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The Development and Promotion of Environmentally Sustainable Food Products in South Africa

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ABSTRACT

The purpose of this paper was to estimate consumers' preferences for environmentally sustainable beef products, with the aim of developing and promoting environmentally sustainable products in South Africa. The findings reveal that there is profound preference heterogeneity at segment level for environmentally sustainable beef products. Three distinct consumer segments were identified. We demonstrate that socioeconomic factors, public awareness creation and campaigns on threats posed by climate changes, subjective and objective knowledge on environmental sustainability significantly explain consumers' choice of environmentally sustainable beef products. Furthermore, it is concluded that there are relevant segmental equity issues that need to be addressed when designing environmental sustainability policies to promote environmentally sustainable products. Finally, we demonstrate that there is a potential market for environmentally sustainable products in South Africa.

KEYWORDS: Carbon footprint; compensating surplus; sustainable products; water footprint; welfare implications

1. Introduction

Governments and policy-makers across the globe are increasingly getting interested in the development and implementation of environmental or ecological sustainability policies (IPCC, 2007). Carbon and water footprint sustainability assessment in particular is gaining particular attention, as some industries, agribusinesses and governments rely on these sustainability indicators to evaluate their environmental and water-related risks and impacts. The food and agricultural sector is one of the sectors where carbon and water footprint assessment is gaining much prominence as a result of the association between production and consumption of agricultural food products and the effects of these activities on water resources and the environment (IPCC, 2007). For instance, food and agricultural production utilizes about 86% of the global fresh water (IWMI, 2007). In terms of carbon emissions, the agricultural sector in general accounts for about 30-35% of the global greenhouse gas emissions (Foley *et al*., 2011).

Given the significant impacts that the food and agricultural sector have on the environment and water resources, stakeholders and policy-makers in recent years are keen on coming out with policies and strategies aimed at changing producers and consumers sustainability behaviour.

The Carbon Tax Policy Paper of the South Africa outlines ways of dealing with environmental challenges such as water scarcity, water pollution and climate change as a whole (National Treasury, 2013). One of the key initiatives under this policy is the introduction of carbon pricing. Carbon pricing initiative is expected to motivate producers to change their production patterns to a more sustainable one, through the adoption of innovative technologies with minimal environmental effects (National Treasury, 2013). The introduction of the carbon tax and pricing policy is expected to have

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significant impact on prices of food products, with low footprint products expected to have high prices because of the cost associated with the investment in minimal carbon emission technologies. The cost incurred is either transferred to the consumer or bear by the producer, or shared by both. This implies that the introduction of the environmental policy has significant economic implications on the welfare of consumers (Kearney, 2008). The policy requires food producers, agribusinesses and companies to make their sustainability information available through labelling. Carbon labelling has received some attention in the food and agricultural industry in South Africa.

Currently, the Water Research Commission has also directed their attention to water footprint assessment; particularly in the agricultural sector because the sector has been identified as a major user of the scarce water resource in South Africa (Department of Water Affairs, 2013). Therefore, the commission and concerned food companies seek to rely on sustainability campaigns and awareness creation through footprint labelling as a possible marketing strategy for marketing environmentally sustainable food products.

Consumer preferences for environmental environmentally sustainable food products have received some attention in recent literature (Grebitus *et al*., 2015: 2016; Peschel *et al*., 2016). Additionally, an assessment of carbon footprint labelling in respect of exports of agricultural product (Edwards-Jones *et al*., 2009) and legal issues concerning carbon labelling (Cohen and Vandenbergh, 2012) have been explored. However, the growing body of literature has focused consumer preferences (Grebitus *et al*., 2015: 2016; Peschel *et al*., 2016; Shumacher, 2010), trading (Edwards-Jones *et al*., 2009) and labelling issues (Cohen and Vandenbergh, 2012; van Loo *et al*., 2015). None of these studies have considered the development and promotion of environmentally sustainable product through consumers' preferences and choices of footprint labelled products. Additionally, these studies have focussed only on developed countries, with little or no study in arid and semi-arid African countries, including South Africa. Therefore, current knowledge on the impact of consumers' behaviour and choices on the development of environmentally sustainable products marketing.

The present paper fills this gap in literature and contributes to previous works (Grebitus *et al*., 2016; Peschel *et al*., 2016; Shumacher (2010) by estimating preferences and willingness to pay for water and carbon footprint sustainability attributes in South Africa, with the aim of developing and promoting environmentally sustainable products. Findings from this study can provide evidence based policy scenarios for developing the food and agricultural sector, for improved policy-making and regulations towards environmentally sustainable food production, marketing and consumption.

2. Materials and Methods

2.1 Compensating surplus estimation approaches

The theory of how respondents choose between different discrete choice sets is modelled under the random utility theory which assumes respondents to be rational and preferring products that give them the highest utility (Hensher and Greene, 2003; McFadden, 1974). The underlying assumption of the random utility is that consumers in recent years tend to have heterogeneous preferences for sustainable product attributes (Grebitus *et al*., 2013; Grebitus *et al*., 2015). Hence, the latent class model is adopted to account for unobserved heterogeneity among different consumer segments.

Under the latent class modelling approach, consumers are assumed to be organised implicitly into a set of classes. The class to which a consumer belongs to, whether known or unknown, is unobserved by the analyst. Consumers within each class are presumed to homogeneous but vary across different classes (Wedel and Kamakura, 2000). The number of classes in the sampled respondents is determined by the data. Belonging to a specific latent class hinges on the consumer's observed personal, social, economic, perception, attitudinal and behavioural factors. Assuming that a rational consumer i belonging to class l obtain utility U from product option k, the random utility is specified as:

$$U_{ik/l} = \beta_l Z_{ik} + \ell_{ik/l} \tag{1}$$

where β_l denotes class specific vector of coefficient, Z_{ik} represents a vector of characteristics allied with each product option and the error term of each class is denoted by ℓ_{ikl}. The error term is assumed to be distributed independently and identically. The likelihood that product option k is chosen by consumer i in l class is specified as:

$$\Pr_{ik/l} = \frac{\exp(\beta_l Z_{ik})}{\sum_n \exp(\beta_l Z_{in})} \tag{2}$$

The probability that consumer i belongs to a particular class is denoted by P_{il} and defined by a probability function G. The likelihood that consumer i belongs to class l is represented by the function $G_{il}=\delta_l X_i+\varsigma_{il}$ where X_i denotes a vector of consumers' personal, social, economic and other relevant factors and ς_{il} represents the error term. The error term is assumed to be distributed independently and identically. The likelihood of consumer i belonging to class l is then specified as:

$$\mathrm{P}_{il} = \frac{\exp(\delta_l X_{il})}{\sum_s \exp(\delta_l X_i)} \tag{3}$$

The combined possibility that consumer i belongs to class l and selects product option k is represented by:

$$\mathrm{P}_{ikl} = (P_{ik/l}) * (P_{il}) = \left[\frac{\exp(\beta_l Z_{ik})}{\sum_n \exp(\beta_l Z_{in})}\right] \times \left[\frac{\exp(\delta_l X_i)}{\sum_l \exp(\delta_l X_i)}\right] \tag{4}$$

The choice experiment employed and the random utility underlying the latent class model adopted in this study correspond with utility maximizing theory and demand (Bateman *et al*., 2003). Once the utility estimates for consumer segments are estimated, their willingness to

pay estimates can be computed as:

$$WTP = -\frac{\partial U/\partial X}{\partial U/\partial P} = \frac{\beta_{sustainability\ attributes}}{\beta_{price}} \quad (5)$$

where X is a vector of the product attributes. P denotes the price. $\beta_{sustainability\ attributes}$ is a non-monetary coefficient of sustainability attributes and β_{price} is the monetary coefficient on price. The class-specific WTP estimates are computed using parametric bootstrapping technique.

2.2 Sampling and data description

The survey was conducted in the Gauteng province of South Africa, using trained interviewers. Gauteng is the most populous province in South Africa and very diverse in terms of social, economic and demographic characteristics (Statistics South Africa, 2012). We employed a multistage sampling procedure to select 402 households in Centurion, Pretoria, and Midrand (Johannesburg). Face-to-face interviews were conducted, using samples of the labelled products, after the questionnaire had been pretested with 15 respondents. The questionnaire focused on the choice experiment, respondents' socioeconomic characteristics, knowledge of environmental sustainability and attitudinal data. The survey focussed on meat buyers, with particular note to beef consumers because beef is one of the most purchased livestock products in South Africa, making it easier to ensure high representation. Moreover, the water footprints of beef products in South Africa are known to be quite high, relative to the global averages.

Prior to the experiment, respondents' subjective knowledge were examined. As in Flynn and Goldsmith, (1999) respondents were asked how knowledgeable they consider themselves to be about ecologically sustainable production, water usage, carbon emission and ecological footprint. Responses to each statement ranged from "no knowledge (1)" to "very knowledgeable (5)". An index was calculated for subjective knowledge by averaging the responses of each respondent. After the choice experiment, we further examined respondent's objective knowledge by assessing the level to which they agree or disagree to six statements about ecologically sustainable production, water usage, carbon emission and ecological footprint, using five-point Likert scale ranging from "strongly disagree (1)" to "strongly agree (5)". In the interest of brevity, the statements used are not presented but are available upon request.

2.3 Experimental design

Attribute-based choice experimental design was employed. The choice experiment allows respondents to choose from a set of product alternatives, with different attribute combinations. The choices made by respondents' aid in revealing their preferences, without subjectively asking them to value the product attributes. This method minimizes social desirability bias (Norwood and Lusk, 2011). The choice experiment consisted of different combinations of water usage (water footprint), carbon emissions and prices. Different choice sets were designed for beef rump steak. The water footprint values were estimated using South African data and the Water Footprint Network Standard Approach as outlined in the Water Footprint Assessment Manual. Water footprint estimate for beef from Mekonnen and Hoekstra (2010) was also included. The carbon equivalents were obtained from Milk South Africa (Milk SA) and Scholtz *et al.* (2014). The selected prices considered for the product were the prevailing retail prices from markets across the study area for beef rump steak. Water footprint, carbon footprint and price attributes had three levels each in the choice sets designed (Table 1).

Table 1: Chosen attributes and levels

Attribute	Beef rump steak	Categorical level
1. Water footprint	1. 15415 l/kg	Low
	2. 17300 l/kg	Medium
	3. 17387 l/kg	High
2. Carbon footprint	1. 22.90 kgCO_2e	Low
	2. 26.37 kgCO_2e	Medium
	3. 27.50 kgCO_2e	High
3. Price	1. ZAR 159.99/ kg	Low
	2. ZAR 179.99/ kg	Medium
	3. ZAR 185.00/ kg	High

The attributes and their levels were combined using Ngene software to create random parameter panel efficient design with three alternatives (A, B and "none") (Choice Metrics, 2014). D-error efficiency and blocking strategy were also used during the design. The blocking strategy circumvents respondent fatigue during the survey. Twenty choice sets were generated using the Ngene software and blocked into ten, with each block containing two choice sets. Each person was randomly allocated to a block. Since the concept of carbon and water footprint is new, the possibility that some respondents may not be aware of water and carbon footprints was resolved by generating statements explaining the carbon and water footprints, their measurements and meanings of the footprint values to the respondents in their local and preferred language before the survey.

3. Results and Discussion

3.1 Descriptive characteristics of respondents

The descriptive characteristics of respondents are presented in Table 2. The average age of the sample was about 35 years. This concurs with Stats SA's population estimates which indicate that about 66% of the South African population are about 35 years or less (Statistics South Africa, 2014). The mean number of years of formal education was 15 years and an average monthly income of ZAR10132.24. Most of the respondents were females, as indicated by a percentage of 67.70%. About 53.50% of the respondents were aware of the department of water and sanitation's campaign on threats posed by climate changes in South Africa. This suggests the need for more awareness and campaigns on climate changes, as 46.50 % of the people were not aware.

Most of the respondents (73.44%) trust in food labelling regulatory bodies in South Africa. In terms of respondents' subjective and objective knowledge regarding environmental sustainability, the results revealed an average subjective knowledge (SUBKI) index of 3.41. Similarly, the objective knowledge index was found to be 2.68. The subjective and objective knowledge estimates show that the respondents consider themselves as moderately knowledgeable about environmental

Table 2: Descriptive statistics of respondents' socioeconomic characteristics

Variable	Description	Mean (SD)
Age	Years	35.08 (11.51)
Education	Years of formal education	15.08 (2.31)
Income	Monthly income in ZAR	10132.24 (43.98)
Subjective knowledge index (SUBKI)	Subjective knowledge about environmental sustainability	3.41 (1.00)
Objective knowledge index (OBJKI)	Objective knowledge about environmental sustainability	2.68 (1.10)
Variable	**Description**	**Percentage**
Female	1 if female, 0 otherwise	67.70
Awareness	1 if respondents is aware of the department of water and sanitations campaign on climate changes	53.50
Trust	1 if respondent trust in food labelling regulatory bodies	73.44

Authors' calculations.

Table 3: Latent class results for beef consumers

Attributes	Class 1	Class 2	Class 3
Water footprint			
Low	2.55*** (0.65)	2.07*** (0.43)	-0.63** (0.30)
Medium	-0.75*** (0.23)	-0.50 (0.36)	0.44** (0.19)
High	-1.56** (0.71)	-0.46* (0.24)	0.54** (0.22)
Carbon footprint			
Low	1.57*** (0.41)	1.25*** (0.33)	-0.42*** (0.13)
Medium	-0.69 (0.40)	1.16 (0.81)	1.02 (0.73)
High	-1.36*** (0.42)	-1.08** (0.48)	0.54* (0.3)
None	-3.11*** (0.66)	1.23*** (0.69)	0.74** (0.30)
Price	-0.35*** (0.11)	-0.37*** (0.07)	-0.18*** (0.05)
Class share	**46%**	**35.10%**	**18.90%**
Class membership estimates			
Constant	-1.66*** (0.24)	-2.43*** (0.39)	
Age	-0.57** (0.2)	0.33** (0.12)	
Female	-0.34 (0.24)	0.27** (0.11)	
Education	0.72** (0.22)	0.23 (0.19)	
Income	0.62** (0.31)	-0.32** (0.12)	
Awareness	0.46** (0.22)	0.55 (0.41)	
Trust	0.41** (0.20)	-0.39** (0.19)	
SUBKI	0.27** (0.11)	-0.16* (0.09)	
OBJKI	0.21** (0.09)	-0.13* (0.07)	
Diagnostic statistics	LL= -514.80; AIC=1051; BIC=1251.98; McFadden's (ρ^2) =0.21		

Authors' calculations: Values in parentheses are standard errors.
***=significant at 1%, ** =significant at 5%, * = significant at 10%.

sustainability. Generally, the index for subjective knowledge is higher than objective knowledge; implying that what respondents think they know about environmental sustainability is higher than what is actually observed or practical.

3.2 Latent class estimates

The latent class model estimates are provided in Table 3. Ben-Akiva and Swait (1986) test was conducted to ascertain whether the latent class model or mixed logit models best fit our data. It was found that the latent class model is the best fit and that the heterogeneity in our data is better explained at segment level, rather than at individual level. Therefore, we present the results of the latent class model. Using McFadden's (ρ^2), AIC and BIC selection criteria, three-latent class model was found to be optimal. The McFadden (ρ^2) statistic of 0.21 indicates that the model was fit (Hensher *et al*., 2005).

The results reveal that the respondents are heterogeneous in their preferences for water usage, carbon emission and price. This is indicated by the differences in magnitude, direction and significance of the utility function estimates. This concurs with recent findings of Grebitus *et al*. (2015). Three distinct consumer classes were found. Price is significantly negative in all the classes as expected and in accordance with economic theory (McFadden, 1974). This means that all the three classes of consumers are sensitive to price and consider it as a relevant attribute in their decision to purchase environmentally sustainable food products.

For class 1, the utility estimates show that low levels of water usage and carbon emissions are significantly positive. This means that respondents in this class prefer beef products with low water and carbon footprints. Medium water usage level was significantly negative. Also, high levels of water usage and carbon emission variables were significantly negative. This suggests that apart from low water and carbon footprint levels, respondents in this class will not prefer beef products with medium or high footprint estimates. This is confirmed by the status quo bias observed for the ''none'' option. The significantly negative coefficient estimate of ''none'' option implies that respondents in

Table 4: Class specific willingness to pay estimates and 95% confidence intervals

	Class 1 (ZAR)	Class 2 (ZAR)	Class 3 (ZAR)
Water footprint			
Low	7.29 (5.22 to 9.57)	5.59 (3.55 to 7.99)	-3.50 (-6.30 to -2.05)
Medium	-2.14 (-4.33 to -1.85)	NS	2.44 (1.90 to 4.45)
High	-4.46 (-7.75 to -3.15)	-1.24 (-4.44 to -0.99)	3.00 (2.22 to 5.11)
Carbon footprint			
Low	4.49 (2.45 to 8.10)	3.38 (2.33 to 5.80)	-2.33 (-5.13 to -1.99)
Medium	NS	NS	NS
High	-3.89 (-6.42 to -3.05)	-2.84 (-4.12 to -2.05)	3.00 (2.53 to 5.15)
None	-8.89 (-10.06 to -5.50)	3.32 (2.69 to 5.45)	4.11 (3.24 to 6.90)

NS: Not significant: All values are in South African Rand (ZAR). Values in parentheses are confidence intervals at 95%. Authors' calculations.

this class prefer to select one of the product options than to choose the ''none'' option. This class accounts for 46 % of the sampled respondents. The class membership estimates for this class reveal that having high levels of formal education, income as well as subjective and objective knowledge on environmental sustainability increases the likelihood of a particular respondent belonging to this class, relative to class three. Additionally, members of class one are likely to be aware of threats posed by climate changes through the department of water and sanitations campaigns. They are also likely to trust food labelling regulatory bodies in South Africa. Members of this class are likely to be younger individuals, as indicated by the significantly negative coefficient of age variable.

For the second class, the utility estimates for low levels of water usage and carbon emissions are significantly different from zero and positive. High levels of water usage and carbon emission variables are significantly negative. This suggests that members of this class have negative preferences for beef products with high water and carbon footprints. The status quo variable ''none'' is significantly different from zero and positive. This implies that respondents in this class also prefer beef products without water and carbon footprint sustainability information.

Class two accounts for 35.10% of respondents. The class membership estimates for this segment indicate that respondents in this class are likely to be older females with low income, relative to class three members. Respondents in this class are less likely to trust food labelling regulatory bodies, relative to class three members. They are also less likely to report having high subjective and objective knowledge on environmental sustainability, compared with class three members.

For class three, the significance and directions of the utility function estimates differ. The utility function estimates for low water usage and carbon emission levels are significantly different from zero and negative. This suggests that respondents in class three do not prefer beef products with low water and carbon footprints, relative to the other two classes. Medium and high levels of water usage are preferred by this segment of respondents, as indicated by the significantly positive coefficient estimates. Members of this class also prefer high carbon footprint estimates, compared with the other two classes. The status quo variable ''none'' is significantly positive; indicating that respondents in class three prefer products without water and carbon footprint sustainability information. Class three accounts for 18.90 % of the respondents. Class membership estimates for this class were normalized to zero, such that the other classes could be compared with it.

3.3 Willingness to pay estimates for water and carbon footprints sustainability attributes

Class-specific willingness to pay estimates for the different levels of sustainability attributes evaluated at 95% confidence interval are presented in Table 4. The WTP estimates for the attributes were estimated across the latent classes in order to ascertain the differences in preference structure. The results show that respondents in class one and class two are willing to pay ZAR7.29 and ZAR 5.59, respectively for low water footprint level. Respondents in class three on the hand are willing to accept ZAR 3.50 as compensation to choose beef products with low water footprint. Respondents in class one are willing to accept ZAR 2.14 and ZAR 4.46 as compensations to choose beef products with medium and high water footprint levels, respectively. Contrary to class one members, those in class three are willing to pay ZAR 2.44 and ZAR 3.00 for beef products with medium and high water footprint levels, respectively.

In terms of carbon emissions, respondents in classes one and two are willing to pay ZAR4.49 and ZAR 3.38, respectively for low carbon emission levels whereas those in class three were willing accept ZAR 2.33 to choose beef product with the same level of carbon emissions. Additionally, class one members were willing to accept compensation to choose products with high carbon emissions, whereas class three members were ready to pay for the same emission level. For both classes one and two, willingness to pay estimates for low water usage are higher than low carbon emissions. This implies that preference for low water footprint is higher than low carbon footprints. Finally, class two and three members were willing to pay for beef products without water and carbon footprint sustainability information, whereas class one members will only choose this product when they are compensated with ZAR 8.89.

4. Conclusion

The study concludes that there is considerable preference heterogeneity at segment level for environmentally sustainable beef products. Three distinct consumer segments were identified, with each class exhibiting different preference attitude for the same set of environmentally sustainable beef product attributes. The profound heterogeneity

in preferences is explained by socioeconomic factors such as age, gender, education and income of respondents. Beside socioeconomic factors, public awareness creation and campaigns on threats associated with climate changes as well as trust in regulatory bodies in charge of food labelling, including environmental sustainability labelling play significant role in influencing consumers' preferences for environmentally sustainable beef products. Additionally, respondents' subjective and objective knowledge levels on environmental sustainability significantly impact on their choices of environmentally sustainable beef products. Therefore, demographic targeting of consumer segments, awareness creation and segment-specific educational campaigns aimed at enhancing subjective and objective knowledge on environmental sustainability are important tools for governments, food companies and agribusinesses for promoting and marketing environmentally sustainable food products.

Willingness to pay for different water usage and carbon emission levels of beef production varies across the identified classes. Willingness to pay exists for low water usage and carbon emissions in classes one and two. Class three members on the other hand are willing to accept compensations to purchase beef products with low water and carbon footprint values. For both segments one and two, respondents were willingness to pay higher amounts for low water footprint level, compared with low carbon footprint level. Therefore it is concluded that preferences for low water footprint is higher than carbon footprints.

Generally, the willingness to pay estimates and class membership probabilities indicate that there is market for environmentally sustainable products in South Africa, as about 81% of the respondents have positive preferences for low water usage and carbon reduction. Given that classes one and two have significant positive preferences and willingness to pay premiums for low water usage and carbon reduction, agribusinesses and food companies can capitalize on this consumer segment and create a niche market for environmentally sustainable products in South Africa. Nonetheless, there are imperative segmental equity issues that need to be taken into consideration when designing environmental sustainability strategies to change consumers' behaviour, while aiming at promoting environmentally sustainable products and minimizing environmental impacts.

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