Measuring the determinants of pork consumption in Bloemfontein, Central South Africa

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Abstract

The main objective of this study is to investigate the determinants of households' pork consumption using a logistic regression procedure. The model was initially fitted with ten variables, selected from factors identified by precious studies, that affect meat consumption in South Africa. Six of these variables were found to be significant at the 10 per cent significance level and all had the expected signs. These include household monthly income, current household monthly expenditure on meat, relative price of pork, preference for value-added pork products, price of substitutes (the most preferred household meat type), and response of household to change in pork quality. The result obtained was further analyzed to compute partial effects and to conduct simulations for significant factors. Analysis of partial effects revealed that quality assurance and value-adding lead to much greater probability of pork consumption by households. Simulations conducted on the base category of pork-consuming households revealed that quality assurance and value-adding have relatively high potential to almost double and more than double household pork consumption respectively.

1. Introduction

In 2003, the primary pig sub-sector contributed 4.63 per cent to the gross value of livestock production (R26 925 308 000) in South Africa, while sheep and goats, and cattle contributed 5.99 and 21.3 per cent respectively (NDA, 2005). According to Eskort (2005) the pork processing industry is estimated to be worth in excess of R900 million rand per annum.

South Africa slaughters around 1.7 million pigs per annum; this accounts for less than 0.2 per cent of world pork production. South African pork exports to other African nations, the Far East and the European Union reached 0.35 tonnes in 2004, while over 20,000 tonnes of pork were imported in the same year, with ribs constituting close to 60 per cent of imports (SAMIC, 2005).

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In 1970 pork was the second-most consumed meat in the world after beef. However, in 1980 pork overtook beef as the most consumed meat. Pork's share of world consumption of meat increased from 34.6 per cent in 1970 to 43.4 per cent in 2003 (Barnard, 2005). Pork consumption is on average 15 kg per capita (NPPC, 2004). Per capita consumption of pork in South Africa, on the other hand, is relatively low and has shown a decreasing trend since the early 1970s, from 3.5 kg per capita to 2.7 kg per capita currently (NDA, 2005). A concern in this regard is that (i) the real price of pork has experienced a declining trend since the early 1970s, (ii) real prices of substitutes have declined over the same time and (iii) real income per capita, although moving sideways for most of the period since the early 1970s to the early 1990's, has increased since the early 1990s; given this one would expect pork per capita consumption to increase, but it has not.

A question that arises is whether economic factors are still the only factors that determine the consumption of pork in South Africa. In this regard it is important to take note of the work of Bansback (1995), Huston (1999) and Dickinson *et al* (2003), who showed that non-economic factors (i.e. non price/income factors) are becoming more important in determining consumers' purchasing decisions. For example, in a study by Bansback (1995) on the demand for meat in the EU, he showed that, for the period 1955 to 1979, price and income factors accounted for a higher proportion of the explanation of changes in meat consumption than the period 1975 to 1994[2]. Huston (1999) argues that, by focusing only on product consistency and quality, food safety, health and nutrition concerns and convenience, since 1998 the US beef industry was able to stabilize beef demand. Dickinson *et al* (2003) concludes that many, but not all, Canadian and American consumers would be willing to pay for red-meat traceability, transparency, and enhanced quality assurances in red-meat products.

The objective of this study is to examine whether economic factors alone are still the main drivers of pork consumption among households in central South Africa.

2. Survey procedure

Due to cost constraints, this study covered a limited geographical area (randomly selected households within the Bloemfontein area in South Africa). There is however a high degree of similarity between the racial composition and income distribution of South African households in general and that of the

[2] *See Appendix A ,Table A1 for the result obtained by Bansback (1995).*

Free State in particular (see Appendix A, Tables A.2 and A.3). The meat preferences and pork consumption survey was carried out by personal interviews with meat shoppers representing 333 households.

Table 1 shows the preferences of households for pork products in the survey area by race and product preference. While whites consume the most pork products, the percentage of blacks who consume high-value pork is close to that of whites. Asians consume the least amount of pork products, which could most probably be traced back to religious beliefs.

Table 1: Household preferences for pork products

Race	Fresh meat	Value-added product	Pre-prepared pork foods
Blacks	48.4%	70%	46.2%
Whites	76.9%	78%	57.1%
Coloureds	53.8%	48%	35%
Asians	25%	37.5%	25%

Source: Authors' computation based on survey data.

3. Methodology

3.1 Description of variables

Ten explanatory variables identified by previous studies (as reported by Visser, 2004) as the major determinants of meat (pork) consumption in South Africa were initially used in this study. These include four continuous variables (income, relative price of pork, price of other meat types, and expenditure on meat) while six are discrete variables (race, gender, religion, quality, place of purchase and value adding). Six were found to be significant and all had the expected signs. The significant variables include household monthly income, relative price of pork, current household monthly expenditure on meat, preference for value-added pork products, price of substitutes (the most preferred household meat type) and pork quality. The result obtained was further analyzed to compute partial effects and to conduct simulation analysis on significant variables.

Two further aspects need mention, i.e.:

- In this study pork consumers are aggregated. The aggregation of all pork consumers is motivated by the study conducted by McGuigan and Nieuwoudt (2002), which projected that pork consumption between

high and low income groups of the South African population is closely related (which is highly correlated with racial composition).

- Resurreccion (2003) regards visible pork fat as the strongest visual cue for consumers considering the purchase of meat at the retail level. This study therefore considers appearance and health as the dimensions of quality affecting purchase motives of consumers.

3.2 The model

This study uses similar theoretical and methodological approaches as used by Kinnucan *et al* (1993) (cited in Hanson *et al,* 1995) and Gempesaw *et al* (1995) who analyzed consumer preferences and household choices of food products.

Households derive utility from food consumption; hence they make decisions regarding food choices on the basis of a set of perception characteristics that translate to preferences. The model used in this study to determine factors affecting household choice of pork consumption is given below.

$$\phi_i = E(y_i = 1/X_i) = \frac{1}{1+e^{-(\beta_1 + \sum_j^k \beta_{ij} x_{ij})}} \quad (1)$$

Where: ϕ_i stands for the probability that household ***i*** consumes pork, y_i is the observed pork consumption status of household ***i***, x_{ij} are factors determining household pork consumption ***i***, and β_j stands for parameters to be estimated. Denoting $\beta + \sum_{j=1}^{k=n} \beta ij$ as Z, equation 1 can be written to give the probability of pork consumption of household ***i*** as:

$$\phi_i = E(y_i = 1/X_i) = \frac{1}{1+e^{-Z_i}} \quad (2)$$

Given equation 2, the probability that a household will not consume pork can be written as (1-ϕ_i). This is expressed in equation 3 as follows:

$$(1-\phi_i) = \frac{1}{1+e^{z_i}} \quad (3)$$

From the two equations above, the odds ratio, i.e., ϕ_i / (1-ϕ_i), is given by equation 4 as

$$\left(\frac{\phi_i}{1-\phi_i}\right) = \frac{1+e^{z_i}}{1+e^{-z_i}} = e^{z_i} \tag{4}$$

The natural logarithm of the odds ratio in equation 4 gives rise to equation 5

$$Ln\left(\frac{\phi_i}{1-\phi_i}\right) = \beta + \sum_{j=1}^{k=n} \beta ij + \varepsilon_i \tag{5}$$

Rearranging equation 5, with the dependent variable (pork consumption) in log odds, the logistic regression can be manipulated to calculate conditional probabilities as

$$\phi_i = \frac{e^{\left(\overline{\beta_o} + \sum_{i=1}^{k=n} \overline{\beta_j} x_{ij}\right)}}{1+e^{\left(\overline{\beta_o} + \sum_{j=1}^{k=n} \overline{\beta_j} xij\right)}} \tag{6}$$

Once the conditional probabilities have been calculated for each sample household, the "partial" effects of the continuous individual variables on household pork consumption can be calculated by the expression:

$$\frac{\partial \phi_i}{\partial x_{ij}} = \phi_i(1-\phi_i)\beta_j \tag{7}$$

The "partial" effects of the discrete variables are calculated by taking the difference of the probabilities estimated when value of the variable is set to 1 and 0 ($x_i = 0, x_i = 1$), respectively.

4. Results

4.1 Descriptive results[3]

This section reports the descriptive results of the relationship between pork consumption and the major determinants (significant variables) of pork consumption. Table 2 shows that average income, monthly expenditure on meat and price of substitutes for pork-consuming households are higher than for non-pork-consuming households. Furthermore, the percentage of households who regard quality assurance as the determining factor for pork

[3] *Only the descriptive statistics of the significant determinants are reported in this section. Results of non-significant factors can be provided upon request.*

consumption is higher for non-pork consumers than for pork consumers. More pork-consuming households show a preference for value-added products than non-pork-consuming households. The relative price of pork is lower for pork-consuming households than for non-pork-consuming households, i.e. non-pork consuming household regard pork as being more expensive than the meat they usually consume. The results confirm the findings of previous surveys (as discussed in Visser, 2004) regarding the relationship between pork consumption and the major determinants of pork consumption examined in this study.

Table 2: Household pork consumption rates for significant variables

Variable	Pork consumer	Non-pork consumer
Income (R)	9678.29	3492.11
Monthly expenditure on meat (R)	616.54	257.25
Value-adding (%)	0.56	0.24
Price of substitute (R)	24.05	13.82
Relative price of pork (unit)	0.96	1.01
Quality (%)	0.46	0.83

Note: Pork consumers are regarded as those consumers who consume fresh, value added and pre-prepared pork foods. Non-pork consumers are regarded as those consumers who do not consume pork at all or who indicated that they would purchase other types of meat before they would purchase pork.

Source: Authors' computation based on survey data.

4.2 Empirical results - determinants of household pork consumption

Table 3 shows the results of the test of significance of the determinants of pork consumption examined in this study and the predictive efficiency of the model. Two variables, namely price of substitute and value adding, were found to be significant at the 1 per cent probability level. Income, quality and the relative price of pork were significant at the 5 per cent probability level, while expenditure was significant at the 10 per cent probability level.

In addition, the LR statistic value[4] of 117.26, with $p<0.001$ indicates the overall significance of the model. The result shows that all the parameters of the determinants of pork consumption shown in equation 1 are jointly significant. Also, the predictability efficiency of the model is 76.3 per cent.

[4] *Calculated on the basis of the formula LR=2(ULLF-RLLF) where ULLF and RLLF are, respectively, unrestricted log-likelihood function and restricted log-likelihood function. It is chi-square distributed with 6 degrees of freedom.*

Table 3: Parameter estimates of the logistic regression

Variable	Coefficient	Standard error	Z-statistic	Probabilities
Constant	-1.087924	0.447917	-2.428854	0.0151**
Price of substitute	0.046843	0.017020	2.752277	0.0059*
Income	0.000158	6.81E-05	2.316510	0.0205**
Expenditure	0.001713	0.001029	1.663800	0.0962***
Value adding	1.725280	0.352074	4.900336	0.0000*
Quality	0.700903	0.337475	2.076903	0.0378**
Relative price of pork	-1.048767	0.428097	-2.449834	0.0143**
Percentage of correct prediction	0.763			
LR statistic	117.2635			<0.001

*Significant at the 1% level; **significant at the 5% level; and ***significant at the 10% level.

Source: Authors' computation based on survey data.

4.3 Parameter estimates of determinants of pork consumption

The marginal effects of a unit change in the continuous variables, computed at sample means, on the probability of pork consumption were estimated. Tables 4 and 5 give results of partial effects of continuous and discrete variables, respectively. According to Table 4, the marginal effect of a unit change in the price of substitutes, computed at the sample mean of price of substitutes, is 0.01. This means that the probability of pork consumption increases by 0.01 (1%) for a one rand increase in the price of substitutes. The probability of pork consumption for a rand increase in both monthly income and expenditure (computed at their sample means) are however less than 1 per cent. The relative price relationship of pork with other types of meat appears to be a much stronger determinant of pork consumption, i.e. the probability of pork consumption decreases by 21 per cent for a unit increase in the relative price of pork.

Table 4: Partial effects for continuous determinants

Determinant	Partial effect
Price of substitute	0.01
Income	0.00003
Expenditure	0.0004
Relative price	-0.21

Source: Authors' computation based on survey data.

Table 5 shows that adding value to pork increases the probability of a household consuming pork from 0.22 to 0.43, i.e. by 21%. In addition,

household response to quality satisfaction yields an increase in the probability of consuming pork by 2% (i.e. from 0.155 to 0.175).

Table 5: Change in probabilities between X=0 and X=1 for discrete determinants

Determinants	Probabilities	Change in probabilities
Value		
Non value-added pork	0.22141	0.21
Value-added pork	0.43132	
Quality		
Other-factor	0.15535	0.02
Quality-factor	0.17523	

Note: other factor is mostly price.

Source: Authors' computation based on survey data.

Simulations were conducted with reference to a base group of households representing non-pork-consuming households. The results are reported in Table 6. The base group represents non-pork-consuming households with an average monthly income of R3,492.11 and monthly expenditure on meat of R257.25. The base group of households also pays an average of R13.82 for their choice meat per kg and a relative price of 1.01 for pork. In addition, the dummy variables for value adding and quality were set to zero.

Table 6: Simulated impact of determinants on the probability of household pork consumption

Variable	Predicted probability
Base	0.38
Monthly income increased by R500	0.40
Monthly expenditure on meat increased by R35	0.39
Average price of substitutes increased R2.5 per kg	0.40
Relative price of pork increased by one unit	0.17
If value is added	0.77
If pork quality is assured	0.55

Source: Authors' computation based on survey data.

According to Table 6, the conditional probability of pork consumption for the base group of households is 0.38. This means that, of 100 meat-consuming households, 38 consume pork. However, if a group of households with characteristics similar to that of the base group of households is assured of pork quality, the number of pork-consuming households will increase to 55. Adding value to the pork consumed by the base group of households will

increase the number of pork-consuming households to 77. Table 6 shows further that neither an increase of R500 in income, a R2.5 per kg increase in the price of a substitute, nor a R35 increase in expenditure on meat results in a substantial increase in the number of households that consume pork. However, if the relative price of pork increases by one unit (i.e. a substantial price gap between pork and substitutes) the number of pork-consuming households will reduce.

5. Conclusion

The analysis shows that non-economic factors are becoming increasingly more important when consumers have to make purchasing decisions regarding pork. This corresponds with trends internationally. The analysis furthermore shows that the price of pork relative to other types of meat remains important. Note should however be taken that a unit change in the relative price is very unlikely, since pork meat prices, as well as that of other meats, tend to more or less follow that of beef (Van Heerden *et al*, 1989).

The results of this study may have important implications for the South African pork industry, especially if also considering the findings by Nieuwoudt (1998) who estimated future demand for meat in South Africa based on economic factors, and concluded that the demand for pork in South Africa is unlikely to increase at the same rate as other meats over the next 15 years.

Firstly, it is imperative that the pig/pork industry, especially at primary level, undergo a substantial paradigm shift to move closer to the end consumer of pork in an effort to better understand changing consumer preferences and, through this, make the required changes to stimulate and grow pork consumption. In addition, it would allow primary producers, as well as other role players to capture greater value from consumers' spending on meat. Relationship management will form the essence of moving closer to end consumers of pork and pork products. Relationship management entails that producers change their strategic position from an arms-length relationship with clients focused on product exchange, to one of partnering (Goldsmith and Gow, 2001). This would allow role players, especially producers and processors, to integrate themselves into the supply chain without the managerial burden of vertical integration. Closer collaboration also creates the scale to enable dedicated or sourced expertise to bridge the gap between production competencies and supplier needs, as well as releasing the capital to invest in service related assets, like product research (Goldsmith and Gow, 2001).

Secondly (and related to the previous remark), product research and innovation should be a second core imperative in the South African pork industry. Moreover, determination of consumer needs and adapting to meet these needs is vital for the long-term sustainability and profitability of the pork industry in South Africa. Grunert *et al* (2004) argue that the level of correlation between quality expectation and experienced quality determines, to a great extent, the predictability of the purchase decision by consumers. Therefore the challenge facing producers/processors of pork and pork products in South Africa is ensuring that the end product meets high quality expectations as well as consumers' experienced quality demands.

Thirdly, communicating the various quality attributes of pork and pork products to consumers should receive increasing attention. Promotional activities focusing only on economic factors will only provide part of the required incentive for consumers to purchase more pork and pork products, and may be short lived. International experience in Australia and the US (Barnard, 2005; Huston, 1999) has clearly shown the value of (primarily) focusing on the non-economic attributes of red meat in recent years to turn around the downward trend in red meat per capita consumption.

Within the framework of this paper, areas of further research include investigation of consumers' willingness to pay for specific non-economic attributes of pork and pork products and the geographical characteristics associated with this.

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Appendix A

Table A1: Importance of economic and non-economic factors in meat demand

Product	1955 – 1979		1975 - 1994	
	Economic	Non-Economic	Economic	Non-Economic
	Percentage			
Beef	95	5	68	32
Pork	98	2	55	45
Sheep meat	84	16	58	42

Source: Bansback, 1995.

Table A2: South Africa's population by province and racial composition[5]

Province	African (%)	Coloured (%)	Indian (%)	White (%)
Western Cape	17.28	57.92	1.99	22.81
Eastern Cape	81.04	12.33	0.38	6.24
Northern Cape	30.05	50.31	0.56	19.07
Free State	**79.15**	**7.39**	**0**	**13.46**
KwaZulu-Natal	79.08	3.25	10.29	7.38
North-West	83.75	5.26	1.92	9.07
Gauteng	56.47	9.67	6.83	27.03
Mpumalanga	86.69	1.99	1.45	9.86
Limpopo	94.4	0.7	0.26	4.64
National	**71.77**	**13.27**	**3.27**	**11.69**

Source: Rantho, 2003.

Table A3: Co-efficient of income distribution by province and race, 2003

Province	African	Coloured	Indian	White
Eastern Cape	0.63	0.55	0.48	0.47
Free State	**0.60**	**0.56**	**0.52**	**0.49**
Gauteng	0.60	0.52	0.46	0.42
KwaZulu-Natal	0.62	0.52	0.51	0.45
Limpopo	0.63	0.59	0.48	0.47
Mpumalanga	0.61	0.56	0.52	0.46
North-West	0.57	0.55	0.50	0.48
Northern Cape	0.61	0.58	0.51	0.48
Western Cape	0.60	0.52	0.48	0.46
South Africa	**0.62**	**0.55**	**0.51**	**0.46**

Source: Kane-Berman, 2004.

[5] *The report itself refers to the fact that although the 1996 Census show that Asians/Indians reside in the Free State, the OHS/IES survey failed to capture them due to small sample size.*