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Economic welfare implications of policy changes regarding food safety and quality in Ghana

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Abstract

Food safety and quality issues in sub-Sahara Africa are receiving increasing attention from governmental and non-governmental organisations by raising awareness of food safety and quality incidents. This paper has examined the economic welfare implications of policy changes in relation to safety and quality among 400 beef consumers in Southern Ghana. We conclude that most respondents are willing to pay premiums to assure food safety and quality. The willingness-to-pay (WTP) estimates vary significantly as a function of respondents' underlying attitudes towards food safety and quality issues. There are considerable variations in preferences, willingness to pay and welfare effects across the different consumer classes. There is evidence of crucial segmental equity issues in food safety and quality policies. The paper suggests that future research and policy decisions on food safety and quality changes should consider those segments of consumers whose welfare can potentially be improved or reduced due to the policy changes.

Key words: economic welfare; food policy; food quality; food safety; Ghana

1. Introduction

Food safety and quality issues in sub-Saharan African countries are receiving growing attention from governmental and non-governmental organisations. Consumers in sub-Sahara Africa and other developing regions are becoming progressively more aware of food safety and quality issues as urbanisation proceeds and incomes continue to rise at increasing rates (Owusu-Sekyere *et al*. 2014; Baker *et al*. 2016;). 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; Thunström *et al*. 2016; Ortega & Tschirley 2017).
Nonetheless, guaranteeing food safety and quality in modernising economies encompasses substantial costs, and the present income levels of emerging economies are far lower than in developed countries (Baker *et al*. 2016). 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 using different standards, such as process, product or information standards (Caswell 2003).

Food policy changes have implications for consumers' welfare and utility, given the associated costs of such policies (Birol *et al*. 2009). This paper focuses on the income change needed to keep beef consumers at their initial utility level, assuming that the food safety and quality policy changes are implemented. The overall effect of introducing new products or changes in product attributes on consumer welfare in sub-Saharan Africa in economic terms needs to be given particular attention. The welfare assessment of changes in food safety and quality policy provides an economic justification for implementing specific policies. Notably, welfare measures of changes in food safety and quality attributes, apart from minimising the economic costs of foodborne illness and reducing the health risk (FAO 2009), could provide evidence-based policy scenarios for developing the food sector, and for improved policymaking and regulation towards safer livestock and meat production, marketing and consumption (FAO 2009; FDA 2013).

One aspect of welfare estimates arising from changes in food quality and safety policy is consumers' trust and confidence in and perception of food quality and safety authorities and actors (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. 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).

An assessment of consumers has shown that their readiness to pay for safety and quality livestock product attributes has been on the ascendancy (Lusk & Norwood 2005; Olynk *et al*. 2010; Schumacher *et al*. 2012). Some documented studies have emphasised preferences and willingness to pay (WTP) for country-of-origin labelling, traceability and food safety enhancement attributes among German and US consumers (Enneking 2004; Loureiro & Umberger 2007; Lim *et al*. 2013). Also, Ortega *et al*. (2011) assessed the demand for food safety attributes in China. All these studies have focused mainly on developed countries, with a few studies focusing on developing countries, particularly in sub-Saharan Africa. Owusu-Sekyere *et al*. (2014), however, examined consumers' choices and willingness to pay for food safety assurance labels in two regions in Ghana. Nonetheless, this study and the growing body of literature has tended to focus on traditional willingness-to-pay estimates at the expense of the economic impact of changes in product attributes on consumers' welfare. Additionally, these studies have identified social, economic and demographic factors influencing consumers' choice of food safety and quality attributes, with little attention being paid to respondents' attitudes towards food safety and quality occurrences. Hence, this study raises the following research questions: What are the economic impacts of changes in food safety and quality attributes on the welfare of consumers in Ghana? How do consumers' choice of food safety and quality attributes differ as a function of their underlying attitudes and behaviour in Southern Ghana?

The study hypothesises that accounting for consumers' underlying attitudes towards food safety and quality has a significant impact on their class-assignment probabilities (Hess *et al*. 2013; Mariel *et al*. 2015).

The findings of this study 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 losses regarding changes in food safety and quality attributes for 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, the findings of this study could help in the implementation of food safety and quality measures and could enlighten policymakers and regulators on the likely distribution of welfare benefits across consumer segments. Notably, the findings of the current study could give detailed insight into the economics of food safety and quality in emerging and developing countries. Accounting for consumers' welfare 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 Africa.

2. Materials and methods

2.1 Conceptual framework and empirical strategy

The present paper employs the hybrid latent class (HLC) framework, which uses the hybrid choice modelling structure described by Hess *et al*. (2013). The HLC model consists of structural and measurement aspects. The structural equations part is based on random utility theory, which postulates that consumers are rational and prefer products that give them the highest utility (McFadden 1974; Hensher & Greene 2003). Hence, the utility of consumer i for alternative k in the choice situation q is expressed as:

$$U_{kiq} = V(x_{kiq}, h_i, \gamma) + \mu_{kiq}, \quad (1)$$

where U_{kiq} is the latent unobservable utility for the k^{th} alternative in the choice scenario q; $V(x_{kiq}, h_i, \gamma)$ is the observable systematic portion of utility function, with x_{kiq} denoting a vector of attributes of alternative k, h_i denoting a vector of socioeconomic characteristics, γ denoting a vector of parameters, and μ_{kiq} being the random component of the utility, which is independently and identically distributed over all alternatives and choice scenarios.

Each segment (z) is distinguished by a distinct class-specific utility estimate, denoted as γ_Z. Assuming that an individual i belongs to segment z, the conditional probability that he or she selects alternative k in choice situation *q* can be specified as:

$$P_i = Pr(y_{iq} / z, x_i) = \prod_{q=1}^{Q_i} \frac{\exp^{(\gamma_z x_{kiq})}}{\sum_{l=1}^{L} \exp^{(\gamma_z x_{kiq})}}, \quad (2)$$

where y_{iq} represents the order of choices for individual i over Q_i. Equation (2) is a product of multinomial logit probabilities, with the scale parameter fixed to one for identification purposes. The latent class methodology assumes that a consumer's real class allocation is probabilistic, since the classes are not easily comprehended by the researcher. Hence, we represent the class assignment probability ($\Omega_{i,Z}$) of individual *i* in a logistic model form, as in Equation (3):

$$\Omega_{i,z} = \frac{exp^{(\phi_{o,z} + \lambda_z \square i)}}{\sum_{z=1}^{Z} exp^{(\phi_{o,z} + \lambda_z \square i)}} \quad (3)$$

The utility of a given segment is a function of socioeconomic factors (h_i), while λ_z and ϕ_o represent vectors of parameters and a constant for segment z respectively. The constant for one of the segments is fixed at zero for normalisation purposes. As a result, the unrestricted likelihood over the order of pragmatic choices is then obtained by taking the expectation over all segments, Z. This is expressed as:

$$P_i = Pr(\frac{y_{iq}}{x_{i)}} = \sum_{z=1}^{Z} \Omega_{i,z} \prod_{q=1}^{Q_i} \frac{exp^{(\gamma_z x_{kiq})}}{\sum_{l=1}^{L} exp^{(\gamma_z x_{kiq})}} \quad (4)$$

Regarding the second aspect of the HLC (measurement aspects), recent studies have revealed that the addition of consumers' responses to attitudinal questions as part of class member estimates or explanatory variables can potentially lead to estimation problems, such as endogeneity bias and erroneous measurements (Ben-Akiva *et al*. 1999; Hess *et al*. 2013). In this study, we expressed the individual's attitude or behaviour towards food safety and quality as a latent variable (δ_i), which is specified as:

$$\delta_i = h(H_i, \vartheta) + \ell_i, \quad (5)$$

where $\hbar(H_i, J)$ is the deterministic component, with $\hbar(\cdot)$ as a linear function; H_i denotes a vector of socioeconomic characteristics of individual i, and ϑ is a vector of parameters to be estimated; ℓ_i is a random and normally distributed term, with 0 the mean and standard deviation ζ_i. The estimates of the attitudinal factors are then used as endogenous variables in the estimation. Specifically, the estimate of the a^{th} attitudinal factor for individual i is expressed as:

$$t_{ai} = f(\delta_i, \xi) + \varepsilon_i, \quad (6)$$

where t_{ai} is a function of the latent variable (δ_i) and a vector of parameters (ξ), and ε_i is a random and normally distributed term, with 0 the mean and standard deviation φ_i. The ordered logit framework was employed for the attitudinal factors (a_1 - a_5). The probability of a given observed attitudinal factor t_{ai}(a = 1 … 5) is specified as:

$$T_{t_{ai}} = t_{(t_{ai}=k_1)}\left[\frac{\exp^{(\tau_{a,k_1}-\xi_a\delta_i)}}{1+\exp^{(\tau_{a,k_1}-\xi_m\sigma_i)}}\right] + \sum_{c=1}^{C-1} t_{(t_{ai}=k_1)}\left[\frac{\exp^{(\tau_{a,c}-\xi_a\delta_i)}}{1+\exp^{(\tau_{a,c}-\xi_a\delta_i)}} - \frac{\exp^{(\tau_{a,(c-1)}-\xi_a\delta_i)}}{1+\exp^{(\tau_{a,(c-1)}-\xi_a\delta_i)}}\right] + t_{(t_{ai}=k_C)} \quad (7)$$

$$\left[1 - \frac{\exp^{(\tau_{a,(C-1)}-\xi_a\delta_i)}}{1+\exp^{(\tau_{a,(C-1)}-\xi_a\delta_i)}}\right],$$

where ξ_a captures the influence of the unobserved variable (δ_i) on the indicator t_{ai}. The set of estimated threshold characteristics (parameters) resulting from equation (7) are denoted by $\tau_{a,1}$, $\tau_{a,2}$ … $\tau_{a,C-1}$. The unobserved variable (δ_i) is added to the rest of the model via the class assignment probabilities expressed in Equation (3). In line with Mariel *et al*. (2015), we re-specified Equation (3) as in Equation (8), because during the class assignment specification it was found that there were no significant socioeconomic interactions, except for those measured by means of the unobserved variable (δ_i), as in Equation (5). Equation (8) is then specified as:

$$\Omega_{i,z} = \frac{\exp^{(\phi_{o,z}+\phi_{1,z}\,\delta_i)}}{\sum_{z=1}^{Z}\exp^{(\phi_{o,z}+\phi_{1,z}\,\delta_i)}}, \quad (8)$$

where $\phi_{0,z}$ and $\phi_{1,z}$ denote the parameters to be estimated. The impact of the latent variable (δ_i) in defining the likelihood of an individual i belonging to a given consumer segment is determined by the sign of $\phi_{1,z}$.

2.2 Choice experiment design

This study employed the choice experiment design. The design of the study focused on policy-relevant attributes that are of interest to consumers in Ghana in terms of the safety and quality of beef products. Five important policy-relevant attributes were chosen, namely the method of animal production, fat content, steak colour, health inspection (certification) and price. We chose these attributes because they are policy-relevant attributes that are of interest to the Food and Drugs Authority (FDA) and municipal health directorates in Ghana. The attributes and their levels of measurement are presented in Table 1.

Table 1: Attributes and levels of measurement

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

1 US Dollar (US$) =4.39 Ghana Cedi (GH¢) in December 2017

The production method attribute refers to raising cattle either solely on pasture or on a conventional basis. Implementing a pasture-raised product-differentiation policy in Ghana could potentially improve the livelihood of local livestock farmers due to the associated price premiums for pasture-raised products (Conner & Oppenheim 2008; Owusu-Sekyere *et al*. 2014).

The fat content attribute refers to the percentage of back fat by mass that should be allowed in beef products. Minimising the level of fat in beef products will help reduce fat-induced illnesses (Curtis *et al*. 2011; Mare *et al*. 2013). The health inspection (certification) attribute refers to health inspection of live animals by the FDA before slaughter, after which a certification stamp is issued (Nilsson *et al*. 2006; FDA 2013).

The attribute steak colour refers to the colour of the beef cut in the retail shops. The first impression that consumers have of any meat product is its colour (Mare *et al*. 2013). While steak colour indicates freshness and contamination, the grey or greenish colour of beef may indicate contamination from moulds or smoke sticks that leads to the occurrence of foodborne diseases in consumers.

The price attribute has three levels – GH¢15, GH¢12 and GH¢10 per kilogram of ordinary boneless beef cuts. The attributes and their levels were combined using Ngene software to create a random-parameter panel-efficient design with two sustainability alternatives (A and B) and a "none" option (Choice Metrics 2014).

2.3 Description of data

The survey was conducted in the southern part of Ghana. The Kumasi Metropolis and Sunyani Municipality were selected because of their multicultural and multi-ethnic nature and high beef-consumption status (GLSS 2010). We employed a multistage sampling procedure to select 400 meat buyers from three income-class residential areas. These areas are high-, middle- and low-income residential areas. Two meat markets were randomly selected from each of the residential zones. The income stratification supports an existing finding that income has a significant impact on consumer choices (Boccaletti & Nardella 2000). The survey focused on meat buyers, with particular attention being paid to beef consumers, because there are greater preferences for beef related to other meat products, making it easier to get high representation. Prior to data collection, the questionnaire was pre-tested using 15 respondents. The questionnaire queried demographic characteristics and attitudinal variables and included choice questions. Table 2 presents the food safety and quality related statements.

Table 2: Attitudinal statements about food safety and quality

Indicator	Description	Expected signs
t_1	It is reasonable to pay more to ensure food safety and quality	+
t_2	The occurrence of foodborne diseases is greatly overemphasised	-
t_3	Livestock farmers are competent in ensuring excellent health status of animals sold for slaughter	-
t_4	Health and food safety inspection authorities are investing enough money to control foodborne diseases	-
t_5	Government is responsible for food safety and quality assurance	-

Answers ranged from "strongly disagree" (1) to "strongly agree" (5)

A preliminary multivariate analysis of the attitudinal factors was conducted to confirm that the factors (t_1 - t_5) really represent the underlying construct (Daly *et al*. 2012) and the test results proved so. In the interest of brevity, the results are not presented but are available upon request.

3. Results and discussion

3.1 Descriptive characteristics of respondents

The descriptive statistics of the respondents are presented in Table 3. The mean age of the respondents was 37 years. Forty-three per cent of the respondents were men, while 57% were women. The high proportion of women 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 dependants was 4.76, which falls within the national range of 3.4 to 6.5 (GLSS 2010). The mean monthly household income was GH¢1 206.69, which compares well with the national average household income of GH¢1 217 (GLSS 2010). In terms of education, 23% of the respondents had attained a basic education, 25% had attained secondary education, whereas 22% and 30% had attained tertiary and postgraduate education respectively.

Table 3: Descriptive statistics of socioeconomic factors used in the model

Socioeconomic factors	Mean	Standard deviation
Age (Years)	37.06	9.18
Dependents (Number of dependents)	4.79	2.30
Income (Monthly income in GH¢)[a]	1 206.69	33.2
Female (1 if female, 0 otherwise)	0.57	0.12
BasicEdu (1 if basic education was attained, 0 otherwise)	0.23	0.11
SecondaryEdu (1 if secondary education was attained, 0 otherwise)	0.25	0.09
TertiaryEdu (1 if tertiary education was attained, 0 otherwise)	0.22	0.07
PostgraduateEdu (1 if postgraduate education was attained , 0 otherwise)	0.30	0.12

Source: Authors' calculations. [a] 1 US dollar (US$) = 4.39 Ghana Cedi (GH¢) in December 2017

3.2 Heterogeneity in preferences for food safety and quality attributes

The empirical analysis began with the identification of an optimal number of latent classes in our data. Using the AIC and BIC criteria, we found the four latent-class model to be optimal and, as such, four-class models were estimated for the standard latent and hybrid latent class models (Ben-Akiva *et al*. 1999). Four distinct consumer classes (segments) were found in the sample population, with each class exhibiting a different preference structure for the same set of safety and quality attributes of beef, as shown in Table 4. Belonging to a given class depends significantly on the respondents' observable socioeconomic or attitudinal factors. From the standard latent class estimates, 64.9% of the sample have the fitted likelihood of belonging to class 3, whereas 18.2%, 11.9% and 4.9% are likely to fit into classes 4, 2 and 1 respectively. The largest proportion of the heterogeneous respondents belong to class 3. The identification of different classes with different magnitudes, directions and significant levels of utility estimates across diverse latent segments exhibits the existence of preference heterogeneity (Owusu-Sekyere *et al*. 2014). This implies that preference and willingness-to-pay estimates for safety and quality attributes are not illustrative of the complete sample, but rather are aligned with specific consumer segments (Hensher & Greene 2003).

Consistent with economic theory, the results show a significantly negative coefficient for the price variable in all the classes at the conventional levels, suggesting a decline in utility as prices increase, and that all four classes of consumers are sensitive to prices (McFadden 1974).

In class 3 there are significantly positive preferences for all the safety attributes considered, and a negative utility from the status quo. The significantly negative coefficient for the "none" option shows that there is status quo bias, suggesting that respondents in this segment are more likely to choose one or more of the food safety and quality options, all things being equal – a result supported by the findings of Birol *et al*. (2009). The policy implications are that the majority of consumers in Ghana are interested in food safety assurance attributes in the livestock sector.

Class 4 is the second highest consumer segment. Members of this class obtain negative utility from the pasture-raised livestock production method. However, the members of this segment attain significantly positive utilities from the remaining food safety attributes, as well as from the status quo option.

For class 2, we found the alternative specific constant (none), which captures the effects in utility from the status quo, to be significantly positive in this class. Members of this class obtain significantly positive utility from all the food safety and quality attributes. Members of class 1, which represents the smallest segment, obtain negative utility from the pasture-raised production method and show an insignificant preference for the low-fat attribute. Members of this class obtain positive utilities from assured health certification and reddish steak colour, as well as from the status quo option.

Table 4: Maximum likelihood estimates from standard latent class and hybrid latent class models

	Standard LC model				**Hybrid LC model**			
No. if respondents	400				400			
Observations	3 600				3 600			
Log-likelihood	-1 589.54				-1 779.34			
Parameters	17				35			
	Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4
Class probability	0.049	0.119	0.649	0.182				
Utility function	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
$\gamma_{Prodmet}$	-1.249*** (-3.02)	0.027** (2.34)	0.320** (2.40)	-0.214** (-2.56)	-1.949*** (-3.81)	0.297*** (4.34)	0.377*** (4.00)	-0.217*** (-3.56)
γ_{Fatcon}	0.136 (1.34)	0.111** (2.40)	0.731 ** (2.17)	0.210** (2.53)	0.196 (1.49)	0.133*** (5.40)	0.373 *** (8.17)	0.230*** (5.53)
γ_{Stkcol}	0.117*** (3.16)	0.045** (2.05)	0.441* (1.69)	0.103** (2.44)	0.270*** (6.06)	0.219*** (5.05)	0.581** (1.98)	0.192*** (4.44)
γ_{Hcert}	0.345** (2.02)	0.134 ** (2.14)	1.021*** (3.12)	0.155** (2.21)	0.735** (2.62)	0.224 *** (3.14)	2.721*** (8.12)	0.204*** (4.21)
γ_{None}	0.207* (1.73)	0.039** (2.29)	-0.805** (-2.30)	0.406** (2.31)	0.607** (2.30)	0.739*** (6.29)	-1.005*** (-5.30)	0.806*** (3.31)
γ_{Price}	-0.104* (-1.67)	-0.012** (-2.08)	-0.058*** (3.02)	-0.115** -(2.04)	-0.212** (-2.12)	-0.019*** (-3.08)	-0.078*** (-4.12)	-0.019*** (-5.04)
Class allocation function								
$\phi_{0,2}$	1.689*** (3.79)				3.461*** (6.33)			
$\phi_{1,2}$					-2.342 (-1.36)			
$\phi_{0,3}$	1.616*** (4.60)				1.233*** (5.41)			
$\phi_{1,3}$					2.662*** (3.54)			
$\phi_{0,4}$					-0.312*** (-2.36)			
$\phi_{1,4}$					-3.042*** (-3.36)			

Authors' calculations, *** = significant at 1%, ** = significant at 5%, * = significant at 10%

Although the estimates from the two models appear to be similar, it is significant to note that the estimates from the hybrid latent class are more accurate, as anticipated, due to the inclusion of attitudinal information (Mariel *et al*. 2015). Moreover, the HLC model is consistently estimated with a specification that accounts for both potential endogeneity and measurement errors. This confirms the stated hypothesis that the incorporation of additional attitudinal or behavioural information in the hybrid latent class model improves the accuracy of the estimated coefficients and has a significant effect on class assignment probabilities. This is supported by the fact that all the incorporated latent attitudinal variables are significantly different from zero at the conventional levels (see Table 5).

Table 5 presents the results of the structural and measurement components of the hybrid latent class model. The results indicate that the latent variable really informs the allocation to latent classes in the hybrid latent class models. It is revealed that the latent variable significantly affects all five attitudinal factors ($\xi_{t1}.....\xi_{t5}$) relating to food safety and quality assurance. Similarly, the signs of the attitudinal indicators indicate that consumers who are more concerned about safe and high-quality meat products have a higher probability of being associated with a higher latent variable. Specifically, and consistent with our hypothesis, we found that *segment 2* and *segment 3* assign higher values to the statement that it is reasonable to pay more for food safety and quality assurance. This is indicated by the significantly positive coefficient of ξ_{t1}.

The results further reveal that the remaining four indicators attract lower values, as shown by the significantly negative coefficients, suggesting that *segment 2* and *segment 3* are less likely to allocate higher values to statements that the occurrence of foodborne diseases are greatly overemphasised, and that livestock farmers are competent in ensuring the excellent health status of animals sold for slaughter. Also, these segments of consumers place less value on the statement that health and food safety inspection authorities are investing enough money to control foodborne diseases, and that food safety and quality assurance are the responsibility of government.

From the class allocation function estimates, the results indicate that consumers with higher latent variables have higher likelihoods of belonging to classes 2 and 3, whereas those with the lowest latent variables are likely to belong to classes 1 and 4, as the sign of $\theta_{1,4}$ is significantly negative. The socioeconomic factors further indicate that the latent variable is very dominant among young female consumers with a high income and a number of dependants. This is contrary to the findings of Roininen *et al*. (1999), but consistent with the findings of Tonsor *et al*. (2005) and Olynk *et al*. (2010). The results further show that these segments (2 and 3) of respondents are more likely to have attained secondary to postgraduate education.

3.3 Implied trade-offs and monetary values attached to food safety and quality attributes

The implicit trade-offs and willingness-to-pay values corresponding to significant attributes are presented in Table 6 for the standard latent class model. The estimates were calculated based on the inferred monetary evaluation of different variations in the attribute levels. A positive willingness-to-pay estimate indicates the amount respondents are willing to pay for a change in food safety and quality assurance from its base level, whereas a negative amount indicates how much the respondents are willing to offer to avert the change.

Table 5: Results of hybrid latent class structural and measurement components

Variable	Coefficient	t-value
Structural equations (specification of latent variables)		
ϑ_{Age}	-0.508***	3.01
$\boldsymbol{\vartheta_{Female}}$	2.171***	3.62
$\boldsymbol{\vartheta_{Dependants}}$	1.562**	2.34
$\boldsymbol{\vartheta_{Income}}$	0.891***	4.13
$\boldsymbol{\vartheta_{BasicEdu}}$	-1.019***	-8.08
$\boldsymbol{\vartheta_{SecondaryEdu}}$	0.151***	7.78
$\boldsymbol{\vartheta_{TertiaryEdu}}$	0.521***	4.03
$\boldsymbol{\vartheta_{PostgraduateEdu}}$	1.105***	5.03
Measurement equation (effects of latent variables)		
ξ_{t_1}	5.348***	7.40
ξ_{t_2}	-2.079***	-6.99
ξ_{t_3}	-0.707***	-3.52
ξ_{t_4}	-5.068***	-5.65
ξ_{t_5}	-6.237**	-4.25
Measurement equation (threshold)		
$_{t_1}$,1,2&3	-2.176**	-5.01
$_{t_1}$,4&5	-0.507***	-2.38
$_{\boldsymbol{t_2}}$,1,2&3	-1.194***	-3.29
$_{t_2}$,4&5	-0.094*	1.74
$_{t_3}$,1,2&3	-0.558***	-4.01
$_{t_3}$,4&5	-0.319**	2.05
$_{t_4}$,1,2&3	-0.966***	-3.65
$_{t_4}$,4&5	-0.321**	-2.43
$_{t_5}$,1,2&3	-1.972**	-2.40
$_{t_5}$,4&5	-0.244***	-2.03

Authors' calculations. *** = significant at 1%, ** = significant at 5%, * = significant at 10%

The results show that members of class 1 are willing to pay a premium of US$ 0.8 to assure health certification of meat products, whereas they are willing to accept as much as US$ 2.7 to choose a pasture-raised beef product. For class 2, members are willing to offer US$ 2.6 and US$ 2.1 for assured health certification and low-fat content respectively. Additionally, members of class 2 are willing to offer US$ 0.9 and US$ 0.5 for reddish steak colour and pasture-raised beef respectively. Respondents in class 3 are willing to pay higher premiums of as much as US$ 4 and US$ 2.9 for assured health certification and low-fat beef products respectively. Also, members of this class value reddish steak colour and pasture-raised beef products, at US$ 1.7 and US$ 1.3 respectively. In addition, members of class 3 are willing to accept US$ 3.2 as compensation to choose the status quo option. For class 4, the results show that the highest premium was attached to low-fat content (US$ 0.4) among the food safety and quality attributes, followed by assured health certification. Also, members of this class are willing to accept compensation to choose a pasture-raised beef product. This means that classes 1 and 4 are likely to be made up of consumers who perceive pasture-raised products with scepticism.

Table 6: Inferred trade-offs and monetary values attached to food safety and quality attributes from the standard latent class model

Attribute	Class 1 (US$)	Class 2 (US$)	Class 3 (US$)	Class 4 (US$)
Pasture raised	-2.7 [-3.3 to -1.7]	0.5 [0.3 to 1.5]	1.3 [0.9 to 1.7]	-0.4 [-0.8 to -0.4]
Low fat content	Ns	2.1 [0.8 to 2.4]	2.9 [2.1 to 3.3]	0.4 [0.3 to 1.1]
Reddish steak colour	0.3 [0.1 to 0.7]	0.9 [0.6 to 1.3]	1.7 [1.0 to 2.1]	0.2 [0.1 to 0.7]
Assured health certification	0.8 [0.7 to 1.3]	2.6 [2.1 to 3.1]	4.0 [2.8 to 4.4]	0.3 [0.2 to 0.7]
None	0.5 [0.7 to 1.5]	0.8 [0.7 to 1.0]	-3.2 [-3.5 to -2.2]	0.8 [0.7 to 1.0]

Source: Authors' calculations
Note: Ns = not significant

An evaluation of the inferred trade-offs and valuation estimates shows that there are remarkable variations in the preferred structure of the food safety and quality attributes across the identified latent classes. Given that the latent variable incorporated a set of socioeconomic characteristics, we simulated the class assignment probabilities of the identified consumer segments, and the results are presented in Table 7. More emphasis is placed on classes 3 and 2, as they are the two segments that have significantly positive preferences for all the food safety and quality attributes.

Table 7: Characteristics of the identified latent segments from the hybrid latent class

Variable	Class 2	Class 3	Class 4
Age	> 45	< 43	< 27
Gender	Women	Men	Women
Dependents	> 5	> 4	< 3
Income (GH¢)	< 1 507 (US$ 343)	> 2 500 (US$ 569)	< 1 015 (US$ 231)
BasicEdu	Yes	Yes	Yes
SecondaryEdu	Yes	Yes	Yes
TertiaryEdu	Yes	Yes	No
PostgraduateEdu	No	Yes	No

Source: Authors' calculations
Note: Class 1 was used as the reference segment

The results show that members of class 2 are women who are older than 45 years of age with more than five dependants and who earn less than US$ 343. Members of this class have attained basic to tertiary education relative to class 1. Members of class 3 are defined as men who are younger than 43 with more than four dependants and who earn more than US$ 569. The members of this class have attained up to a postgraduate level of education compared with class 1. Class 4 comprises women who are younger than 27 years of age with fewer than three dependants and who earn less than US$ 231. The highest level of education attained by members of this segment is secondary education.

Table 8 presents the implied trade-offs, and the monetary amount consumers attach to the safety and quality attributes of the hybrid latent class model. The results indicate that the monetary values attached to the attributes among classes 2, 3 and 4 vary significantly. The simulated welfare estimates reveal that, for all the safety and quality attributes considered, members of class 3 offered higher premiums relative to class 1. Specifically, the highest premium of US$ 4.4 was offered for assured health certification, followed by low-fat content, with an amount of US$ 3.1 among class 3 members, who form the largest segment.

Table 8: Implied trade-offs and monetary valuation of food safety and quality attributes from the HLC model

Attribute	Pooled (US$)	Class 2 (US$)	Class 3 (US$)	Class 4 (US$)
Pasture raised	1.1[a] [0.7 to 1.7]	0.9 [0.6 to 1.1]	1.5 [1.1 to 1.9]	-0.6 [-1.0 to -0.4]
Low fat content	1.7[b] [1.2 to 2.1]	2.2 [1.3 to 2.5]	3.1 [2.7 to 3.6]	1.1 [0.7 to 1.6]
Reddish steak colour	0.9[c] [0.5 to 1.5]	0.8 [0.5 to 1.5]	1.9 [1.3 to 2.1]	0.4 [0.2 to 0.8]
Assured health certification	2.6[d] [1.5 to 3.0]	2.8 [2.2 to 3.2]	4.4 [3.7 to 4.8]	0.9 [0.4 to 1.1]
None	-0.8[e] [-1.1 to -0.1]	0.7 [0.6 to 1.0]	-3.3 [-3.8 to -2.8]	0.9 [0.5 to 1.1]

Values in parentheses are confidence intervals at 95% from the Krinsky and Robb approach
[a, b, c, d, e] indicate that the estimate is statistically different from all other WTP estimates

For class 2, the welfare estimates show that consumers attach higher premiums to assured health certification and low-fat content, similar to class 3. However, the values attached to these attributes are lower than those of class 3 members. For class 4, members are mainly concerned about low-fat beef products, as indicated by the significantly positive preferences and high premiums relative to class 1. This is followed by assured health certification. Reddish steak colour is the least valued among all the safety and quality attributes in classes 2 and 3, as well as in the pooled sample.

Member of class 3, who form the majority, obtain disutility from the status quo option and are willing to accept compensation of US$ 3.3. This implies that, given the current consumer consciousness about foodborne diseases and food safety issues, it has become relevant for food producers to reconsider the food safety and quality assurance of their production decisions, since the introduction of food safety and quality assurance labelling could result in most consumers having disutility for products that do not carry safety and quality information. For the pooled sample, the results generally reveal that the respondents are willing to offer a higher premium to ensure health certification of meat products, followed by the promotion of low-fat meat products and pasture-raised products.

4. Conclusions and policy implications

Heterogeneous preferences for and economic welfare implications of food safety and quality attributes were examined in Southern Ghana using a hybrid latent class model. Consistent with earlier findings by Owusu-Sekyere *et al*. (2014), we conclude that most respondents are willing to pay premiums for both food safety and quality assurance in the meat industry. Health certification of meat products is highly valued by the majority of the respondents, and this supports the available evidence of Ghanaian consumers' preferences and the current debate on food safety assurance in the country.

Contrary to earlier studies, which examined preferences at the individual level (Enneking 2004; Conner & Oppenheim 2008; Mare *et al*. 2013), we conclude that preferences for food safety and quality attributes are better explained at the segment level in Ghana. Four distinct segments of consumers were identified in the sample population, with each class exhibiting different preference structures and willingness-to-pay estimates for the same set of safety and quality attributes of beef. Overall, the majority of the consumers belonging to class 3 are willing to pay for all the attributes. This is not surprising, considering the food safety scandals, foodborne illnesses and economic costs of fighting foodborne illness, as well as the damage caused in recent years. This suggests that the 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 when designing specific food safety and quality plans.

A shift from the production of high- to low-fat beef products was valued the second highest among all the attributes. This suggests that consumers are shifting towards the consumption of low-fat products in the study areas. Price premiums exist for pasture-raised beef products. Although it is not possible at present to differentiate beef products based on production method due to a lack of proper labelling, the economic benefit of initiating pasture-raised product differentiation among local livestock farmers would evidently be significant, since about 77% of the respondents (classes 2 and 3) were willing to pay premiums for pasture-raised products and still obtain a substantial improvement in their welfare.

Besides traditional socioeconomic factors identified in previous studies (Enneking 2004; Mare *et al*. 2013; Owusu-Sekyere *et al*. 2014), we conclude that the heterogeneity in preferences for food safety and quality attributes differs significantly as a function of consumers' underlying attitudes towards food safety and quality issues. We demonstrate that respondents exhibit a range of distinct preferences, and that the disparities in behaviour may be manifesting in dissimilarities in underlying attitudes. This provides the rationale for the consideration of consumers' attitudes in the quest to understand and design effective food safety and quality policies.

Furthermore, it is concluded that, to promote the market for safe and high-quality meat products, it is vital to make the public understand that ensuring food safety and quality is the responsibility of all citizens, not just of the government. Strategies to ensure food safety and the quality of meat products should consider educating the public to understand that the occurrence of foodborne diseases is real and not overemphasised. The public should be educated to contribute to or invest in ensuring food safety in the food sector.

Based on the welfare estimates, we conclude that an improvement in economic welfare varies from one class to another, with class 3 obtaining the highest welfare benefits. There are imperative segmental equity issues that need to be taken into consideration when designing food safety and quality strategies to minimise foodborne diseases. The implication for future research is that choice-evaluation studies should not be limited only to willingness-to-pay estimates; instead, welfare estimates should accompany WTP estimates for efficiency and policy purposes. Our study contributes to the current debate on the possibility of using food safety and quality labelling to address food safety and quality incidents, such as foodborne diseases in the food and agricultural sector, particularly in emerging economies.

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