

Consumer Preferences on Peanut Aflatoxin Safety in Ghana

by

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Abstract

Food safety attracts growing attention in discussions among scientists, policymakers, and the general public. The introduction and enforcement of appropriate regulatory standards for pervasive food toxins, such as aflatoxins, is a major policy issue. This thesis determines consumer preferences for aflatoxin-free peanut, and how consumer concern for food safety impacts willingness to pay for safer foods. To this end, I analyze a contingent valuation data under a utility maximization framework that incorporates ‘risky’ foods. A cumulative binary logistic regression model is estimated.

Results show that consumers in Ghana massively approve of aflatoxin regulation interventions, and are prepared to pay a conservative price premium of 16%. Also, findings show that consumers prioritize food safety above all other factors that influence their market decisions, including prices. Guaranteeing good health is a desirable goal for consumers in Ghana.

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CHAPTER 1

INTRODUCTION

1.1 Background and Problem Statement

Peanut (*Arachis hypogaea*) is an important food crop produced and consumed in many countries (Nwokolo, 1996). As a result of heavy consumption within producing countries, only 5% of world peanut production is traded across borders (Diop, Beghin and Sewadeh, 2004).

The peanut crop is a major source of protein in Ghana, and it is predominantly grown in the northern regions (Atuahene-Amankwa, Hossain and Assibi, 1990). Food products commonly derived from peanut include butter (paste), confectionaries, oil, and cake. Figure 1 shows peanut production in Ghana from 1995 through 2008. Domestic consumption is high and nearly identical to local supply. Hence, cross-border trade is small. Peanut production in the country has generally increased since the middle of the 1990s.

In the developing world, peanut and many other basic food staples are susceptible to mycotoxin contamination, especially aflatoxins (Jolly et al., 2006).¹ Mycotoxins are produced by a group of fungi which contaminate food crops during production and after harvest. Many global food supply chains are affected by the mycotoxin contamination problem. Particularly, environmental conditions such as high temperature and humidity, insect infestation, as well as improper hygiene are known to be conducive to the growth of mycotoxin-producing fungi (Dohlman, 2003). As a result, incidence of the mycotoxin problem is high in tropical and

¹ Mycotoxins are composed of chemical substances produced by fungi which contaminate crops during production and after harvest. Aflatoxins of concern are designated B1, B2, G1 and G2 (Park et al., 2002).

sub-tropical regions of the world. This adversely affects the health and economic welfare of populations. Predominantly, available research findings show strong associations between aflatoxins exposure and a host of negative health outcomes (Wang et al., 2001; Turner et al., 2003; Williams et al., 2004; Lewis et al., 2005; Wu, 2006; Liu and Wu, 2010; Wu and Khlangwiset, 2010). Examples of disease burdens linked to aflatoxins and other harmful mycotoxins include liver cancers, mycotoxicosis (e.g. aflatoxicosis), kwashiorkor in children, and suppression of individuals' immune systems leading to the onset of opportunistic diseases (Montesano, Hainaut, and Wild, 1997; Wild and Hall, 1999; and Dash et al., 2007). Among the notable groups of mycotoxins — aflatoxins, fumonisins, zearalenone, and ochratoxins — this thesis focuses on aflatoxins due to their toxicity (Park et al., 2002; Jolly et al., 2006).

Food safety concerns have been growing in recent times, particularly among consumers in developed countries (Grunert, 2005). The general public's rising interest in food safety issues has stimulated extensive inquiries and policy discussions (Grunert, 2005). On the policy front, regulatory agencies in some developed countries have responded to the credible threat from aflatoxins by setting permissible standards to protect consumers. For instance, the United States (US) enforces its own aflatoxin standards at 20 parts per billion (ppb), whereas the European Union (EU) imposes 4 ppb on food produced for direct human consumption (Otsuki, Wilson and Sewadeh, 2001). However, enforcing acceptable aflatoxin levels for food crops has been a contentious policy issue among countries engaged in cross-border trade. The enforcement of unilateral and non-uniform standards often leads to trade disputes in various international markets. As one would expect, the debate on the use of strict regulations by some countries as trade barriers has motivated numerous policy evaluation studies (Otsuki, Wilson and Sewadeh, 2001a, 2001b; Yue, Beghin, and Jensen, 2006; Nogueira et al., 2008; Nguyen, and Wilson, 2009).

In general, the published literature on food regulations tends to focus on implications for international trade. Findings from existing studies show that Sanitary and Phytosanitary Standards (SPS), such as aflatoxin regulations, lead to reductions in trade volumes. Furthermore, given that regulations introduce compliance costs into food supply chains, it is widely believed that retail prices would go up following regulation interventions. In other words, the enforcement of strict food standards is generally regarded as welfare decreasing to consumers. However, to the best of my knowledge, there are no studies that evaluate consumer preferences for food with reduced mycotoxin content, in spite of the useful policy implications of such knowledge. That is, establishing consumer demand for safer foods would be critical to the successful management of the mycotoxin problem.

As national economies grow more integrated with time, it is inevitable that most countries will converge to enforce uniform food standards. For example, Ghana's Ministry of Food and Agriculture (2008) reveals preparations toward enforcing own standards, which would then be harmonized with other countries in the West African sub-region. Therefore, this thesis determines how consumer preferences for peanut are affected by food safety concerns. Specifically, the study pursues consumer behavior regarding their willingness to pay for safer peanut, and how individuals' preferences are influenced by choices that may demonstrate their concern for food safety. To meet this goal, I analyze relevant information obtained from a contingent valuation survey carried out in Ghana.

CHAPTER 2

LITERATURE REVIEW

This section reviews existing research on consumers' willingness to pay (WTP) for safer foods through revealed and stated preferences attained in CV surveys. In addition, I highlight some notable developments in the CV methodology known to improve the realization of valid WTP estimates.

2.1 Importance of Food Safety to Consumers

Using the best-worst scaling method, Lusk and Briggeman (2009) investigate the stability of consumer preferences for a set of food values. The authors found that 'safety' was among the most important food attributes. Food safety was also shown to be related to people's stated and revealed preferences.

Wang, Mao, and Gale (2008) carried out a CV survey in China concerning consumer interest in food safety issues. Report from their study reveals that consumers are willing to pay price premiums for milk products certified under the Hazard Analysis Critical Control Point (HACCP). The authors employed a hedonic price model to analyze their survey data.

In Taiwan, Jan, Fu, and Huang (2005) estimate consumers' demand and WTP for hypothetical cigarettes known to have reduced lung cancer risk. The authors conducted a contingent valuation survey on 264 smokers and subsequently employed a dichotomous-choice model in a random utility framework. Jan, Fu, and Huang found that consumers were willing to pay an average price premium of 152% relative to existing market prices. The authors argue that the high WTP values indicate people's demand for healthy products.

In spite of the high stated preference for safe cigarettes, the authors acknowledge that the study's findings may be limited due to the small sample size. A study by Eom (1994) also shows that consumers in the United States are willing to pay high price premiums to avoid adverse health issues associated with pesticide residues in food. Eom (1994) integrates important concepts on food safety, namely "perceptions, behavior, and valuation", in a random utility framework. Individuals' stated preferences were estimated using discrete choice models.

The literature generally suggests that people are concerned about food safety and are, therefore, willing to pay for safer food products and services.

2.2 Hypothetical Bias in Contingent Valuation Studies

One of the important methodological challenges in the application of CV surveys is minimizing 'hypothetical bias'; defined as the difference between people's WTP in hypothetical markets (where products are hypothetical and money is not involved) as opposed to experimental market settings where real products and money transactions occur (see Cummings and Taylor, 1999; List and Gallet, 2001; Alfnes, Yue, and Jensen. 2010).

List and Gallet (2001) conducted meta-analyses to identify factors that affect hypothetical bias in WTP values. They indicate, among others, that the problem of hypothetical bias is 'systematically' less prevalent in WTP as against willingness-to-accept (WTA) surveys. Also, the authors show that hypothetical bias occurs more frequently in CV studies involving public goods than with private goods, even though Murphy et al. (2005) found 'weak evidence' in support. Furthermore, Whitehead et al. (1995) argue that the 'validity and reliability' of WTP values obtained in contingent valuation surveys are enhanced when participants are familiar with the goods and services in question; as opposed

to the case where respondents are not used to the product/service. Therefore, the hypothetical CV survey discussed in this thesis (as presented in the next section) is appropriate given that peanut is a private good and an important food product in Ghana.

2.3 Use of Double-bounded Dichotomous Choice Models

Discrete-choice models have been widely applied in the analyses of numerous CV surveys. Double-bounded dichotomous choice models are known to perform better than the single-bounded dichotomous choice alternative, in terms of providing more efficient WTP estimates (Hanemann, Loomis, and Kanninen, 1991; Kanninen, 1993; McCluskey et al., 2003). This subsection briefly highlights some selected studies that have employed double-bounded dichotomous choice methods to evaluate a number of contingent valuation problems.

With the application of a standard double-bounded dichotomous choice model on CV data, Lin et al. (2005) evaluate consumers' WTP for biotech rice and soybean oil in China. Findings suggest that people in China prefer non-biotech foods and are willing to pay high premiums relative to their biotech counterparts. The stated WTP for non-biotech rice is between 41.5% and 74%. Similarly, WTP for non-biotech soybean oil ranges from 23.4% to 52.6%. The authors argue that food safety considerations influence consumers' WTP since the stated price premiums for important food staples such as rice appear substantial than soybean oil. Notwithstanding the key role played by food safety fears, the authors partly attribute the high price premium to possible hypothetical bias from the CV survey.

McCluskey et al. (2003) analyze consumer preference for genetically modified (GM) foods in Japan. They applied a semi-double-bounded dichotomous choice model on their contingent valuation survey data. Results indicate that 80% of respondents were not willing to accept GM foods even with price discounts. The authors show that consumer behavior is influenced by food safety concerns.

De Groote and Kimenju (2008b) investigate Kenyan's preference for yellow (biofortified) versus white maize. The authors applied the semi-double-bounded dichotomous choice method on contingent valuation survey data collected on urban consumers. Since people in Kenya consider yellow maize as inferior to white maize, the study ignored premiums for yellow maize although standard white maize are often deficient in vitamin A. As a result, the study had three WTP response categories focusing on acceptance of yellow maize with and without discounts. De Groote and Kimenju (2008b) show that urban consumers exhibited strong preference for white maize and would only buy yellow (biofortified) maize on discounts. However, there was some interest in fortified maize meal although price premiums were modest, ranging from 6% to 7.4%. In addition, Kimenju and De Groote (2008a) explore how consumers' willingness to pay for genetically modified food is determined by awareness, perceptions, and socioeconomic characteristics. The authors employ a standard double-bounded dichotomous choice model and find that even though most people in Kenya accept GM foods their willingness to pay is negatively affected by safety concerns. The findings are consistent with studies conducted in other parts of the world regarding the importance of food safety (and health) considerations in consumer decisions.

2.4 New Addition to the Food Safety Discussion

The literature on consumer willingness to pay premiums (or accept discounts) for the introduction and/or change in food products (and services) is extensive. Food safety and environmental concerns have largely motivated discussions in published studies. On food safety issues, a majority of the existing research on consumer preferences only highlight acceptance of genetically modified foods, and consumer interest in chemical residues in food products. To the best of my knowledge, the contingent valuation literature is silent on consumer behavior toward the mycotoxin contamination problem; in spite of the predominant

role of mycotoxins in global food safety discussions. Therefore, it is necessary to further evaluate consumers' behavior (and attitudes) toward food safety and how individuals' preferences for mycotoxin-free foods are affected.

CHAPTER 3

THEORETICAL AND CONCEPTUAL FRAMEWORK

Analyses in this thesis are based on the random utility theory predominantly applied in contingent valuation problems. Consistent with consumer theory, a key assumption is that individuals make choices to maximize their utility in the face of limited budgets (Hanemann and Kanninen, 1998; Lusk and Hudson, 2004; De Groote and Kimenju, 2008b; Gallardo et al., 2009). That is, the central goal of this thesis is to analyze the importance of safer/quality food products to consumers' ultimate goal of utility maximization. This objective is achieved through the assessment of individuals' stated preference for peanut with reduced aflatoxin content.

3.1 Consumer Theory Underlying Food Safety Choices

In this subsection, I introduce the theoretical import of the analyses conducted in this study by adapting relevant concepts and assumptions from the seminal work of Choi and Jensen (1990, 1991) that shows utility maximization in the context of 'risky' goods. Choi and Jensen provide extensions to standard demand theory by incorporating food safety (i.e. demand for risky foods) into an expected utility framework. As a result, it is shown that in addition to prices and income the harmful contaminant (e.g. aflatoxin) is one of the important factors influencing consumer demand for 'risky' goods. The theory is derived as follows.

Consider the existence of a 'risky' bundle of goods with exogenous toxic (or 'hazardous') contents; such as basic food staples with given levels of aflatoxin concentration. This implies that consumers have no control over the amount of the toxin present in the risky

good since the contamination is naturally-occurring on the supply side. However, the consumer endogenously selects quantities of the risky good to consume in order to maximize his utility. In addition, the theory is presented in the context of the following simplifying assumptions:

- All firms are identical and produce the homogeneous risky good X; e.g. peanut.
- Consumers are unable to visually identify the colorless and tasteless toxin.
- The representative consumer lives for two periods.
- Consumption of the risky good affects utility only in the second period since the toxin is undetected in the initial period (i.e. before and during consumption); hence the health of the individual is impacted either positively ('good health') or negatively ('poor health') in the second period. The consumer is said to have 'survived' the second period if he gains in health (or his health remains unchanged), otherwise an adverse health effect is interpreted as 'nonsurvival'. Also, the 'invisibility' characteristic of the toxin introduces an element of uncertainty about the consumer's survival in the second period. The probability of survival (i.e. Ω) is, therefore, assumed to be less than one; $0 \leq \Omega < 1$. In spite of the uncertainty facing the consumer, he knows that the probability of his survival is influenced by the quantity of the risky food he consumes.
- If the individual fails to survive the next period due to poor health, we assume he earns no income; hence he attains a zero utility level in the second period (i.e. $U_2=0$).
- The toxin is scientifically measurable and the consumer is aware of its hazardous effects when ingested through dietary exposure.

Furthermore, the individual possesses time-invariant utility functions based on two consumption goods namely X and Y; where X represents quantity of the risky food purchased at the relative price P_x whereas Y is the quantity of a composite (numeraire) good

comprising of all non-food items with a normalized price of unity. Also, suppose the representative consumer survives in the second period, then we can represent his preferences in the two periods by employing a monotonically increasing and concave utility function as shown below:

$$(1) \quad U_i = U(X_i, Y_i)$$

The consumer maximizes the above utility subject to the following budget constraint:

$$(2) \quad I_i = P_{X_i}X_i + Y_i$$

where the subscript $i=1, 2$ represents periods 1 and 2, respectively (note that price of the riskless composite good equals one in both periods owing to the normalization).

If the consumer ‘survives’ after consuming the risky food in addition to the non-food goods, he maximizes his utility in the second period $U_2(X_2, Y_2)$, subject to the corresponding budget constraint I_2 . Thus, the resulting demand functions are $X_2(P_{X_2}, I_2)$ and $Y_2(P_{X_2}, I_2)$, with the associated indirect (optimal) utility as $V(P_{X_2}, I_2)$.²

On the other hand, as stated earlier, if the individual fails to ‘survive’ in the second period due to poor health from consuming contaminated food, then his utility level is zero, $U_2=0$. Furthermore, if we assume that the consumer’s utility function in each period is normalized, then the individual’s utility level in the second period (following his survival) equals one. Consequently, a consumer’s utility in the second period can be expressed as a dichotomous random variable as shown below:

$$3 \quad U_2 = \begin{cases} 0, & \text{with probability } 1 - \Omega \\ 1, & \text{with probability } \Omega \end{cases}$$

Choi and Jensen (1990, 1991) argue that, regardless of market structure, some form of government intervention is required when the food industry produces goods with ‘hazardous content’; given that toxins are typically invisible to consumers, and producers have no

² See the full derivations in Choi and Jensen (1990, 1991) for details on how food safety parameters are explicitly expressed as arguments in the demand functions for the two goods, X and Y.

incentive to reveal levels of contamination or commit resources to reducing the toxin. With the foregoing theory in mind, I analyze a contingent valuation problem in connection with consumers' preferences for peanut with reduced aflatoxin contamination. Before introducing the survey, it is worth emphasizing the following further assumptions:

- Minimizing aflatoxin contamination in peanut and other foods is costly to producers; this leads to an increase in production costs on the supply side.
- Additional production costs lead to higher market prices of peanut for consumers.
- Individuals who vote 'Yes' to the introduction of aflatoxin regulations are willing to pay more to increase their 'survival' in the future (i.e. demand good health). However, consumers who vote 'No' to aflatoxin regulations are prepared to face the risk of food contamination.

3.2 Contingent Valuation Survey on Consumer Preferences in Ghana

The data used in this thesis were collected in a survey carried out in Ghana from May through July, 2012. Contingent valuation (CV) questionnaires were used in face-to-face interviews with peanut consumers who agreed to participate in the survey (see Appendix for questionnaire). In CV methods, researchers conduct surveys on subjects sampled from target populations and elicit their willingness to pay more (price premium) or accept compensation (price discount) for proposed changes in products/services. Individuals' willingness to pay (WTP) for a given change is determined in hypothetical market settings using survey instruments such as questionnaires; with interactions through mails, telephones, or face-to-face interviews. In the present research, activities such as preparation of questionnaire, survey design and administration were carefully executed in accordance with recommended practices in the CV literature (Portney, 1994; Carson et al. 2003; McCluskey et al., 2003;

Gallardo et al., 2009). For instance, interviewers explained to respondents that researchers have found strong evidence of the association between aflatoxin exposure and health problems, namely aflatoxicosis, immune system suppression, liver cancer, among others (Wang et al., 2001; Williams et al., 2004; Liu and Wu, 2010). In view of the negative health issues associated with dietary aflatoxin exposure, survey participants were briefed on potential benefits of consuming peanut with zero or reduced contamination. Furthermore, the referendum format of value elicitation was adopted in that respondents were offered the opportunity to vote either in favor or against aflatoxin policy interventions that would ensure availability of safer peanuts in markets but at higher prices. Consumers who vote in favor of regulation enforcement are subsequently asked to state the premium they are willing to pay for aflatoxin-free peanuts. Thus, information on respondents WTP was solicited using both referendum voting and open-ended questions where consumers indicate precisely how much they are willing to pay relative to existing local market prices (base reference points). Since peanut is an important food crop consumed in various forms in Ghana, the use of CV methodology is legitimate. Wedgwood and Sansom (2003 p.7) argue that “when the CV method is used to estimate the use of goods and services with which the individuals are familiar...CV surveys that are carefully designed and administered can yield accurate and useful information on household preferences (Cummings et al, 1986).”

A sample of 652 peanut consumers was randomly selected to participate in the survey, after pre-testing the questionnaire on some consumers in Kumasi. Survey participants were sampled from five (out of ten) administrative regions of Ghana. The purposively selected regions are Ashanti, Brong Ahafo, Western, Central, and Eastern (see Table 3.1). Capital cities of the listed regions were selected since urban centers are prominent destination markets for peanut produced in the northern part of the country. Table 3.1 shows the proportional samples of consumers in the selected regions according to population size.

Regions with large populations are weighted more given their importance as peanut markets. Some sub-metropolitan areas within each capital city were identified and peanut consumers chosen from those areas. A total of 68 areas (referred to as ‘suburbs’) were covered. The sampling procedure for choosing peanut consumers was systematic where every third individual (representing a household) along a given street was interviewed. In cases where the selected individual fails to qualify as a respondent, interviewers move to the next person and repeat the sampling order after successfully identifying a peanut consumer. Figure 3 shows the geographical distribution of the survey regions and corresponding urban centers.

The survey was approved by the Auburn University Institutional Review Board. Furthermore, interviewers sought the approval of survey participants by reading out consent protocols to them. The questionnaires were administered by trained interviewers in all face-to-face interviews conducted with peanut consumers who agreed to participate in the survey. It is worth emphasizing that interviewers explained to respondents the goal of the survey and also provided concise description of the peanut aflatoxin issue with possible regulation enforcement in the future. In the course of the interviews, respondents were shown printed photographs of three peanut samples labelled as follows: ‘Sample A’, ‘Sample B’, and ‘Sample C’ where ‘C’ was a clean and well-sorted peanut sample with no moldy, broken or shriveled kernels whereas ‘A’ was a sample with high proportion of moldy, broken and shriveled kernels plus other foreign materials; Sample B was moderately sorted peanuts with lower percentage of broken/shriveled kernels. Thus, Sample A would typically possess the highest possibility of aflatoxin contamination while Sample C would have the least contamination among the three, and therefore, the safest product. Respondents were then asked to make their choices and state whether they will vote for peanut aflatoxin regulation that will ensure availability of aflatoxin-free peanuts in local markets (such as Sample C) and most likely cause retail prices to go up.

Consumers who indicated their willingness to pay were subsequently asked to state how much they will be willing to pay for aflatoxin-free peanuts. Respondents were frequently prompted to make objective choices (decisions) in the context of their peculiar preferences, limited income and food expenditure patterns. In addition to demographic and socioeconomic characteristics, the survey gathered information on important factors that possibly influence consumers' food purchase decisions. Thus, survey participants were asked to indicate the single most important factor considered in their household food transactions— whether prices, food safety concerns, or other issues. Questions were also asked about any adverse health experiences attributed to peanut consumption in the past.

3.3 Methods of Estimating Willingness to Pay

There are two main methods used to elicit WTP, namely the application of single-bounded dichotomous-choice approach, or the use of double-bounded dichotomous-choice procedures. However, the double-bounded dichotomous-choice method has been the preferred approach over the past two decades due to its desirable property of yielding more efficient WTP estimates (Hanemann, Loomis, and Kanninen, 1991; Kanninen, 1993; McCluskey et al., 2003). The double-bounded method extends the single-bounded approach by introducing additional dichotomous-choice questions in order to obtain more reliable results. Owing to its appealing property, a special form of the double-bounded method (discussed below) is employed in the present CV survey. In the next subsections, I introduce the two standard methods of estimating WTP using derivations adapted from De Groote and Kimenju (2008a, 2008b).

3.3.1 Single-Bounded Dichotomous-Choice Method

In this method, the random utility model is operationalized in dichotomous-choice CV functions. Although consumers are assumed to know their preferences with certainty, investigators and econometricians perceive individual utility functions as consisting of systematic and random/unobservable components (Hanemann, 1984; Hanemann and Kanninen, 1998). Therefore, we state a peanut consumer's utility as follows;

$$(4) \quad U_i = f(y_i, z_i, e_i)$$

where y is the individual's income, z is a vector of the respondent's socioeconomic and/or demographic characteristics, e is the random term and i represents the consumer. Since consumer utility is directly unobservable to researchers, the probability of utility maximization is often obtained from observed behavior. In dichotomous-choice questions, people are required to indicate whether they would agree to pay a proposed price or not. Owing to the utility maximization objective, consumers would be willing to pay for a new product if they believe that the proposed change (such as the introduction of aflatoxin-free peanut) will increase or retain their existing utility (Hanemann, 1984; Hanemann and Kanninen, 1998). The preceding assumption is expressed below in probabilities;

$$(5) \quad P_i = P(U_{i1}(y_i - B_i, z_i, e_{i1}) \geq U_{i0}(y_i, z_i, e_{i0}))$$

where P_i is the probability of a consumer's willingness to pay a bid price of B_i for the new product; U_{i1} is the final utility after acquiring the new product; U_{i0} is the initial utility before buying the new product; y_i is the consumer's income; z_i is a vector of the individual's socio-demographic information; and e_{i1} is the random component after obtaining the new product, while e_{i0} is the random term for the case without the new product. Notice that the bid price is paid directly from the consumer's income.

Therefore, consumers will only agree to pay a bid price when their willingness to pay equals or exceeds the offered price of the aflatoxin-free peanut, otherwise they will reject the bid.

This consumer behavior is illustrated in the next two equations:

$$(6) \quad \Pr(\text{No to } B) = \Pr(B > \max WTP)$$

$$(7) \quad \Pr(\text{Yes to } B) = \Pr(B \leq \max WTP)$$

Equation (6) indicates that an individual will reject (or say ‘No’ to) the supply of aflatoxin-free peanut if the proposed bid price is greater than his maximum willingness to pay.

Similarly, a consumer will accept (or say ‘Yes’) to an offer on condition that his maximum willingness to pay outweighs or, at least, is identical to the bid price of the new product.

Derivations presented so far imply that consumers’ willingness to pay for any new product depends on the bid price, as well as individual and demographic factors. Hence, the distribution of maximum willingness to pay i.e. $G(B; \theta)$ is presented as a cumulative distribution function of the bid price (B), and a vector of parameters θ . Respectively, Equations (6) and (7) are expressed in a suitable distribution function as follows:

$$(8) \quad \pi^n = \Pr(B > \max WTP) = G(B; \theta)$$

$$(9) \quad \pi^y = \Pr B \leq \max WTP = 1 - G(B; \theta)$$

where π^n is the probability of bid rejection, whereas π^y is the probability of a consumer agreeing to pay a bid price.

Typically, the logistic distribution is employed. The S-shape of the logistic distribution function with values ranging from 1 to 0 provides the opportunity to estimate the probability of a consumer’s willingness to pay given a bid price. Consistent with consumer theory, a downward-sloping logistic function is assumed in CV studies to represent the decreasing probabilities of consumers’ willingness to pay as bid price increases (see De Groot and Kimenju, 2008b). Thus, assuming the logistic functional form, we can express the two possible outcomes of individuals’ willingness to pay, from Equations (8) and (9) respectively, as follows:

$$(10) \quad \pi^n = G(B; \theta) = \frac{1}{(1 + \exp -(\alpha - \rho B))}$$

$$(11) \quad \pi^y = 1 - G(B; \theta) = 1 - \frac{1}{1 + \exp -(\alpha - \rho B)}$$

where

$$12 \quad G(B; \theta) = \frac{1}{1 + \exp -v}$$

is the cumulative distribution function (cdf) for the logistic distribution; $v = (\alpha - \rho B)$ is an index function taken to be linear in the bid price; and α and ρ are elements of the parameter vector, θ . It must be emphasized that the sign of ρ is positive, thereby ensuring a downward sloping curve (i.e. probability of WTP) consistent with economic theory.

The corresponding log likelihood function is derived as follows;

$$(13) \quad L = \sum_{i=1}^N (d_i^y \ln \pi^y(B_i) + d_i^n \ln \pi^n(B_i))$$

$$13' \quad L = \sum_{i=1}^N (d_i^y \ln(1 - G(B; \theta)) + d_i^n \ln G(B; \theta))$$

where d_i^y is a binary-indicator variable which equals 1 if the i th respondent accepts the bid price, and 0 otherwise; similarly, d_i^n equals 1 if the i th respondent rejects the bid price and 0 otherwise. Estimation of the vector of parameters in the log likelihood function is then achieved using the maximum likelihood estimator. Subsequently, the mean (and median) willingness to pay is derived from the estimated parameters using the following formula:

$$(14) \quad \text{mean WTP} = \frac{\alpha}{\rho}$$

3.3.2 Double-Bounded Dichotomous-Choice Method

The present method is an extension of the single-bounded approach derived above. In the double-bounded dichotomous-choice model each respondent faces two bid prices with the magnitude of the second price contingent on the individual's answer to the first price (see De Groot and Kimenju, 2008a, 2008b). That is, each person is offered a first dichotomous-choice question with a proposed price B^1 and if the individual agrees to pay this price then the interviewer follows up with another dichotomous-choice question with a higher price, B^H .

However, if the respondent rejects the first bid B^1 then he is offered a second dichotomous-choice question with a lower bid price B^L . The double-bounded dichotomous-choice method, therefore, produces four possible outcomes with the following WTP probabilities:

$$(15) \quad \pi^{yy} = Pr B_i^U \leq \max WTP_i = 1 - G(B_i^U; \theta)$$

$$(16) \quad \pi^{yn} = Pr B_i^1 \leq \max WTP_i \leq B_i^U = G(B_i^U; \theta) - G(B_i^1; \theta)$$

$$(17) \quad \pi^{ny} = Pr B_i^L \leq \max WTP_i \leq B_i^1 = G(B_i^1; \theta) - G(B_i^L; \theta)$$

$$(18) \quad \pi^{nn} = Pr B_i^L > \max WTP_i = G(B_i^L; \theta)$$

where π^{yy} is the probability of a respondent accepting both first and second bid prices; π^{yn} is the probability of a respondent accepting the first bid but rejecting the second price; π^{ny} is the probability of a respondent rejecting the first price but accepting the second price; π^{nn} is the probability of a respondent rejecting both first and second bid prices; $B_i^L < B_i^1 < B_i^U$ and G is assumed to be a logistic distribution. The corresponding log likelihood function is;

$$19 \quad L = \sum_{i=1}^N (d_i^{yy} \ln \pi^{yy}(B_i^U) + d_i^{yn} \ln \pi^{yn}(B_i^1, B_i^U) + d_i^{ny} \ln \pi^{ny}(B_i^1, B_i^L) + d_i^{nn} \ln \pi^{nn}(B_i^L))$$

where d_i^{yy} is a binary-indicator variable which equals 1 if the i th respondent accepts both bids, and 0 otherwise; d_i^{yn} equals 1 if the i th respondent accepts the first price but rejects the

second bid price and 0 otherwise; d_i^{ny} equals 1 if the i th respondent rejects the first price but accepts the second bid and 0 otherwise; and d_i^{nn} equals 1 if the i th respondent rejects both prices, and 0 otherwise. The maximum likelihood estimator is then employed to estimate parameters in the log likelihood function, and the mean willingness to pay is derived as in the single-bounded CV case presented earlier.

3.3.3 The Semi Double-Bounded Dichotomous-Choice Method

The CV survey used in the present study has three WTP response categories discussed below. As a result, this thesis estimates a modified version of the standard double-bounded dichotomous-choice approach known as the Semi Double-Bounded (SDB) model (McCluskey et al., 2003; De Groot and Kimenju, 2008b; Meenakshi et al., 2012). Specifically, I employ the SDB method to determine the probability of consumers' willingness to pay for aflatoxin-free peanuts as a function of prices, as well as relevant socioeconomic factors (including characteristics that demonstrate consumers' concern for food safety). This thesis focuses on individuals' willingness to pay price premium for safer peanut, where a consumer's stated price for aflatoxin-free peanut must exceed the existing peanut price in his local market. As a result, prices in respondents' preferred markets serve as their lower bound (i.e. reference prices). There is, therefore, no provision for discount bid prices in this study since aflatoxin-free peanuts would be of superior quality relative to the kind commonly available in Ghanaian local markets. Precisely, the following three response levels are used to measure consumers WTP for peanut with reduced aflatoxin contamination:

- 1.) "No" : This means rejection of both first-bid and second-bid prices;
- 2.) "Yes–No": Acceptance of first-bid price but a rejection of a second-bid price;
- 3.) "Yes–Yes": Acceptance of both first-bid and second-bid prices;

where the *first-bid price* refers to any stated price that strictly exceeds the existing price in a respondent's preferred market, whereas the *second-bid price* is a respondent's next stated price (following acceptance of the first-bid price) that must necessarily be greater than his previously stated price.

This implies that a respondent who rejects the first-bid price would not be willing to pay any premium for aflatoxin-free peanuts. In this study, if a consumer agrees to the first bid B_i^1 , he is subsequently asked for a second higher bid B_i^U . However, if the respondent answers 'No' to the first bid then that terminates the elicitation process. Therefore, following the procedure and assumptions invoked for the two dichotomous-choice methods derived earlier, the corresponding probabilities for all three WTP-response categories are presented as follows:

$$(20) \quad \pi^n = Pr B_i^1 > \max WTP_i = G B_i^1; \theta$$

$$(21) \quad \pi^{yn} = Pr B_i^1 \leq \max WTP_i \leq B_i^U = G B_i^U; \theta - G B_i^1; \theta$$

$$(22) \quad \pi^{yy} = Pr B_i^U \leq \max WTP_i = 1 - G B_i^U; \theta$$

where π^{yy} is the probability of a respondent accepting both first and second bid prices; π^{yn} is the probability of a respondent accepting the first bid but rejecting the second price; π^n is the probability of a respondent rejecting the first price and, by implication, the second bid price; the WTP probabilities and bid prices respectively have the following order, $\pi^{yy} > \pi^{yn} > \pi^n$ and $B_i^U > B_i^1 > B_i^L$; and $G(.)$ is the cumulative distribution function for the logistic distribution. B_i^L is the prevailing price in a respondent's local market serving as the base or lower-bound price.

Equation (20) shows the probability of consumers who would not be willing to pay a price premium for aflatoxin-free peanuts. That is, their maximum WTP are lower than any bid that exceeds prevailing prices in their preferred markets. In Equation (21), the probability of a consumer offering a price premium but declining to further increase the premium in a

follow-up question suggests that his maximum WTP falls between his stated price and a higher bid. Finally, from Equation (22), we note that the probability of a consumer agreeing to pay a premium through his stated first and second bid prices indicates that his maximum WTP is above the highest bid he offers to pay.

With the WTP probabilities specified, the corresponding log likelihood function is shown below:

$$23 \quad L = \prod_{i=1}^N (d_i^{yy} \ln \pi^{yy} B_i^U + d_i^{yn} \ln \pi^{yn} B_i^1, B_i^U + d_i^n \ln \pi^n B_i^1)$$

where d_i^{yy} is a binary-indicator variable which equals 1 if the i th consumer accepts both bids, and 0 otherwise; d_i^{yn} equals 1 if the i th consumer accepts the first price but rejects the second bid price, and 0 otherwise; and d_i^n equals 1 if the i th consumer rejects both prices, and 0 otherwise. Similarly, the maximum likelihood estimator is employed to estimate parameters in the log likelihood function. Also, the median WTP can be computed as shown earlier in Equation (14) after estimating a simple multi-category (or polytomous) ordered logistic regression; where the WTP categories are regressed on maximum bid prices stated by the respondents.

In addition to mean WTP, this study estimates the impact of socioeconomic and demographic characteristics on individuals' willingness to pay for aflatoxin-free peanuts. This is achieved by augmenting the model's index function through the inclusion of important factors that may influence consumers WTP. Thus, the probabilities of respondents' WTP for safer peanuts would depend on bid prices as well as relevant consumer characteristics, as stated below:

$$(24) \quad \pi(B, Z; \theta) = \pi(v; \theta)$$

where

$$(25) \quad v = \alpha - \rho B + \lambda Z + \varepsilon$$

is the expanded index function which is linear in bid price, B, and consumer characteristics, Z; α , ρ , and λ are elements of the vector of parameters θ ; and ε is an error term assumed to have a logistic distribution. To illustrate, the probability of a consumer agreeing to pay a price premium by accepting both bids (as in Equation (22)) is stated as follows:

$$\begin{aligned} 26 \quad \pi^{yy} B_i^U, Z_i &= 1 - G B_i^U, Z_i; \theta \\ &= 1 - \frac{1}{1 + \exp -(\alpha - \rho B_i^U + \lambda Z_i + \varepsilon)} \end{aligned}$$

The vector Z comprises of consumer characteristics such as age, sex, household income, household size, level of formal education, concern for food safety, region of residence, among others.

3.4 Empirical Model and Information on Variables

This subsection specifies the model to be estimated and presents a description of all variables used in this thesis. Due to the presence of inherently ordered WTP-response categories (i.e. $\pi^{yy} > \pi^{yn} > \pi^n$), ordered logistic regressions are estimated using the LOGISTIC procedure in SAS (SAS Institute Inc., 2008). Specifically, the cumulative logistic regression is specified as follows:

$$\begin{aligned} (27) \quad \text{logit}(\text{wtp_order1}_j) & \\ &= \alpha_j + \rho(\text{max_price}) + \lambda_1(\text{income_gp}) + \lambda_2(\text{hhsz2}) + \lambda_3(\text{age_group}) \\ &+ \lambda_4(\text{edu_class}) + \lambda_5(\text{healthp}) + \lambda_6(\text{sex}) + \lambda_7(\text{region1}) + \lambda_8(\text{topprior1}) \\ &+ \varepsilon \end{aligned}$$

where α , ρ , and λ 's are parameters to be estimated; ε is the error term with a cumulative logistic distribution; subscript j represents unique functions (equations) with corresponding

intercepts for each category of the response variable; and all variables in the model are defined below in Table 3.2.

Summary statistics on the variables are provided in the next section.

CHAPTER 4

RESULTS AND DISCUSSION

This chapter presents results obtained from both descriptive and inferential analyses performed on the survey data. Specifically, I begin with preliminary analyses where I show summary statistics on important variables for the purposes of this thesis. Next, I discuss results derived from estimation of the cumulative logistic regression model.

4.1 Preliminary Analyses

Below, Tables 4.1 and 4.2 display summary statistics on some relevant socioeconomic characteristics of consumers interviewed in the survey.

4.1.1 Consumer Characteristics

From Table 4.1, the median monthly income in Ghana is 500 Ghana cedis for a typical household comprising of four individuals (as at July 2012, the average exchange rate in Ghana was 1 US Dollar = 1.8 Ghana cedis).

Also, the average household member selected for the in-person interview was 30 years old. The survey shows that a household in Ghana typically consumes about 1.8 ‘margarine cups’ (i.e. 0.67kg or 1.5lbs) of shelled peanut every week.³

³ Six local ‘margarine cups’ equal one ‘olonka cup’. On average, an ‘olonka’ of shelled peanut weighs 2.24 kg or 4.93 lbs. Hence, one ‘margarine cup’ of shelled peanut would approximately weigh 0.37 kg or 0.82 lbs. The present survey adopted ‘margarine cup’ as the standard measure. See Nagai (2008) for details on local units of measurement for some cereal grains and legumes in Ghana.

Furthermore, in Table 4.2 we observe that many female household members participated in the survey than males. The female dominance is due to lower interview decline rate among females as opposed to males. Also, in most cases where two or more members of a household were present, females were unanimously chosen by the other members to participate on behalf of the household. This is because females play important household roles such as food-purchase decisions, food handling and storage, meals preparation, among others.

On formal education levels attained by the survey respondents, Table 4.2 indicates that three-quarters of the individuals interviewed have had at least 9 years of formal schooling at the ‘Middle School’ level (or junior high school level).

4.1.2 Consumers’ Willingness to Pay for Safer Peanut

The distribution of the variable ‘wtp’ in Table 4.2 provides clear indications that consumers in Ghana are willing to pay more for aflatoxin-free peanuts. Specifically, approximately 79% of the survey participants voted in favor of aflatoxin regulation interventions that would guarantee the supply of aflatoxin-free peanut in local markets. This overwhelming support for the enforcement of aflatoxin regulations was received in spite of repeated reminders about the attendant increase in retail prices. The respondents who voted in favor of aflatoxin regulations were apprehensive of the alternative world without food standards since they believe that suppliers would not voluntarily discard unwholesome food products.

In Table 4.1, the average market price of shelled peanut was recorded at 1.5 Ghana cedis per cup at the time of the survey. Against this reference price, the survey participants were willing to pay 2.5 Ghana cedis per cup for aflatoxin-free peanut. The implication is that consumers in Ghana would be willing to pay a price premium of about 66% for safer peanut. Nevertheless, the logistic regression show a more conservative mean WTP estimate of 1.73

Ghana cedis; representing a price premium of approximately 16% relative to the prevailing market prices (see Model (1) in Table 4.3 for the appropriate regression estimates).

It is interesting to also note that almost all the respondents who offered to pay various first bid prices were further willing to pay more by stating prices greater than those they had provided. The preceding observation is found in the distribution of the three-level WTP variable (i.e. 'wtp_order1') shown in Table 4.2.

4.1.3 Consumers' Prioritization of Food Safety

The survey data reveal that consumers in Ghana place importance on food safety in their household food transactions. For instance, about 9 out of every 10 of the respondents interviewed stated that issues concerning food safety (including cleanliness) rank supreme among the list of factors they usually take into account before buying food (see Table 4.2). In other words, the majority of consumers prioritize food safety considerations above prices as shown in the frequency distribution of the variable named 'topprior1' in Table 4.2. Furthermore, when asked about factors that could cause consumers to switch away from their regular peanut consumption pattern, only a little over one-third of the respondents chose price as the strongest candidate. Thus, consistent with the previous results, a majority (i.e. more than 56%) of the survey participants selected food safety concerns as the most paramount determinant of their food purchase decisions.

To study consumers' health considerations in their regular food choices, the survey also gathered information on respondents' history of adverse health conditions due to their peanut consumption habits. The frequency distribution of the variable 'healthp' in Table 4.2 indicates that about one-quarter of the consumers had experienced poor health in the past which they attributed to peanut consumption. Similarly, about 20% of the survey participants were familiar with a number of cases where close relatives had complained about health

problems believed to have developed after eating meals prepared with peanut (see distribution of the variable ‘familyp’ in Table 4.2).

4.2 Determinants of Consumer Preference for Safer Peanut

In this subsection, the discussion is focused on estimation results obtained from the cumulative (i.e. ordered) binary logistic regression model (see Table 4.3). Although the original WTP-response variable (i.e. ‘wtp_order1’) has three levels, I do not estimate a polytomous logistic regression. The decision to estimate a binary model instead was arrived at after performing two-way cross tabulation analyses pairing each of the categorical regressors against the three-level WTP variable. The two-way contingency tables revealed a number of low (sometimes zero) cell entries (see Appendix for examples of the crosstabs). Given that low cell frequencies are problematic for hypothesis testing involving Chi-Squared statistics, I collapse the original variable from three levels to two levels. Hence, the variable ‘wtp_order1’ has been recoded to ‘wtp_gp’; where the originally separate response levels ‘Yes-Yes’ and ‘Yes-No’ have been combined to form a new category called ‘Yes’. In the resulting binary WTP variable, the ‘Yes’ category refers to the group of consumers who offered to pay a price premium, whereas the ‘No’ category captures responses from the survey participants who declined to pay more for safer peanut.

Table 4.3 displays relevant information on all the estimated logistic regression models, namely Model (1) and Model (2); respectively representing the simple logit and full logit models. Note that the mean WTP value is computed from the estimated parameters in the simple model — with bid price as the only covariate. In the discussions that follow, I focus on the estimation results obtained from the full model, i.e. Model (2). The response variable represents increasing levels of consumers’ WTP for peanut with reduced aflatoxin

contamination. Moreover, WTP probabilities are cumulated over the lower response value. In general, the concordance index indicates that the logistic model performs well on the data in that observed probabilities for the response variable are correctly predicted in most cases.

Generally, the estimated parameters show expected signs. The model, therefore, yields reasonable results reflecting impacts of various consumer characteristics on their willingness to pay for safer peanut.

First, on the variables that illustrate respondents' concern for health and food safety, we observe that individuals who have never experienced health problems after consuming peanut in the past are less willing to pay premiums for aflatoxin-free peanut (see the estimate for 'healthp'). Precisely, for respondents who do not have any history of poor health (after eating peanut) their odds of paying more for safer peanut is about 90% less than that of their counterparts who have encountered health problems after consuming peanut meals. This result is statistically significant at the 5% level. Also, the result is consistent with the fundamental theory of utility maximization in that consumers who have had poor health episodes in the past in connection with peanut consumption (i.e. 'nonsurvival') would have incentives to pay more for safer peanut in order to guarantee good health (or 'survival') in the future. Similarly, the parameter estimate on the variable 'topprior1' has the expected sign in the sense that people who prioritize food safety in their market transactions would be more inclined to offer price premiums for safer food products. In addition, it is revealing to note that even those respondents who chose price as their topmost priority are equally willing to pay more for aflatoxin-free peanut. This is because the estimate for 'topprior1' is statistically insignificant at all conventional levels. The preceding finding is not surprising given that over 90% of the survey participants ranked food safety concerns as the most important factor in their food purchase decisions (see Table 4.2 for distributions of the variables 'topprior1', as well as 'sub_cause').

Next, we turn attention to the impact of the other socio-demographic factors in the model. From the estimation results, we observe that household income, number of individuals in households, age of respondents, gender, and level of formal education are important determinants of consumers' preferences for safer peanut. However, the geographical location of a consumer appears to have no effect on his willingness to pay for aflatoxin-free peanut — regional influence on consumer preference is not statistically significant at all conventional levels.

Specifically, respondents from high income households (i.e. with monthly incomes exceeding the median) are 16 times more willing to pay price premiums for safer peanut compared to their lower-income counterparts. The preceding result is statistically significant at the 1% level. Also, people from smaller households are more willing to pay higher prices for aflatoxin-free peanuts compared to participants from larger households. Thus, the odds of larger households are only 13% in comparison with smaller households' willingness to pay. This result is statistically significant at the 5% level. Furthermore, at the 1% level of significance, younger consumers (i.e. 35 years and below) are 14 times more willing to offer price premiums for safer peanut, as compared to their older counterparts. In addition, males are more likely to offer price premiums than females since the odds of females' willingness to pay is about 76% less than that of their male counterparts. The influences of gender and formal education on consumer preference for safer peanut are weak given that their effects are only significant at the 10% level. Nevertheless, it is interesting to note that people with at least a three-year college education are less likely to pay more for safer peanut compared to elementary school leavers.

CHAPTER 5

CONCLUSION

Mycotoxin contamination has received growing attention in food safety discussions particularly in setting regulatory standards for food toxins. The principal objective of this thesis is to study consumer preferences for aflatoxin-free peanut in Ghana, and how food safety concerns impact their willingness to pay price premiums for safer foods. To achieve these goals, I analyzed relevant information obtained from contingent valuation survey data under a consumer utility maximization framework in the context of risky foods. Thus, employing the random utility theory, a cumulative binary logistic regression model was estimated to determine consumers' willingness to pay, as well as identifying socioeconomic factors that influence consumer behavior. Conclusions drawn from the results are presented below.

Results from the study indicate that aflatoxin regulation interventions would receive support from consumers in Ghana. A majority of the survey participants offered to pay a conservative price premium of 16 percent relative to prevailing market prices.

Furthermore, almost all consumers in Ghana prioritize food safety above prices in their regular food transactions. Consequently, individuals who rank food safety above all other factors in their market (buying) decisions are more willing to pay price premiums for safer food supplies in order to guarantee their good health. In fact, the study found no evidence of differences in willingness-to-pay between individuals who selected food safety

concerns as their paramount factor versus those who claimed price was their most important determinant of food choices. In addition, people who have suffered poor health in the past — believed to have been caused after consuming contaminated peanut — are more willing to offer price premiums for safer foods, compared to individuals who have no such experiences.

Finally, individuals who exhibit the following socio-demographic characteristics are more likely to pay price premiums for safer food products compared to their respective counterparts: persons aged 35 years and below, members of high-income households, as well as people from smaller households comprising of four or less members. Also, we found some weak evidence of gender and formal education influences on consumer preference for safer foods — where males are more willing to offer price premiums than females, and people with advanced formal education show lesser willingness-to-pay. Moreover, as far as preference for safer foods is concerned, we do not find any evidence of disparity among consumers from different geographical regions in Ghana.

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Table 3.1: Selected Regions in Ghana and Sample Sizes

Region	Population*	Sample Size	Capital City
Ashanti	4,780,380	299	Kumasi
Eastern	2,633,154	109	Koforidua
Western	2,376,021	92	Takoradi
Brong Ahafo	2,310,983	86	Sunyani
Central	2,201,863	66	Cape Coast
Total Sample Size		652	

*Population figures obtained from Ghana Statistical Service (2012).

Table 3.2. Definition of Variables

Variable Name	Variable Label	Type	Categories and Codes ¹
hhincome	Household income per month	Continuous	-----
income_gp	Income group of household	Categorical	(1=Low) and 2=High
hhsiz	Household size	Continuous	-----
hhsiz2	Category of household size	Categorical	(1=Small) and 2=Large
max_price	Maximum bids offered	Continuous	-----
premium	Price premiums offered	Continuous	-----
peanutp	Existing peanut market prices	Continuous	-----
age	Age of respondent in years	Continuous	-----
age_group	Age group of respondent	Categorical	1=Young and (2=Old)
healthp	Personal health problems linked to peanut	Categorical	(1=Yes) and 2=No
familyp	Family health problems linked to peanut	Categorical	(1=Yes) and 2=No
edu_class	Education Level	Categorical	(1=Primary sch), 2=Middle sch, 3=High sch, 4=College/University
topprior1	top priority in purchase decisions	Categorical	(1=Prices) and 2=Food safety 1=In favor, 2=Against, 3=Undecided
wtp	Aflatoxin regulation intervention	Categorical	(1=No), 2=Yes-No, 3=Yes-Yes
wtp_order1	Willingness to Pay in 3 levels	Categorical	(1=No) and 2=Yes
wtp_gp	Willingness to Pay in 2 levels	Categorical	(1=Male) and 2=Female
sex	Sex of respondent	Categorical	(1=Male) and 2=Female
region1	Region of survey	Categorical	(1=Ashanti), 2=BA, 3=Central, 4=Eastern, 5=Western
sub_cause	Major factor to cause switch from peanuts to substitutes	Categorical	1= Prices, 2=Food safety, 3=Others

¹Reference levels of the categorical variables used in the regression model are shown in parentheses.

Source: Survey Data

Table 4.1. Summary Statistics for the Continuous Variables

Variable	N	Mean	Median	Std Dev	Minimum	Maximum
max_price	652	2.8	2.5	1.1	1.2	7
premium	652	84.1	66.7	73	0	366.7
amount	652	1.8	1.8	1.1	0.3	10
peanutp	652	1.5	1.5	0.2	0.9	2
hhincome	652	577.6	500	342.8	80	4000
age	652	32.9	30	9.6	18	68
hhsiz	652	4.5	4	2.4	1	20

Note: Prices and income are stated in Ghana cedis (1 U.S. Dollar=1.8 Ghana cedis).

Source: Survey Data

Table 4.2. Summary Statistics for the Discrete Variables

Variables	Categories	Frequency	Percent	Cumulative Frequency	Cumulative Percent
age_group	Young	423	64.88	423	64.88
	Old	229	35.12	652	100
edu_class	Primary sch	81	12.42	81	12.42
	Middle sch	269	41.26	350	53.68
	High sch	211	32.36	561	86.04
	Coll/Univ.	91	13.96	652	100
income_gp	High	305	46.78	305	46.78
	Low	347	53.22	652	100
sex	Female	406	62.27	406	62.27
	Male	246	37.73	652	100
hhsiz2	Large	309	47.39	309	47.39
	Small	343	52.61	652	100
wtp_gp	No	140	21.47	140	21.47
	Yes	512	78.53	652	100
wtp_order1	No	140	21.47	140	21.47
	Yes-No	18	2.76	158	24.23
	Yes-Yes	494	75.77	652	100
wtp	In favor	512	78.53	512	78.53
	Against	106	16.26	618	94.79
	Undecided	34	5.21	652	100
sub_cause	Food safety	367	56.29	367	56.29
	Others	35	5.37	402	61.66
	Prices	250	38.34	652	100
topprior1	Food safety	597	91.56	597	91.56
	Prices	55	8.44	652	100
healthp	No	482	73.93	482	73.93
	Yes	170	26.07	652	100
familyp	No	522	80.06	522	80.06
	Yes	130	19.94	652	100

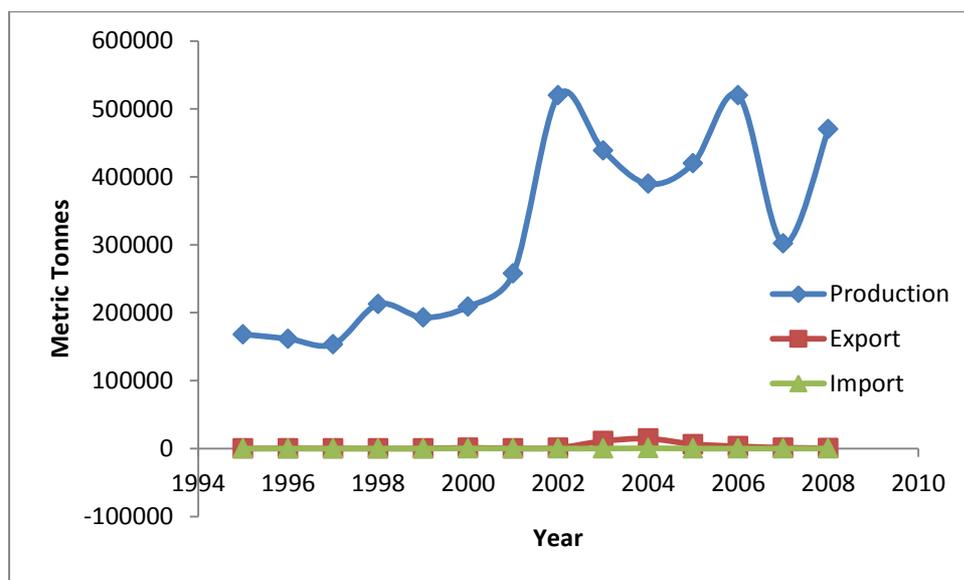
Source: Survey Data

Table 4.3. Estimation Results from the Cumulative Logistic Regression

		(Dep. Var=wtg_gp)		
Variables	Category	Model (1)	Model (2)	Odds Ratio for Model (2)
Intercept	yes	-21.4009*** (2.2996)	-32.4364*** (5.5458)	----
max_price	----	12.3507*** (1.3513)	18.4594*** (3.1815)	>999.9990***
healthp	no		-1.1249** (0.4636)	0.1050**
topprior1	food safety		0.2597 (0.5237)	1.6810
income_gp	high	----	1.3739*** (0.5006)	15.6080***
hysize2	large	----	-1.0212** (0.5005)	0.1300**
age_group	young	----	1.3213*** (0.4560)	14.0500***
edu_class	coll/univ	----	-2.1186* (1.0649)	0.0330*
	high sch	----	-0.2499 (0.6877)	0.2130
	middle sch	----	1.0736* (0.6098)	0.8010*
sex	female	----	-0.7241* (0.3917)	0.2350*
region1	BA	----	0.2001 (1.6958)	0.2660
	Central	----	-0.6576 (0.9570)	0.1130
	Eastern	----	-0.9543 (0.9436)	0.0840
	Western	----	-0.1142 (0.9180)	0.1940
Likelihood Ratio		571.723***	615.017***	615.017***
Concordance Index(c)		0.992	0.998	0.998
Number of observations		652	652	652

Notes: 1. *** Significant at 1% ; ** Significant at 5%; and * Significant at 10% .
 2. Standard errors are shown in parentheses.
 3. Probabilities modeled are cumulated over lower-ordered response values.

Figure 1. Peanut Production and Distribution in Ghana from 1995-2008



Source: Computed from FAO Statistics (2011)

Figure 3. Map of Ghana Showing Distribution of Regions and Urban Centers



Source: adapted from Owusu (2005).

APPENDIX

1. Distribution of Some Variables Shown in Two-way Contingency Tables

A. Crosstabs on the 2-leveled WTP Variable against Selected Categorical Regressors

Table A1. Cross tabulation of sub_cause by wtp_gp

sub_cause	wtp_gp	
Frequency Percent	No	Yes
Food safety	71 10.89	296 45.40
Others	2 0.31	33 5.06
Prices	67 10.28	183 28.07

Table A2. Cross tabulation of topprior1 by wtp_gp

topprior1	wtp_gp	
Frequency Percent	No	Yes
Food safety	110 16.87	487 74.69
Prices	30 4.60	25 3.83

Table A3. Cross tabulation of healthp by wtp_gp

healthp	wtp_gp	
	No	Yes
Frequency		
Percent		
No	110 16.87	372 57.06
Yes	30 4.60	140 21.47

B. Crosstabs on the 3-leveled WTP Variable against Selected Categorical Regressors

Table B1. Cross tabulation of region1 by wtp_order1

region1	wtp_order1		
	No	Yes-No	Yes-Yes
Frequency			
Percent			
Ashanti Region	43 6.60	11 1.69	245 37.58
Brong Ahafo Region	19 2.91	5 0.77	62 9.51
Central Region	25 3.83	0 0.00	41 6.29
Eastern Region	30 4.60	1 0.15	78 11.96
Western Region	23 3.53	1 0.15	68 10.43

Table B2. Cross tabulation of topprior1 by wtp_order1

topprior1	wtp_order1		
	No	Yes-No	Yes-Yes
Food safety	110 16.87	14 2.15	473 72.55
Prices	30 4.60	4 0.61	21 3.22

Table B3. Cross tabulation of income_class by wtp_order1

income_class	wtp_order1		
	No	Yes-No	Yes-Yes
High	12 1.84	2 0.31	82 12.58
Low	56 8.59	3 0.46	100 15.34
Medium	72 11.04	13 1.99	312 47.85

Table B4. Cross tabulation of healthp by wtp_order1

healthp		wtp_order1		
Frequency		No	Yes-No	Yes-Yes
Percent				
No		110 16.87	12 1.84	360 55.21
Yes		30 4.60	6 0.92	134 20.55

2. Survey Questionnaire for Studying Consumers' Willingness to Pay for Aflatoxin-free Peanuts in Ghana

Date of interview.....
Name of interviewer.....
Region..... Capital.....
Suburb.....
Interviewee Number /___/___/___/

Introduction

Auburn University and KNUST, as members of USAID-sponsored Peanut CRSP team of investigators, are conducting this survey to assess Ghanaian consumers' demand/preferences for quality (or safe) peanuts in domestic markets. We will therefore be glad if you could grant us a few minutes of your time and objectively respond to questions we have for you. We assure you that opinions expressed will be strictly treated as confidential.

A. Screening

- A1. Have you ever eaten peanuts and other peanut products before?
1.) Yes/___/
2.) No/___/ (Terminate interview)
- A2. How often do you eat peanuts and peanut products?
1.) Once per week /___/
2.) Two to three times per week /___/
3.) Four to six times per week /___/
4.) Daily /___/
5.) Other/___/ (please specify).....
- A3. Based on the above codes (A2) please indicate the frequency at which you consume the following peanut products (Multiple Response Allowed).
1.) Soup, butter or paste /___/
2.) Raw/uncooked kernels/___/
3.) Boiled kernels/pods/___/
4.) Roasted kernels/pods/___/
5.) Peanut oil/___/
6.) Peanut products like candies, cookies/pastry, fried peanut bars and kernels/___/
- A4. What is your main source of peanut supply (Over 50%)?
1.) Own farm/producer/gifts/___/ (Terminate interview)
2.) Buys from market/___/
- A5. About how many cups of shelled peanuts do you purchase weekly for your family needs?
..... cups per week.

B. Awareness of Aflatoxin Contamination

- B1. Have you heard about any food contaminants that pose health problems to consumers?
1.) Yes/___/

2.) No/___/ (Skip to B2)

B1.1 If yes, please

list.....

B2. Are you familiar with the problem of aflatoxin contamination in peanuts?

1.) Yes/___/

2.) No/___/ (Skip to Section C)

B2.1. (If 'yes' to question B2): How did you become aware of peanut aflatoxin contamination? For each of the sources below, please answer by indicating 1). Yes or 2). No:

1.) Through print/electronic media (e.g. TV, radio, newspapers) /___/

2.) Through individuals like friends and other relations/___/

3.) Through bodies like religious groups, NGOs/___/

4.) Through workshops by universities and other government research institutions/___/

5.) Others /___/ (please specify).....

C. Market Description

At this point, the interviewer MUST clearly and accurately explain the text below to all respondents before proceeding to Section D. This part is crucial since consumers must make informed decisions in the subsequent sections of the questionnaire.

Market Description

“Given the warm and humid weather conditions in Ghana, peanuts are often contaminated with aflatoxins particularly during post-harvest handling and marketing. Aflatoxins are substances produced by molds (fungi) that cause people to fall sick when highly contaminated peanuts are consumed over time. Researchers have found associations between aflatoxins exposure and health problems such as aflatoxicosis, fever, jaundice, and liver cancer. Although environmental conditions make the elimination of aflatoxins nearly impossible, there are scientifically proven measures that could be adopted by peanut producers through retailers to minimize contamination. Activities that effectively reduce aflatoxins include proper drying, sorting, and hygienic practices. However, the procedures that achieve no/low aflatoxin contamination involve additional costs (in terms of more labor and the discarding of contaminated peanuts) which could lead to higher retail prices. To protect the consuming public, government regulators in Ghana will have to enforce aflatoxin standards in the near future. In view of the above, we would want you to candidly answer the questions below by taking decisions in the context of your preferences, income, and regular food expenditure patterns.”

D. Willingness to Pay, Demand and Preferences

“Please observe these three peanut samples – A, B, and C – for a moment. Note that sample A is *unsorted* and has the highest possibility of aflatoxin contamination. Sample B is fairly sorted (i.e. still contains broken and shriveled kernels) and has a lower possibility of aflatoxin contamination compared to A. Sample C has the least possibility of aflatoxin contamination since it is *well-sorted* and thoroughly cleaned. We would want you to answer a few questions

shortly.”

D1. If we asked you to make a choice, which of the samples will you first pick for consumption?

- 1.) Sample A i.e. unsorted peanuts/___/
- 2.) Sample B i.e. moderately-sorted peanuts/___/
- 3.) Sample C i.e. thoroughly-sorted peanuts/___/

D2. Based on the quantities of peanuts you buy per week for your family, if you were to buy the same number of cups indicate how many cups you would buy of each category (sample) at each of the prices below.

Prices (GHC/cup)	Less than 1.0	1.0	1.5	2.0	2.5	3.0	Above
Peanut samples							
Sample A i.e. unsorted peanuts							
Sample B i.e. moderately-sorted peanuts							
Sample C i.e. thoroughly-sorted peanuts							

D3. What is the approximate price of peanuts in your preferred market? (Please specify unit of measurement and whether shelled or unshelled).....

D4. In preparing your meals that typically include peanuts, do you have other substitutes/ingredients that you can use instead of peanuts?

- 1.) Yes/___/
- 2.) No/___/ (Skip to D5)

D4.1. If ‘yes’ to question D.4, please specify your peanut substitutes.....

D4.2. What do you think can strongly influence you to switch away from peanuts to the substitutes you have listed?

- 1.) Prices/___/
- 2.) Food safety reasons/___/
- 3.) Others/___/ (please specify).....

D5. If the Government of Ghana organized a referendum calling on Ghanaians to express their opinions on a proposition to enforce peanut aflatoxin standards, what will your vote be? Please remember that the regulations will ensure the availability of aflatoxin-free (safer) peanuts in markets but could also mean that consumers will have to pay more than existing peanut prices. Please cast your vote.

- 1.) In favor/___/
- 2.) Against/___/ (Skip to Section E)
- 3.) Undecided/___/ (Skip to Section E)

D5.1. If vote is ‘in favor’ how much will you be willing to pay for a unit of aflatoxin-free peanuts?.....

D5.2. Would you be willing to pay more if the true price of aflatoxin-free peanut turns out to be a little higher than you have stated above?

- 1.) Yes/___/
- 2.) No/___/ (Skip to Section E)

3.) Not sure/___/ (Skip to Section E)

D5.3. If 'yes' please specify the maximum price for aflatoxin-free peanuts beyond which you will no longer be willing to pay.....

E. Attitudes and Behaviors Suggesting Food Safety Consciousness

E1. Please rank the peanut forms below according to your intensity or frequency of consumption using alphabets A to F where A is the highest rank and F is the lowest rank.

- 1.) Peanut butter/soup /___/
- 2.) Uncooked peanut kernels /___/
- 3.) Boiled peanut kernels/pods /___/
- 4.) Dry-fried or roasted kernels/pods /___/
- 5.) Peanut oil /___/
- 6.) Peanut products like candies, cookies/pastry, fried peanut bars and kernels /___/

E2. Which of the following best describes your habit regarding peanut purchases?

- 1.) Buys in bulk and use in bits over a period/___/
- 2.) Buys in bits for one-time use only/___/ (Skip to E3)

E2.1. If you buy in bulk, how do you typically store your peanuts? (Multiple Response Allowed)

- 1.) In a refrigerator/___/
- 2.) Kitchen shelves/cupboard/___/
- 3.) In a storage room with other food items/___/
- 4.) Others/___/ (please specify).....

E3. Which of the factors below do you normally give priority to before you decide to buy peanuts from a particular seller or group of sellers? (Multiple Response Allowed)

- 1.) Prices/Affordability/___/
- 2.) Cleanliness/neatness of products/___/
- 3.) Food safety concerns/health considerations/___/
- 4.) Others/___/ (please specify).....

E3.1. Out of the factors you have picked in E3, which one do you consider as the most important?

- 1.) Prices/Affordability/___/
- 2.) Cleanliness/neatness of products/___/
- 3.) Food safety concerns/health considerations/___/
- 4.) Others/___/ (please specify).....

F. Socioeconomic Characteristics

F1. Gender

- 1.) Male/___/
- 2.) Female/___/

F2. Marital Status

- 1.) Married/___/

- 2.) Single/divorced/separated/widowed/___/
- F3. Type of occupation
- 1.) Unemployed/___/ (Skip to F4)
 - 2.) Self-employed/___/
 - 3.) Public servant or works for a private entity/___/
- F3.1. Please specify your occupation.....
- F4. Highest level of formal education
- 1.) No formal education or zero years of schooling/___/
 - 2.) Primary or 6 years of schooling/___/
 - 3.) JHS/Middle School or 9 years of schooling/___/
 - 4.) SHS or 12 years of schooling/___/
 - 5.) Training College/Polytechnic or 15 years of schooling/___/
 - 6.) University or 16+ years of schooling/___/
- F5. Age of respondent.....years old.
- F6. Number of people in your household.....
- F7. What is your household's monthly income (including wages, salaries, remittances).....
- 1.) Below 300 Gh cedis/___/
 - 2.) From 300- 600 Gh cedis/___/
 - 3.) 601- 900 Gh cedis/___/
 - 4.) 900 and above Gh cedis
- F8. Have you had any health problems after you have eaten peanuts or peanut products?
1. Yes/___/
 2. No/___/ (Skip to F9)
 3. Never noticed/___/ (Skip to F9)
- F8.1 If yes, please list.....
- F9. Has any other members of your immediate family had health problems after eating peanuts or peanut product?
1. Yes/___/
 2. No/___/
 3. Don't know /___/
- F9.1 If yes, please list.....

3. Survey Questionnaire Guide for Enumerators

Interviewers are required to pay particular attention to instructions provided below regarding specific sections in the questionnaire.

A. Screening

For question **A1**; if a respondent's answer is "NO," politely terminate the interview and thank him for his time.

For question **A3**; if a respondent indicates that he consumes ONLY peanut oil (i.e. option 5 of question A3) and no other forms of peanut then politely end the interview.

For question **A4**; if a respondent obtains his peanut mainly (i.e. over 50%) from his own

harvest and/or as gifts then politely terminate the interview. This study focuses on peanut consumers who buy from markets; ‘out-of-pocket’ consumers.

C. Market Description

Please endeavor to communicate the content of this section to respondents in very clear terms. The reliability of responses strongly hinges on how well the content of this particular section is conveyed.

SECTION C

Interviewers MUST clearly and accurately explain the text below to all respondents. This part is crucial since consumers must take informed decisions in the subsequent sections of the questionnaire.

Market Description

“Given the warm and humid weather conditions in Ghana, peanuts are often contaminated with aflatoxins particularly during post-harvest handling and marketing. Aflatoxins are substances produced by molds (fungi) that cause people to fall sick when highly contaminated peanuts are consumed over time. Researchers have found associations between aflatoxins exposure and health problems such as aflatoxicosis, fever, jaundice, and liver cancer. Although environmental conditions make the elimination of aflatoxins nearly impossible, there are scientifically proven measures that could be adopted by peanut producers through retailers to minimize contamination. Activities that effectively reduce aflatoxins include proper drying, sorting, and hygienic practices. However, the procedures that achieve no/low aflatoxin contamination involve additional costs (in terms of more labor and the discarding of contaminated peanuts) which could lead to higher retail prices. To protect the consuming public, government regulators in Ghana will have to enforce aflatoxin standards in the near future. In view of the above, we would want you to candidly answer the questions below by taking decisions in the context of your preferences, income, and regular food expenditure patterns.”

D. Willingness to Pay, Demand and Preferences

At this point, the interviewer must show all three peanut samples to the respondent for careful observation. Emphasize that although all peanut samples may be contaminated, the unsorted one (A) and the moderately sorted (B) are more likely to have higher aflatoxin levels than the sorted sample (C). Also stress that samples A and B are peanuts typically sold in Ghanaian markets.

For question **D3**; find out about the price he normally pays for his peanuts in the appropriate quantity (i.e. whether per margarine can, ‘olonka’, etc).

For question **D5**; again, remind the respondent to take decisions in the context of his preferences, income, and regular food expenditure patterns.

F. Socioeconomic Characteristics

For question **F7**; Actual household monthly incomes are preferred so please attempt to get precise income levels in addition to intervals.

For question **F7**; Household should comprise of all individuals in a home that share meals

and other basic necessities.

Please Note: “Multiple Response” at the end of a question indicates that respondents can choose one or more options.