Welfare estimates of food safety and quality policy changes in Southern Ghana

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Abstract:

The present paper has examined the welfare implications of safety and quality policy changes among beef consumers in Southern Ghana. The empirical results revealed profound heterogeneity in preferences for food safety and quality attributes at individual and segment levels. Four distinct consumer segments were revealed using a latent class model. We show that besides traditional socioeconomic factors; trust, competence and confidence in actors along food safety chain significantly impact on preferences for different food safety and quality policy attributes. Compensating surplus estimates reveal that welfare improvement arising from food safety and quality policy changes varies from one class to another. The findings show evidence of imperative segmental equity issues in food safety and quality policies. The welfare estimates indicate that evaluating willingness to pay values alone is not enough. The paper suggests that future research and policy decisions on food safety and quality changes take into account the segment of consumers whose welfare can potentially be improved or reduced due to the policy changes. Insights from this study are expected to assist policymakers in developing countries, especially in Africa to understand the welfare implications and effective food safety and quality measures

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Keywords: Compensating surplus, food safety, food quality, Ghana, welfare measures

JEL Classifications: D18; I18; I31; I38; Q18

1. Introduction

Food safety and quality issues in emerging and developing sub-Saharan Africa regions are receiving increasing attention from economists, researchers and policymakers. Consumers in sub-Saharan Africa and other developing countries become progressively more aware of food safety and quality issues as urbanization proceeds and incomes continue to rise at increasing rates. The increasing awareness and consumer consciousness of food safety and quality incidents such as foodborne diseases have caused food quality and safety management authorities in developing sub-Saharan African regions to consider these issues as relevant policies worth investigating (Scott 2003; Ortega and Tschirley 2017). However, assuring food safety and quality in modernizing food systems involves significant costs and current incomes in developing sub-Saharan African regions are far lower compared with developed countries. Consumer awareness and knowledge of producer behaviour and consumer demand for food safety and quality in developing countries are very limited.

Emerging countries are focusing on regulating food safety and quality through the use of process, product or information standards (Caswell 2003). Process standards involve the specification of how the product should be produced. Product standards require that final products have specific characteristics. For example, the specification of maximum microbial pathogen load for fresh beef. Lastly, information standards specify the types of labelling or other communication that must accompany products. In Ghana, the Food and Drug Authority (FDA) has outlined policy guidelines to regulate food safety and quality in the livestock industry (FDA 2013). Notably, the FDA guidelines are categorized into four food quality and safety regulations. In the first regulations, beef products are to be sold based on production method and differentiation through product labelling (information standard). The second regulation focuses on maximum allowable fat content that beef products should contain (product standard). In the third regulations, contaminated beef products from moulds or smoke

sticks contamination are restricted (process standards) and the final regulation requires all beef products sold on the market to be certified with certification stamp as evidence (FDA 2013). Food policy changes have implications on consumers' welfare and utility given the associated costs of such policies (Birol *et al*. 2009). The overall effect of introducing a new product or the changes in product attributes on consumer welfare is the compensating surplus.

In the context of the current paper, compensating surplus is the income change needed to keep beef consumers at their initial utility level assuming that the food safety and quality policy changes highlighted in this study are implemented (McKenzie and Pearce 1982; Vartia 1983). The welfare assessment of food safety and quality policy changes provides the economic justification for implementing specific policies. Notably, welfare measures of changes in food safety and quality attribute apart from minimizing the economic costs of food-borne illness and reducing health risk (FAO 2009), could provide evidence-based policy scenarios for developing the food sector, for improved policy-making and regulation towards safer livestock and meat production, marketing and consumption (FAO 2009; FDA 2013).

One aspect of welfare estimates arising from food quality and safety policy changes is consumers trust and confidence in food quality and safety authorities, retailers and farmers (Grebitus *et al*. 2015). The role played by these actors ensures that new policy standards are not violated and as such individuals trust in them is expected to explain their choices and welfare estimates better (Grebitus *et al*. 2015). In Ghana, for instance, recurrent failure to meet food quality and safety standards could attract a ban on the operation of an entity in the livestock market (FDA 2013). In spite of this, there exit insufficient knowledge and understanding on why consumers might shift to high quality and safer food consumption patterns or whether the welfare of the consumer might increase or decrease after the introduction of such policy changes.

Assessment of consumers' willingness to pay for safety and quality livestock product attributes has been on the ascendancy in recent years, particularly in developed countries (Banovic *et al*. 2012; Schumacher *et al*. 2012; Grebitus *et al*. 2013). Unfortunately, the growing body of literature has tended to focus on traditional willingness to pay estimates at the expense of the impact of changes in product attributes on consumers' welfare. Evaluating consumers' welfare estimates or compensating surplus regarding beef safety and quality can potentially assist and provide food policymakers with a monetary measure of the effects of food safety and quality changes on the utility and welfare of the consumer (Varian 2006). An understanding of the welfare benefits and costs regarding food safety and quality attribute changes to consumers is needed for an overall assessment of food policies that create incentives for meat safety and quality improvement in the food sector, particularly in Africa (Schroeder *et al*. 2007; Schumacher *et al*. 2012). Additionally, findings from this study could help in the implementation of food safety and quality measures, and enlighten policy-makers and regulators of the likely distribution of welfare benefits across consumer segments. Notably, the findings from the current study could lead contribute to a better understanding of the economics of food safety and quality in emerging and developing countries.

The current paper pays particular attention to how consumers trust and confidence in food quality and safety impact on the willingness to pay and welfare estimates of authorities, retailers and farmers in the livestock industry in Ghana. Providing empirical evidence on these actors are relevant due to the role they play in ensuring that new policy standards are not violated. Notably, individuals' trust could explain their choices and welfare estimates better (Grebitus *et al*. 2015). In this paper, the latent class approach is employed to identify the preferences of beef consumers for the estimation of the compensating surplus or welfare changes. Apart from accounting for preference heterogeneity among the beef consumers, the latent class approach enables us to determine specific consumer segments where targeted food

safety policies could be recommended to improve their welfare. The main hypothesis tested in the current paper is that compensating welfare effects arising from beef safety and quality regulations have varied implications on consumers' welfare. Notably, the welfare gains and losses as a result of changes in beef safety and quality regulations vary from one consumer segment to another.

2. Literature Review

A number of studies have evaluated consumers' preferences and willingness to pay for food safety and quality attributes of livestock products. Lusk and Norwood (2005) modelled beef quality heterogeneity. Loureiro and Umberger (2007) assessed the relative preferences for food safety, country-of-origin labelling and traceability attributes of beef using choice experiment model in the US. Olynk *et al*. (2010) studied consumer willingness to pay for livestock credence attributes claim verification. Impacts of food safety on beef consumption across countries, and willingness to pay for calf health programs and certification agents have been analysed by Schroeder *et al*. (2007) and Schumacher *et al*. (2012). Most of these documented studies have focused on traditional willingness to pay estimates, the impact of consumers' perception and attitude on their preferences without paying much attention to the welfare implications of the changes in the livestock product attributes (Nocella *et al*. 2010; Olynk *et al*. 2010; Banovic *et al*. 2012; Schumacher *et al*. 2012). As pointed out by the growing empirical studies on compensating surplus estimates (Vartia, 1983; Hanemann, 1984; Birol *et al*., 2009; Torres *et al*., 2014), once the individual consumers' preferences for the new policy changes are revealed, their compensating surplus estimates can be computed based on the utility maximization theory.

To the best of our knowledge, studies that have assessed consumers' welfare or compensating surplus estimates of food safety and quality policy changes are very limited. The

literature on welfare estimates is limited to Hynes *et al*. (2013) who valued multiple changes in water quality attributes using choice experiments. Hynes *et al*. (2008) assessed the effects on welfare measures arising from heterogeneous preferences for alternative recreational demand. Welfare implications of optimal management of wetlands were evaluated by Birol *et al*. (2009). This shows that welfare evaluations of policy changes are limited to water and other environmental attributes with little or no attention given to food policy changes. Knowledge on consumer welfare, notably, compensating surplus estimates that guide food policymakers on the segment of consumers "who gain" or "loose" due to food policy changes have not been rigorously addressed in the empirical literature on preferences for beef products in sub-Saharan Africa.

The present paper builds on the existing literature on consumer preferences for beef products in Africa by estimating compensating surplus estimates for food safety and quality policy changes in Ghana. Accounting for compensating surplus estimates for such policy changes will contribute to the debate on food safety and quality policies, which is still a major and inconclusive policy issue in the Africa.

3. Conceptual framework and empirical strategy

The present paper follows the compensating surplus welfare approach proposed by Vartia (1983), Hanemann (1984) and Birol *et al.* (2009). The compensating surplus is the income change needed to keep consumer *i* at the initial level of utility (U_0) given that the proposed food safety and quality policy changes are implemented. The overall effect of introducing new products or changes in product attributes on consumer welfare is expressed as the difference in the consumer's expenditure function before and after the introduction of the new product or policy at the latent utility levels. The compensating surplus estimate (CSE) is expressed as:

$$CSE = \phi(P_{\phi 0}, P_{\gamma 0}, U_0) - \phi(P_{\phi 1}, P_{\gamma 1}, U_1) \quad (1)$$

where $P_{\phi 0}$ and $P_{\phi 1}$ are vectors of beef product prices before and after the introduction of the new food safety and quality policies. $P_{\gamma 0}$ is the virtual prices of beef following the new policy changes whereas $P_{\gamma 1}$ is the post-introduction prices of beef products. U_0 and U_1 are the utility levels before and after the introduction of the new policies. Equation (1) measures how much a beef consumer would need to be compensated in order to be as well-off as he or she would be after the introduction of the new food safety and quality policies (Small and Rosen 1981; Brynjolfsson *et al*. 2003). There is a gain if the utility after the introduction of the new policy exceeds the utility before the introduction of the new policy $(U_1 > U_0)$.

The difficulty in estimating welfare values arises when preferences cannot be recovered from the observed behaviour of consumers (Small and Rosen, 1981). Hanemann (1985) and Morey (1984) argued that if values cannot be inferred from observed behaviour, the individual consumers could be asked to state their preferences for a given product in a discrete choice modelling framework. Assuming that beef consumers in Ghana are heterogeneous in their preferences for food safety and quality attributes (Owusu-Sekyere *et al*. 2014), the latent class (LC) logit modelling technique is adopted in the present paper to account for the underlying heterogeneous preference assumption, determine specific consumer segments and recommend targeted food safety policies that improve consumer welfare. The latent class (LC) relaxes the assumption of independent observations and allows parameter estimates to vary across individuals (Hynes *et al*. 2012; Torres *et al*. 2014).

In the latent class framework, consumers are assumed to be organised implicitly into a set of z classes which are unobserved by the researcher. If consumer i faces a discrete choice among K_i alternatives of beef products in Q_i choice situations, then the probability that the consumer i chooses alternative in K choice situation q in class z is represented as:

$$\Pr_{kiq/z} = \frac{\exp(x'_{iq,k}\beta_z)}{\sum_{k=1}^{k_i}\exp(x'_{iq,k}\beta_z)} = F(i,q,k/z) \quad (2)$$

Since the choice sets vary by choice situations, we denote the specific choice made by the consumer as Y_{iq}, and express its probability as:

$$P_{iq/z}(k) = \Pr(Y_{iq} = k / class = z) \quad (3)$$

Given that the Q_i choices are independent in the class assignment, the contribution of the consumer i to the likelihood function is the joint probability of $Y_i = [Y_{i1,}Y_{i2,}.....Y_{iQ}]$. Since the class assignment is not known to the researcher, the prior probability M_{iz} for class *z* for the consumer $\boldsymbol{i}$ is formulated as:

$$M_{iz} = \frac{\exp(x_i'\lambda_z)}{\sum_{z=1}^{Z}\exp(x_i'\lambda_z)}, z = 1,....Z, \lambda_Z = 0 \quad (4)$$

where x_i is the set of observable characteristics which forms the class membership estimates of the model and the Z^{th} parameter vector is standardised to zero to secure identification of the model and compare the remaining classes to it (Greene 2003).

The log-likelihood function for the sampled respondents is expressed as:

$$\ln L = \sum_{i=1}^{N}\ln P_i = \sum_{i=1}^{N}\ln\left[\sum_{z=1}^{Z}M_{iz}\left(\prod_{q=1}^{Q_i}P_{iq/z}\right)\right] \quad (5)$$

The log likelihood is maximised with respect to the Z structural parameter vectors, β_z and Z-1 latent class membership parameter vectors, λ_z is a conventional problem in maximum likelihood estimation. Once the utility estimates for consumer segments are estimated using the LC models, their willingness to pay estimates can be computed as:

$$WTP = -\frac{\partial U/\partial X}{\partial U/\partial P} = -\frac{\beta_{as}}{\lambda_{ps}} \quad (6)$$

where X is a vector of the beef safety attributes. P denotes the price. β_{as} is a non-monetary coefficient and λ_{ps} is the monetary coefficient on price [1].

The compensating surplus welfare measures are computed from the estimated parameters of the latent class model as:

$$CS_{Zn/i} = \frac{\ln \sum_{Zn/i} \exp(U_{Zn/i1}) - \ln \sum_{Zn/i} \exp(U_{Zn/i0})}{\lambda_{ps}} \quad (7)$$

where $CS_{Zn/i}$ is the compensating surplus for the individuals and consumer classes. $U_{Zn/i0}$ and $U_{Zn/i1}$ represents indirect utility before and after policy changes.

4. Data description

4.1. Choice experiment design

This study employed the choice experiment in the survey to solicit the relevant data (Grebitus *et al*. 2013). The design of the study focussed on policy-relevant attributes that are of interest to consumers in Ghana in terms of safety and quality of beef products. Five important policy-relevant attributes including, the method of animal production, fat content, streak colour, health inspection (certification) and price were examined in consultation with health professionals at the Food and Drugs Authority (FDA), and meat and livestock experts from relevant institutions in Ghana. The production method attribute refers to raising cattle either on pasture or on a conventional basis. Most of the locally produced beef in Ghana are pasture raised compared to the imported beef, which is conventionally raised. At the present, most beef is sold undifferentiated in Ghana, even though pasture raised product differentiation strategy is proposed to be a feasible marketing strategy (Conner and Oppenheim 2008). Implementing pasture raised product differentiation policy in Ghana would lead to the improved livelihood

of local livestock farmers due to the associated price premiums from pasture raised products. The fat content attribute refers to the percentage of back fat by mass that should be allowed in beef products. The attribute levels are 10% and 20% fat (FDA 2013). Presently in Ghana, beef products are sold without information on the fat content. Minimizing the level of fat in beef products will help reduce fat induced illness. Due to the health implications and risk associated with high-fat products, the FDA intends to promote the sales and consumption of lean meat.

The health inspection (certification) attribute refers to health inspection of live animals by the FDA before slaughter and certification of beef. Presently, there are no certifications of beef products. The certification attribute levels are assured certification and no certification. The attribute steak colour refers to the colour of the beef cut at the retail shops. The first impression consumers have of any meat product is its colour. Whilst steak colour indicates freshness and contamination, grey or greenish colour of beef may indicate contamination from moulds or smoke sticks that lead to the occurrence of foodborne diseases among consumers. The steak colour has grey and reddish as attribute levels. The price attribute has three levels (GH¢15 (US$10.27), GH¢12 (US$ 8.21) and GH¢10(US$6.85) and the levels were based on existing market prices from selected meat shops. Table 1 summarizes the attributes and their levels evaluated in the choice experiments for 1Kg ordinary boneless beef cuts.

Table 1. Beef product attributes and attributes level in the choice experiment

Product Attribute	Attribute Level	Coding structure
1. Production method (Prodmet)	Pasture-raised Conventionally raised	Dummy coding: 1 if pasture raised, 0 if conventional
2. Fat content (Fatcon)	10% fat 20% fat	Dummy coding:1 if 10% fat, 0 if 20% fat
3. Steak colour (Stkcol)	Reddish Grey	Dummy coding: 1 if reddish, 0 if grey
4. Health certification (Hcert)	Assured Not assured	Dummy coding: 1 if assured certification stamp, 0 otherwise
5. Price (GH¢)	GH¢15 GH¢12 GH¢10	Continuous variable

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 (Savage and Waldman 2008). All the choice questions were generated using the Ngene software and blocked into ten, with each block containing two choice sets. Each respondent was randomly allocated to a block.

4.2. Data collection and sampling

The survey was conducted in the Kumasi Metropolis and Sunyani Municipality in Southern Ghana. The paper adopted a multistage sampling approach was used in the survey. The first stage was the purposive sampling of Kumasi Metropolis in the Ashanti region and Sunyani Municipality in the Brong Ahafo region because of their multicultural and multi-ethnic nature with high beef consumption status (GLSS 2010). The second stage involved stratified random sampling of three formal meat shops. The stratification was based on income classifications of residential areas. The selected areas include Nhyiaeso and Ayeduase (high-income area), Kaase (middle-income area) and Asuoyeboa (low-income areas) in the Kumasi Metropolis. The income stratification supports existing finding that income impacts significantly on consumption patterns and preferences (Boccaletti and Nardella 2000) and to obtain a fair representation of different consumer classes. In the Sunyani municipality, Nana Bosoma meat market was purposively selected because it's the only authorized meat market that serves all income groups in the municipality. Specifically, 150 consumers were randomly sampled from the Kaase meat shop, 50 consumers each from Ayeduase, Nhyiaeso, Asuoyeboa meat shops and 100 from Nana Bosoma meat market. In all, a total of 400 consumers were sampled for the study.

Prior to the data collection, the questionnaire was pretested using 15 respondents. The questionnaire comprised of both open-ended and closed-ended questions. The questionnaire consisted of demographic characteristics, several trusts, competence and confidence- related statements pertaining to health and food inspection authorities, livestock farmers and beef retailers and the choice sets.

The data was divided into two sets; the first set contained the socioeconomic and trust variables. An index was calculated by using the Likert scale ranging from 1 to 5 for items defining each identified components in confirmatory and exploratory factor analysis. The index values were used as membership estimates in the subsequent LC model. The identified factors include trust in Food and Drugs Authority (FDA), beef retailers and cattle farmers. In the second data set, each individual choice set was transformed into a binary choice between the alternatives selected by each respondent for all the choice sets. The likelihood ratio test was employed to formally test whether the data from the two regions could be pooled together (Wooldridge 2002).

5. Results and discussions

5.1. Descriptive results

Descriptive statistics and the principal component analysis of variables used in the empirical model are presented in Table 2. The average age of respondents was 37 years. Forty-three percent of the respondents were males whiles 57% were females. The high proportion of female is not surprising given that women are mostly in charge of household grocery shopping and purchasing decisions in South Africa (Mare *et al*. 2013). The average number of dependent was 4.76, which falls within the national range of 3.4 to 6.5 (GLSS 2010). The mean monthly household income was GH¢1206.69 (US$826.5), this compares with the national average household income of GH¢1217 (US$833.56) (GLSS 2010).

Table 2. Summary statistics and principal component analyses.

Variables			
Consumer attitude and trust towards beef stakeholders			
	% variance explained	Cronbach's alpha	Principal component Statistics
Trust in health and food safety inspection authorities	39.56	0.93	KMO = 0.73; Bartlett: $p < 0.000$
Butchers/retailers competence	24.94	0.81	
Confidence in farmers	20.30	0.94	
Socioeconomic factors	*Mean*	*std. deviation*	
Age (Years)	37.06	9.18	
Ndep (Number of dependents)	4.79	2.30	
Inc (Monthly income in GH¢)	1206.69	33.25	
Gen (Dummy:1 = female, 0 = male)	0.57	0.12	
Basic education (Dummy:1 = if basic education, 0 otherwise)	0.23	0.11	
Secondary (Dummy: 1 = if secondary education, 0 otherwise)	0.25	0.09	
Tertiary (Dummy (1 = if tertiary education, 0 otherwise)	0.22	0.07	
Postgraduate (Dummy: 1 = postgraduate education, 0 otherwise)	0.30	0.12	

Source: Authors' calculations

In terms of education, 23% of the respondents had attained basic education, 25% had attained secondary education, whereas 22% and 30% had attained tertiary and postgraduate education, respectively. The principal component labelled as "*trust in health and food safety inspection authorities*" relates to consumers trust in the existing health and food safety inspection system in the study area. This component accounts for 39.56% of the variations. The component labelled as "*butchers and retailers competence*" measured the extent to which respondents believe butchers and retailers are competent in ensuring food hygiene, quality and safety standards are adhered to. This component accounts for 24.94% of the variation. Lastly, the component "*confidence in farmers*" focused on respondents' confidence in cattle farmers in ensuring that the health status of animals sold for slaughter are good and that sick animal will not be offered for slaughter. This component explained 20.30% of the variation.

5.2. Empirical results

5.2.1. Heterogeneity in preferences for food safety and quality attributes and policy changes

Results on heterogeneity are presented in Tables 3. Ben-Akiva and Swait (1986) test results suggest that the systematic preference heterogeneity in our dataset can be better explained at the segment level. Hence, the latent class model estimates are discussed for policy purposes. The idea behind is to examine the impact of changes in food safety and quality policies across different consumer segment (Fiebig *et al*. 2010). Four latent class model was found to be optimal. The results of this model are presented in Table 3. The results indicate significant heterogeneity in preferences for the selected safety attributes across latent classes as shown by the differences in the magnitude, direction and significance levels of the utility estimates. This implies that preference and willingness to pay estimates for safety and quality attributes cannot be interpreted as being a representative of the entire sample, but rather aligned with specific consumer segments (Hensher and Greene 2003).

In line with economic theory, the results show significant negative coefficient for the price variable in all the classes at the conventional levels, suggesting a decline in utility as prices increase (Grebitus *et al*. 2015). Class one exhibit stronger price sensitivity than the remaining classes, as the highest utility estimate is associated with this class. Interestingly, we found the alternative specific constant (ASC), which apprehends the effects in utility from the status quo, to be significantly positive across all classes. This suggests that there is status quo bias across all the consumer classes, signifying that respondents in the various classes prefer to move away from the status quo. The implication resulting from this is that all respondents irrespective of their class are more likely to choose one or more of the food safety and quality policy changes, all things being equal.

Table 3. Four latent class model estimates of beef attributes

Variables	Class 1	Class 2	Class 3	Class 4
Utility parameters				
Asc	0.607**	0.739***	1.005***	0.806***
	(0.303)	(0.229)	(0.309)	(0.301)
Production method	-1.949***	0.297***	0.377***	-0.217***
	(0.181)	(0.023)	(0.140)	(0.035)
Fat content	0.133	-0.196***	0.373 ***	0.230***
	(0.139)	(0.054)	(0.087)	(0.053)
Steak colour	0.270***	0.219***	0.581***	0.192***
	(0.066)	(0.055)	(0.184)	(0.044)
Health certification	1.735***	0.224 ***	0.721***	0.204***
	(0.262)	(0.014)	(0.182)	(0.041)
Price	-0.212*	-0.019***	-0.078***	-0.019***
	(0.120)	(0.005)	(0.012)	(0.004)
Class membership estimates				
Constant	-0.091***	-0.153***	-10.467**	
	(0.008)	(0.042)	(3.678)	
Age	0.146***	-0.041	-0.062 **	
	(0.049)	(0.026)	(0.026)	
Ndep	0.549***	-1.977**	0.012	
	(0.199)	(0.805)	(0.065)	
Gen	4.498***	-1.589***	1.233***	
	(1.339)	(0.497)	(0.332)	
Income	-0.011***	2.652***	1.067**	
	(0.002)	(0.856)	(0.545)	
Basic	2.025**	-1.312	-0.028	
	(0.868)	(0.804)	(0.342)	
Secondary	-0.049	0.012	1.977**	
	(0.034)	(0.065)	(0.805)	
Tertiary	-0.008	3.096***	-0.584**	
	(0.270)	(0.852)	(0.276)	
Trust in authorities	2.025**	0.648**	0.718*	
	(0.868)	(0.285)	(0.383)	
Butchers/retailers competence	1.152***	0.024**	0.009***	
	(0.216)	(0.012)	(0.002)	
Confidence in farmers	0.267	1.595**	0.248***	
	(0.234)	(0.739)	(0.054)	
Latent class probability	0.049	0.119	0.649	0.182
Log-likelihood	-1779.34			
Likelihood ratio test	1823.21***			
McFadden's (ρ^2)	0.24			
AIC	3604.68			
BIC	3696.483			

Values in parentheses are standard errors; ***, **, * denotes significance at 1%, 5% and 10% respectively

Source: Authors' calculations

A result supported by the findings of Birol *et al*. (2009) who found respondents to move towards welfare improvement policies in Poland. The utility function estimates reveal that members of class one obtain lower utility from pasture-raised beef at 1% significance level. This generally suggests that members of class one are pasture raised product sceptics, as indicated by the significantly negative utility estimate for production method attribute.

Consistent with the findings of Schumacher *et al*. (2012), health certification is highly valued in this class. Members of this class have significant preferences for reddish steak colour. This shows that steak colour impacts significantly on heterogeneous preferences of consumers in this class. Members of class two appear to obtain higher utilities from pasture-raised production, reddish steak colour and health certification, as indicated by the strongly significant and positive utility estimates. Low-fat content is negatively valued by members of class two, as shown by the negative and significant utility estimate for fat content. This indicates that members of two are fat preferrers; they prefer some level of fat in beef products. This provides further support for previous research by Maré *et al*. (2013) who found that consumers have varied preferences for fat in South Africa, particularly fat colour.

Part of the lower utility for low-fat content may be attributed to the fact that some consumers are not familiar with fat percentages since most beef products in the sub-Saharan region are sold without proper labelling information. This finding is in line with the results of Banovic *et al*. (2012) who found that consumers' familiarity with quality beef attributes like fat impacts significantly on their preferences and perception. In class three, members place a positive value on all the attributes as shown by the strongly significant and positive estimates for production method, low-fat content, reddish steak colour and assured health certification. This suggests that members of class three prefer all the safety and quality attributes considered in the study. Identifying the segment of consumers that are in support of all the food safety attributes provides vital information for the food sector and consumer choice (Birol *et al*. 2009).

Lastly, members of class four, on the other hand, appear to obtain higher utilities from low-fat content, reddish steak colour and assured health certification.

Similar to class one, members of class four obtain lower utility from pasture-raised products as indicated by the significantly negative utility estimate for production method at 1% level. However, class four members have positive preference for low-fat beef products. This implies that heterogeneity in preferences for meat products across consumer classes can be ascertained by fat content. The four-class model specification assigned 4.90% of respondents to class one, 11.90% to class two, 64.90% to class three and 18.20% to class four. It is worth noting that the largest proportion of the heterogeneous respondents belongs to class three, where there existed positive preferences for all the safety attributes considered. The policy implications are that majority of consumers in Ghana are demanding food safety assurance attributes in the beef sector.

Class membership estimates presented in the lower part of Table 4. Membership estimates for the fourth class were normalized to zero and the remaining classes are compared to it (Greene 2003). Class membership estimates for class one revealed that age, gender, size of dependants and dummy variable for basic education were positive and significantly different from zero relative to class four. This suggests that class one members are more likely to be older individuals with a large number of dependants. This is consistent with the findings of Tonsor *et al*. (2005) and Olynk *et al*. (2010). They are more likely to be females with a basic level of education compared to class four members. Albeit, income has a negative effect in class one, it is not surprising given that members of class one have low level of education. This provides further support for the findings of Owusu-Sekyere *et al*. (2014) who found socioeconomic factors such as age, education, income and gender to impact significantly on preferences for food safety assurance.

Class two is associated with males who have a small number of dependants compared to class four members, as indicated by the negative and significant class membership estimates for gender and dependants at 5% and 1% level respectively. The highly significant and positive estimates for income and tertiary level of education suggests that members of class two are more likely to be in the higher income category with a tertiary level of education relative to members of class four. Members of class three are more likely to be young individuals as indicated by the negative parameter estimate for age at 5% level. The significant and positive estimates of gender, income and secondary level of education imply that members of class three are more likely to be females with high income and secondary level of education compared to class four members. Members of this class are less likely to be at the tertiary level of education as shown by the negative and significant estimate for the tertiary level of education relative to class four members. The intuition drawn from this is that young individuals mostly prefer and are more willing to pay for safety attributes since class most of the respondents belonged to class three as indicated by the class membership probabilities. This finding is contrary to the results of Roininen *et al*. (1999) who found that older individuals are more concerned with health more than younger individuals.

Interestingly, the variable "trust in food and drug authorities (FDA)" has significantly positive parameter estimates at the conventional levels across all the three classes relative to class four. This suggests that beef consumers irrespective of their class are more particular about the trustworthiness food safety assurance authorities. This provides evidence for the relevance of generalized trust in accounting for heterogeneity in consumers' preferences. This is supported by the recent findings of Grebitus *et al*. (2015). Similarly, we found that butchers/retailers competence in ensuring hygienic and food safety practices impacts positively and significantly on consumers preferences and willingness to pay for food safety attributes across all consumers classes, relative to class four. This indicates that the role of retailers and

butchers in ensuring food safety has come to play a vital role in consumers' choice of meat products. The variable "confidence in farmers" about the health status of animals sold for slaughter has significant parameter estimates in classes two and three, compared to class four. This means that members of class three and four are more likely to be consumers who have confidence in farmers, indicated by the significantly positive parameter estimates.

Members of class three who form the majority are more likely to be consumers who are confident in farmers about the health status of the animals sold for slaughter. This again emphasises the need to ensure trust and confidence in from the farm level, since trust in farmers provides a better understanding of consumers' behaviour. Thus, the majority of the consumers are very particular about farmers ensuring that live animals sold for slaughter are in good health relative to members of class four. Thus, members of class two and three are interested in the safety of beef products tracing it from the farm level. The McFadden's ρ^2 value of 0.24 indicates that the model is fit and the estimates are efficient (Hensher *et al*. 2005).

5.2.2. Class-specific willingness to pay estimates for food safety attributes

Class-specific willingness to pay estimates for the different attributes were evaluated at 95% confidence interval and the results 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. Pasture-raised product differentiation strategy is highly valued in class two, but the willingness to pay amount is lower than the mean WTP estimates at the individual level. It is important to note that class one and four members were willing to accept a substantial amount as a compensation to choose pasture raised beef. This means that class one and four are likely to be made up of those who perceive pasture-raised products with scepticism. A change from high to low fat beef products is highly valued by members of class four above the mean WTP value at the individual level. However, class two members are willing to accept up

to GH¢10.32 as a compensation to choose low fat content beef products. Hence, class two members can be classified as fat lovers. A change from greyish contaminated beef products reddish steak colour is highly valued in class two and four respectively but the class specific WTP values are less compared to the mean WTP amount at the individual level. Albeit, all the consumer segments were willing to pay premiums for this food policy change attribute. This is supported by the results of McCluskey *et al*. (2005). Consumers in class two place the highest value on assured health certification (as measured by willingness to pay) across all the classes, with class four offering the next highest value, both of which are higher than the mean WTP value at the individual level. Additionally, all the four classes were willing to pay some amount of premium for certification of beef products. This emphasises the importance of steak colour and health certification in influencing heterogeneous preferences and willingness to pay for meat products in Ghana.

Table 4. Class-specific willingness to pay estimates (GH¢)

Attribute	Class 1	Class 2	Class 3	Class 4
Production method	GH¢-9.19 [-8.50 to -10.55]	GH¢15.63 [10.21 to 21.64]	GH¢4.83 [2.97 to 7.32]	GH¢-11.42 [-9.63 to -15.80]
Fat content	Ns	GH¢-10.32 [-9.57 to -16.45]	GH¢4.78 [2.06 to 6.43]	GH¢12.11 [9.79 to 16.67]
Steak colour	GH¢1.27 [1.20 to 4.64]	GH¢11.53 [8.67 to 15.00]	GH¢7.45 [5.06 to 9.43]	GH¢10.11 [8.09 to 13.22]
Health certification	GH¢8.18 [6.45 to 9.90]	GH¢11.79 [9.32 to 15.78]	GH¢9.24 [6.47 to 11.15]	GH¢10.74 [9.12 to 14.00]

Values in parentheses are confidence intervals at 95%. Ns: Not significant
Source: Authors' calculation:

5.2.3. *Compensating surplus estimates for food safety and quality policy changes*

Compensating surplus estimates for the four policy changes or scenarios are presented in Table 5 for individual and segment levels. The results show that compensating surplus estimates for the four classes differ significantly at 95% confidence level. These findings

highlight the necessity to take account of who gains and who loses from food policy changes when designing strategies to ensure food safety and quality in Ghana and Africa as a whole. In all scenarios, compensating surplus estimates are substantially higher for class four and two, implying that food safety and quality measures affect the utility of classes four and two significantly more than that of class one and three. It is worthwhile to note that highest welfare estimates for all the policy scenarios were observed at the segment level (class 4 and class 2) as shown in Table 5. The highest welfare improvement for respondents in class one stems from the first policy scenario (pasture-raised product differentiation), followed by the second scenario (shift from high to low-fat products) and third scenario (restriction on grey coloured beef products) respectively. However, it must be emphasised that this highest welfare measure is only attainable when consumers in this class are compensated to choose pasture raised beef products. It is worth noting that, if members of class one pay the WTP amount for assured certification, their welfare will be reduced by GH¢5.32 (US$3.64), ceteris paribus. The policy implication is that, for improvement in welfare from health certification policy among members of class one, the government should subsidize or remove the estimated willingness to pay a premium for class one members.

For consumers in class two, the highest welfare improvement is attained from the second scenario, which seeks to change from high fat to low-fat beef products. This is followed by the third and fourth scenarios, which proposes to restrict sales of moulds or smoke contaminated beef products and to ensure that products are certified. Pasture-raised products yielded the lowest welfare estimate across all the policy changes in class two. Akin to class two, the highest welfare improvement in class three is associated with policy scenario two that seeks to promote low-fat products, but with lower compensating surplus estimate compared to the estimate for the second class. Generally, all the remaining policy changes resulted in an improvement in welfare. Consumers in class four attained the highest welfare improvement from scenario one

and this is the highest compensating surplus estimate across all scenarios and classes. Followed by the third and fourth scenarios, which seeks to restrict sales of moulds or smoke contaminated beef products and to ensure that products are certified while low-fat percentage had the least welfare impact. Generally, the results reveal that compensating surplus estimates are relatively low at the individual level compared to estimates at the segment level. Specifically, the highest welfare estimate is associated with a shift towards low-fat products, whiles scenario four was the next highest welfare improvement policy change. Interestingly, policy scenario one, which seeks to promote pasture-raised product differentiation, reduces the welfare of consumers even though highest WTP was observed for this attribute. This means that knowing the willingness to pay estimate for an attribute is not enough and as such choice, experimental studies that stick to traditional WTP estimates alone may no longer be motivated enough in choice studies.

Table 5. Compensating surplus estimates for beef safety and quality policy scenarios

Attribute	Class 1	Class 2	Class 3	Class 4
Scenario 1	GH¢12.04 [9.50; 15.23]	GH¢23.26 [19.11; 26.04]	GH¢8.05 [7.97;16.42]	GH¢53.84 [47.63; 58.30]
Scenario 2	GH¢2.34 [1.33; 5.43]	GH¢49.21 [36.57;55.45]	GH¢8.10 [6.89; 11.43]	GH¢30.32 [27.79; 38.47]
Scenario 3	GH¢1.59 [-1.20; 4.56]	GH¢27.37 [23.67; 34.10]	GH¢5.44 [4.06; 7.23]	GH¢32.32 [29.09; 40.02]
Scenario 4	GH¢-5.32 [-6.45; -3.91]	GH¢27.11 [22.32; 31.78]	GH¢3.64 [2.89; 6.15]	GH¢31.68 [27.52; 39.11]

Scenario 1: Beef products are sold based on production method (product differentiations)
Scenario 2: Maximum allowable backfat content in beef products is reduced to low percentage
Scenario 3: Greyish or greenish beef products resulting from moulds or smoke sticks contamination as practised by some butchers in Ghana is restricted
Scenario 4: All beef products on the market are certified with certification stamp as evidence
Values in parentheses are confidence intervals at 95%.

6. Conclusions and policy implications

In this paper, the choice experimental approach has been employed to estimate willingness to pay and compensating surplus estimates for food safety and quality policy changes in the beef industry of Southern Ghana. Two heterogeneous modelling techniques were compared; the random parameter logit and latent class models were used to account for preference heterogeneity at the individual and segment level. Results show that there is considerable preference heterogeneity at both individual and segment levels with regards to differentiating beef products based on the production method, shift from high to low-fat beef products, restriction of grey coloured beef products resulting from contamination and assured certification of beef products for safety and quality purposes. People are willing to pay for all the food safety and quality attributes modelled at the individual level. Higher willingness to pay exists for pasture-raised products. Although it not possible at present to differentiate beef products based on production method due to lack of proper labelling, the economic benefit of initiating pasture-raised product differentiation to local livestock farmers would be evidently significant.

Four distinct classes of consumers were found in the sample population with each class exhibiting a different preference for the same set of safety and quality beef attributes. Overall, the majority of the consumers belong to class three and are willing to pay for all the attributes. This is not surprising considering the food safety scandals, food-borne illness and economic costs of fighting food-borne illness as well as the damages caused in recent years are evidence. There are considerable variations in preferences and willingness to pay estimates across the different consumer classes for the same set of safety and quality attributes. This suggests that food and drug authority (FDA) and policymakers in charge of safety and quality issues in the meat industry should think carefully about the particular type of meat and safety attributes that consumers value most, in designing specific food safety and quality plans. Heterogeneity in

preferences is related to traditional socioeconomic characteristics such as age, income, gender, education and number of dependants. Besides traditional socioeconomics, we found trust in health and safety inspection authorities, the competence of retailers and confidence in farmers to impact significantly on preferences for food safety and quality attributes. This suggests that consumers' attitude and level of trust in actors along the beef value chain plays a significant role in shaping consumers' purchasing behaviour in the Ghanaian beef industry. Therefore, future studies that account for heterogeneous preferences and willingness to pay for food products should consider trust, competence and confidence in actors along the value chain, since our findings indicate that these variables provide a better understanding of consumer behaviour.

The willingness to pay and welfare estimates show that the primary policy recommendation resulting for pasture-raised product differentiation is that, consumers in class one and four would need to be compensated to attain the highest improvement in their welfare. Although, the majority of the respondents (class two and three) were willing to pay premiums for pasture-raised products and still attain substantial improvement in their welfare. Members of class two would need to be compensated to accept low-fat products in order to ascertain highest welfare improvement. Notwithstanding, consumers in class three and four were willing to pay premiums for low fat with a significant improvement in their welfare. All consumer classes were willing to pay premiums for reddish steak colour and assured certification whiles attaining significant improvement in welfare, with the exception of class one where members' welfare was reduced for assured certification. Generally, welfare improvement varies from one class to another, with classes two and four attaining the highest welfare benefits. Hence, there are imperative segmental equity issues that need to be taken into consideration while designing food safety and quality strategies to minimize foodborne diseases. The compensating surplus estimates at the individual level was generally low compared to the segment level, even though

consumers are willing to pay for the attributes. The implication for future research is that choice evaluation studies should not be limited to only willingness to pay estimates; rather compensating surplus estimates should accompany WTP estimates for efficiency and policy purposes. Therefore, food policy-makers should take into account whose welfare will be impacted positively by food safety and quality policy changes, particularly Ghana. If the target is to minimize foodborne risk and maximize the welfare of consumers, the reduction in maximum allowable fat content coupled with restrictions on the sales of moulds or smoke contaminated beef and certification of products should be implemented. Pasture-raised product differentiation would be a feasible marketing strategy, with compensations to a small fraction of consumers.

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End Notes:

[1] The class-specific WTP estimates are computed using parametric bootstrapping technique when WTP estimates are assumed to vary from one class to another.