important areas will be determined quantitatively. A study of this product is justified on the basis of the fact that its value amounts to between 20 and 25 per cent (1959/60—1970/71), of the total value of annual fruit sales on the nine most important fresh produce markets.

Knowledge of, among others, the price elasticity and income elasticity of demand for bananas, the importance of competing fruits, seasonal preference and quality in the two geographically separated markets are necessary. The economic principles according to which producers can maximise their income are well-known,[3] but without quantifying the above-mentioned factors the actions of the parties involved cannot be defended or criticised.

2. MODELS

In order to estimate the demand functions the following two equations were specified:

$$X_{1m} = a + bX_{2m} + cX_{3m} + dX_{4m} + eD_1 + fD_2 \quad \text{.....(1)}$$

$$X_{1m} = a + bX_{2m} + cX_{3m} + gX_{5m} + hX_{6m} + iX_{7m} + jX_{8m} + kX_{9m} + 1X_{10m} + mX_{11m} + nX_{12m} \quad \text{..... (2)}$$

where

X_{1m} = per capita consumption of bananas[4] in month m; m = August 1959 to July 1971

X_{2m} = retail price of bananas in cents per kilogram[5] deflated by the consumer price index

X_{3m} = real disposable income per capita[6]

X_{4m} = quantity of other fruit available per capita[7] (sum of X_{5m} to X_{12m})

$X_5 .. X_{12m}$ = quantity per capita sales of apples, pears, peaches, grapes, oranges, mangos, pineapples and pawpaws, respectively

D_1 = dummy variable, "1" for all months from August to November (period I) and "O" otherwise

D_2 = dummy variable, "I" for all months from December to March (period II), "O" otherwise

a,b, ... n = constants

Two markets namely the Rand and Pretoria** and Cape Town and surrounding areas*** were delineated as the most important sales areas of bananas. During the period 1959/60 to 1970/71 an annual average of 60,8 per cent of all bananas sold at fixed prices by the Banana Board was allocated to wholesale distributors in the Rand and Pretoria area. These distributors in turn supplied the retailers over a large area.

During the corresponding period an average of 27,4 per cent of all bananas sold outside the production areas have been allocated to the Cape Town market. In contrast to the northern market bananas were sold at public auctions in Cape Town.

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* Based on an unpublished dissertation by J.P.F. du Toit, University of Pretoria, 1974.

** The Rand and Pretoria is defined to include the whole of Transvaal (excluding the production areas) as well as North and Eastern Free State.

*** This area includes 28 magisterial districts from Clanwilliam in the west to Oudtshoorn and George in the south-east and the area south of Calvinia, Sutherland, Laingsburg and Prince Albert.

The influence of the population in each area was taken into consideration by reducing all the relevant variables to per capita terms. For purposes of this study the total population in each market consisted of the Whites, Coloured and Asians residing within the borders of these areas. The Black population is excluded from this analysis because their per capita consumption of fruit is relatively small.[8][9]

In applying single equation multiple regression analysis it must be decided whether prices or quantity should be considered as endogenously determined. In this study the quantity of bananas consumed was considered as endogenously determined.[10] According to Saturnino[11] "... this implies no contradiction with the theory developed by Cournot and Marshall and the estimation procedures more usually followed". Cochrane and Tomek.[12] also state that the issue of which variable to consider as endogenous has not been settled fully. They indicated that in general "better" results are obtained by using quantity as the dependent variable. The Banana Board does not fix the retail price of bananas for the Rand/Pretoria market, but only recommends a consumer price.* The inflexibility of trade margins as well as the Board's preference for stable prices, can be stated as reasons why retail prices were not considered as a dependent variable for this market.

The system of residual marketing** to the Cape Town market implies that the quantity of bananas distributed to Cape Town will be independent of the price (both current and expected market prices). In order to compare the results directly it was decided to consider the quantity of bananas consumed per capita as the dependent variable for both markets.[13]

Only eight different kinds of fruit that were considered most likely to influence the demand for bananas were included. The value of these fruit together with the value of bananas amounted to 80 per cent of the total value of all fruit sold on the nine most important fresh produce markets.

Notwithstanding the fact that bananas, in contrast to other kinds of fruit, are available throughout the year, the quantity available does vary between "seasons". In the case of bananas approximately three seasons of four months each can be identified, namely August to November, December to March and April to July.[14] Use was made of two dummy variables, D_1 and D_2, to test whether the seasonal influences were significantly different from each other.

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* The Board's price policy has since been changed.

** By residual marketing is meant that only the bananas that cannot be accommodated by the Rand/Pretoria market is shipped to the Cape Town market.

3. RESULTS

The results obtained by fitting equation 1 on the data in both markets over the whole period (144 observations) are indicated in Table 1.

In both markets the coefficients associated with price (X_2) were statistically significant and its negative signs were, as expected, according to the law of demand. In the case of the Cape Town market the coefficients associated with income (X_3; $p=0,01$) and other fruit (X_4; $p=0,001$) were also significant. This is in contrast with the Rand/Pretoria market where income as well as other fruit do not seem to influence the consumption of bananas to any significant degree. Of the seasonal effects as tested by the dummy variables (D_1 and D_2) only D_1 was positive and significant in both markets. This indicates that the demand for bananas from August to November is significantly higher than in period III (April to July) that was chosen as base year. The low D.W. values of 1,039 and 1,361 obtained in the Rand/Pretoria and Cape Town markets respectively were lower than the lower critical value of this test statistic and therefore indicated significant auto-correlation. This resulted in a downward bias in the standard error of the regression coefficients and therefore overestimating the levels of significance of the regression coefficients.[15]

This problem of significant auto-correlation reappeared when equation 2 was fitted for the respective markets over the whole period. In this case, however, the problem was overcome by using the by now familiar method suggested by Johnston.[16] The regression coefficients obtained according to equation 2 after the data was transformed to get rid of auto-correlation appear in Table 2.

The significant F values obtained indicate that in the case of both markets the data verified the model. Because of the introduction of the availability of some other fruits separately into equation 2 the coefficient of determination declined markedly. The size as well as the significance of the coefficients associated with the price and income variables were similar to that reported in Table 1. In general the significance levels of the coefficients associated with other fruit varied. Only the more significant fruit variables appear in Table 2.

Because of the seasonality of the different kinds of fruit and the fact that fruit such as peaches, grapes and mangos are only available during certain times of the year a third approach was taken. This approach amounted to separate regressions fitted for the three seasons defined earlier[17] and is presented in Table 3.

In the case of both markets and all three seasons the data seem to verify the stated model. In the case of period II for the Rand/Pretoria auto-correlation was again prevalent as is evident from regression 3 and the data had to be transformed again and this result is presented in regression 4. In all cases between 50 and 77 per

TABLE 1 - Regression results obtained by fitting equation I for Rand/Pretoria and Cape Town, 1959/60 to 1970/71

Variable	Rand/Pretoria		Cape Town	
	Coefficient	t value*	Coefficient	t value
X_2 (price)	— 0,37911	—15,16***	— 0,38617	—12,47***
X_3 (real income)	0,00034	0,51	0,00142	2,73**
X_4 (other fruit)	0,006447	0,33	— 0,16380	— 3,59***
D_1 (dummy variable, period I)	0,52518	7,24***	0,37603	4,06***
D_2 (dummy variable, period II)	0,04957	0,68	0,00955	0,11
Intercept (a)	4,70116		4,38465	
$\bar{R}^2$ (corrected coefficient of determination)	0,6964		0,5936	
F value	65,92***		42,23***	
D.W.	1,039		1,361	

* The levels of significance according to the one-tail t test are : p=0,001=***; p=0,01=** en p=0,05=*, respectively.

TABLE 2 - Regression results obtained by fitting equation 2 for the period 1959/60 to 1970/71

Variable	Rand/Pretoria		Cape Town	
	Coefficient	t value*	Coefficient	t value
X_2 (price)	— 0,26983	—7,40***	— 0,28699	—8,20***
X_3 (real income)	—	—	0,002278	2,88**
X_5 (apples)	—	—	— 0,22435	—1,82 (a)
X_6 (pears)	— 0,45664	—2,06*	— 0,40934	—2,13*
X_9 (oranges)	— 0,05467	—1,47 (b)	— 0,10796	—2,08*
X_{11} (pineapples)	0,41073	1,82	0,63108	1,84 (a)
X_{12} (paw-paws)	0,27202	3,19**	0,78073	3,06**
Intercept	2,198		1,58916	
$\bar{R}^2$	0,4187		0,4742	
F value	12,07***		11,90***	
D.W.	2,05		1,82	

* Levels of significance similar to that in Table I with the addition of p=0,10=a and p=0,20=b.

cent of the variation in the consumption of bananas was explained by the chosen demand model.

4. INTERPRETATION OF RESULTS

Price (X_2) In all the regression equations fitted the coefficients associated with the price variable were significantly different from zero.

The price elasticity of demand in the Rand/Pretoria and Cape Town markets over the period 1959/60 to 1970/71 has been estimated at the mean on —0,915 and —1,777 respectively. A one per cent decrease in the price of bananas on the Cape Town market would be associated with a 1,777 per cent increase in per capita consumption. The corresponding price elasticities for the different seasons are indicated in Table 4.

* It must be emphasized that these observations are valid only for the period under discussion. The present situation with regard to the marketing of bananas was not investigated. It would however be relatively simple to bring this study up to date.

In Table 4 it can be seen that the price elasticity of the demand for bananas on the Cape Town market is relatively elastic. It is in fact about twice as elastic as that of the Rand/Pretoria market. On the Rand/Pretoria market the price elasticity varied around —1,0. Since we used linear demand functions these results seem to indicate ceteris paribus that the per capita supply of bananas to the Rand/Pretoria market is about optimal. Any increase or decrease in the per capita supply to this market will lead to a decline in the total income obtained in this market. The rate of growth in supply to this market must therefore roughly keep pace with the population growth in this market area.* This conclusion must be qualified somewhat if consideration is given to the steady shift to the right in the demand function due to the growth in income as indicated by the income variable. The supply of bananas to the Cape Town market could on the basis of its relatively high price elasticity still be increased. It also seems that some improvement can be obtained in total income and can be realised if some reallocation of bananas is made from the Rand/Pretoria market to the

TABLE 4 - Seasonal price elasticities of demand for bananas, 1959/60 to 1970/71

Season	Rand and Pretoria			Cape Town		
	Average price elasticity of demand	Significance interval Highest	Lowest	Average price elasticity of demand	Significance interval Highest	Lowest
Aug to Nov	—1,1754	—1,4440	—0,9069	—2,5048	—3,0847	—1,9246
Dec to March	—1,0431	—1,3782	—0,7081	—2,1131	—2,8003	—1,4260
April to July	—1,4754	—1,8495	—1,1013	—2,3723	—2,9870	—1,7577

TABLE 3 - Regression results obtained for the Rand/Pretoria and Cape Town markets according to season over the period 1959/60 to 1970/71 (equation 1 : N = 48)

Season	Market and regression	Variables	X_2 Price/kg	X_3 Income	X_5 Apples	X_6 Pears	X_7 Peaches	X_8 Grapes	X_9 Oranges	X_{10} Mangos	X_{11} Pineapple	X_{12} Pawpaws	Intercept	$\bar{R}^2$	F value	D.W.
I August to November	Rand/ Pretoria (1)	Coefficients	-0,39603	0,002395	-0,14449	-0,76105	–	–	-0,09131	–	0,86222	0,15997	4,61500	0,7643	25,6095***	1,379
		Standard error	(0,04479)	(0,001104)	(0,08613)	(0,34545)	–	–	(0,05795)	–	(0,27682)	(0,10309)				
		t value	-8,98440***	2,1695*	2,6775[b]	-2,22031*	–	–	-1,7976[a]	–	3,12090*	1,55775[b]				
	Cape Town (2)	Coefficients	-0,48845	0,002927	-0,31353	–	–	–	-0,25284	–	–	0,79248	4,76993	0,7022	22,4357***	1,597
		Standard error	(0,05601)	(0,000921)	(0,23526)	–	–	–	(0,12586)	–	–	(0,33527)				
		t value	-8,7209***	3,1790**	-1,3327[b]	–	–	–	-2,0089*	–	–	2,3637*				
II December to March	Rand/ Pretoria (3)	Coefficients	-0,32596	–	–	–	–	–	-0,31678	–	0,71447	0,77226	4,40769	0,7336	29,6072***	1,277
		Standard error	(0,034867)	–	–	–	–	–	(0,095972)	–	(0,27535)	(0,18183)				
		t value	-9,3486***	–	–	–	–	–	-3,3008**	–	2,5947*	4,2473***				
	Rand/ Pretoria (4)	Coefficients	-0,32067	–	–	–	–	–	-0,14887	–	0,70388	0,65638	2,52597	0,4846	14,69667***	1,442
		Standard error	(0,05099)	–	–	–	–	–	(0,08809)	–	(0,31354)	(0,311249)				
		t value	-6,2889***	–	–	–	–	–	-1,6899[a]	–	2,2450*	2,1103*				
	Cape Town (5)	Coefficients	-0,36317	–	–	–	–	–	0,39962	0,59086	0,93571	–	3,14515	0,6110	18,7788***	1,589
		Standard error	(0,05846)	–	–	–	–	–	(0,17304)	(0,28148)	(0,46627)	–				
		t value	-6,3887***	–	–	–	–	–	2,3095*	2,0991*	2,0068*	–				
III April to July	Rand/ Pretoria (6)	Coefficients	-0,35122	0,004678	-0,21540	–	–	0,78393	0,09975	–	0,83809	–	2,70879	0,6832	17,30099***	2,069
		Standard error	(0,04409)	(0,00206)	(0,12831)	–	–	(0,31684)	(0,05046)	–	(0,46240)	–				
		t value	-7,9647***	2,2662*	-1,6788[b]	–	–	2,4742*	1,9767[a]	–	1,8125[a]	–				
	Cape Town (7)	Coefficients	-0,28198	0,00106	-0,30478	–	–	0,27049	–	–	–	–	3,13716	0,5963	17,3178***	1,678
		Standard error	(0,03617)	(0,00600)	(0,19778)	–	–	(0,11249)	–	–	–	–				
		t value	-7,7953***	1,76641[a]	-1,5410[b]	–	–	2,4046*	–	–	–	–				

Levels of significance: p = 0,001 = ***; p = 0,01 = **; p = 0,05 = *; p = 0,10 = a; and p = 0,20 = b

Cape Town market. Further analyses would however be necessary especially with respect to the supply side of the market and specifically in the Cape Town market. Transport cost, the perishability of bananas and other cost factors may play an important role.

Income (X_3) The coefficient associated with income over the period as a whole was only significant in the case of the Cape Town market. With the exception of the period December to March the coefficient associated with income in the seasonal regressions was positive and statistically significant. The calculated income elasticity coefficients are presented in Table 5.

TABLE 5 - Income elasticities of the demand for bananas, 1959/60 to 1970/71

Season	Rand and Pretoria	Cape Town
I (Aug to Nov)	0,342	0,59
II (Dec to March)	*	*
III (April to July)	0,733	0,343
Whole period 1959/60 to 1970/71	*	0,562

* Income coefficient not significant

Although the results obtained as far as income elasticities of bananas are concerned are somewhat mixed it does seem to indicate that the demand for bananas does shift to the right due to an increase in income over time.

Other fruit ($X_5 \ldots X_{12}$) The availability of other fruit as well as its price could have a significant bearing on the quantity consumed as well as prices realised for bananas. In order to analyse the influence of this factor variables X_5 to X_{12} were included in the demand equations.

In Table 2 it can be seen that the increase in the availability of pears and oranges on the Rand/Pretoria market and apples, pears and oranges on the Cape Town market was associated with a decrease in the per capita consumption of bananas. This implies that these fruits are substitutes for bananas. The positive signs associated with the coefficients of pineapples and pawpaws indicate that these two are complements to bananas.

The results for the Rand/Pretoria market as presented in Table 3 indicate that during period I apples, pears and oranges, during period II oranges and during period III apples are substitutes for bananas. During period I for instance a one per cent decrease in the per capita availability of apples, pears and oranges is associated with a 0,14 per cent, 0,76 per cent and 0,09 per cent increase in the per capita consumption of bananas respectively.

The availability of pineapples and pawpaws is complementary to the consumption of bananas in all the periods. In period I a one per cent increase in the per capita availability of pineapples was associated with a 0,86 per cent increase in the consumption of bananas.

In the case of the Cape Town market it was established that during period II apples and oranges and during period III only apples can be considered as substitutes for bananas. During period II oranges, mangos and pineapples and during period III grapes can be seen as complementary to bananas. During periods I and II pawpaws can be considered as complementary to bananas.

Judged on the basis of results obtained here it seems as if effects of substitutes as well as complementary fruits for bananas are not very strong. This observation is based on the lower level of significance associated with the various coefficients and also the fact that the absolute sizes of the coefficients are relatively small.

This deduction corresponds with other studies. Houck[18] for instance concludes that "The competitive relationship with other fruit does not seem as strong as one might think, but other data indicate that it may be increasing over time." Some researchers,[19] however, question the validity of this kind of model for the quantification of relations between variables. In this respect Fox[20] states "If the number of significant coefficients obtained is any criterion, short-run competition and substitution among foods are limited".

5. CONCLUSION

It seems that the price elasticity of the demand for bananas on the Cape Town market is relatively elastic. On the Rand/Pretoria market the corresponding elasticity is somewhat lower. It was also found that income as expressed through income-elasticity coefficients has an influence on the consumption levels of bananas. It seems furthermore that the consumption of bananas was not significantly influenced by the availability of other kinds of fruit.

As was briefly indicated in the previous section the results obtained in this study can serve as a starting point in the strategy development of a marketing policy for bananas.

REFERENCES

1. DU TOIT, J.P.F. (1973). *'n Statistiese evaluering van bemarkingstrategie in die piesangbedryf.* D.Sc.(Agric.) thesis, University of Pretoria, pp. 17—18.
2. KOTLER, P. (1967). *Marketing management: analysis, planning and control.* Prentice-Hall, Inc. Englewood Cliffs, New Jersey, p. 161.
3. VAN DEN BOGAERDE, F. (1974). *Elements of micro-economics.* J.L. van Schaik, Pretoria, p. 44.
4. Unpublished records of the Banana Board.
5. *Crops and Markets,* Department of Agricultural Economics and Marketing. Government Printer, Pretoria.
6. *Annual reports of the Department of Inland Revenue* for the years 1959/60 (RP20/61), 1961/62 (RP52/63), 1963/65 (RP 50/66), 1966/67 (RP76/68), Government Printer, Pretoria.

7. *Statistics on Fresh Produce Markets*. Reports 1 to 8, Division of Agricultural Marketing Research, Department of Agricultural Economics and Marketing, Government Printer, Pretoria.
8. Bureau of Market Research (1965). *Market potentials of Bantu living in Pretoria, the Witwatersrand and Vaal Triangle*. Research Report 21, UNISA, Pretoria.
9. DU TOIT, J.P.F., *op cit.*, pp. 77—79.
10. FOX, K.A. (1953). The analysis of demand for farm products. *Technical Bulletin No. 1081*, USDA, Washington D.C., pp. 11—14.
11. SATURNINO, L.E. (1970). *Effects of the European Economic Community agricultural policies on Argentine export of beef*. Unpublished Ph.D. thesis, Michigan State University, p. 75.
12. TOMEK, W.G. and COCHRANE, W.W. (1962). Long-run demand: A concept and elasticity estimates for meats. *Journal of Farm Economics*, Vol. XLIV (3), pp 721—722.
13. A more complete discussion appears in Du Toit, J.P.F., *op cit.*, pp. 82—84.
14. DU TOIT, J.P.F., *op cit.*, pp. 86—92.
15. *Ibid.*, pp. 104—107 and 124—126.
16. JOHNSTON, J. (1965). *Econometric methods*. McGraw-Hill Book Co., New York, p. 194.
17. DU TOIT, J.P.F., *op cit.*, pp. 112—113.
18. HOUCK, J.P. (1964). The US demand for bananas — A neglected topic. *Journal of Farm Economics*, Vol. 38, p. 1329.
19. ROBERTS, I.M. and CUTHBERTSON, A.G. (1972). The market for Australian apples in the United Kingdom. *Quarterly Review of Agricultural Economics*, Vol. 25, p. 132.
20. FOX, K.A., *op cit.*, p. 28.