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Eliciting Consumer WTP for Food Characteristics in a Developing Context: Application of Four Valuation Methods in an African Market

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Abstract

We elicit willingness to pay for conventional, organic and/or food-safety-inspected tomatoes in a traditional African food market. We identify four elicitation methods that can be conducted with one respondent at a time, and use them in a field setting: the Becker–DeGroot–Marschak mechanism, multiple price lists, multiple price lists with stated quantities, and real-choice experiments. All four methods give similar results; showing that consumers are willing to pay a premium for organic and food-safety-inspected tomatoes. However, the size of the premium is significantly larger when consumers choose between alternatives than when they indicate their reservation price. The new multiple price lists with stated quantities were easy to explain in the busy market setting, gave the respondents the opportunity to determine the amount they wanted to buy, and had valuations in line with the other non-comparative valuation methods.

Keywords: *Becker–DeGroot–Marschak mechanism*; *choice experiment*; *field experiments*; *food safety*; *organic*; *price lists*; *Tanzania*; *willingness to pay*.

JEL classifications: *D12, D44, D46*.

1. Introduction

Most consumer valuation studies come from the US or Europe. The traditional way of conducting these studies is through surveys, but in recent years there has been a

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growing literature using lab and field experiments, where products have been evaluated and sold using various experimental valuation methods (Alfnes and Rickertsen, 2011). Implementing these methods in developing countries can be challenging due to technological, logistical and literacy problems, but a few studies have been conducted (Masters and Sanogo, 2002; De Groote *et al*., 2011; Lagarkvist *et al*., 2011; Morawetz *et al*., 2011; Alphonce and Alfnes, 2012; Probst *et al*., 2012).

The most frequently used experimental valuation methods worldwide have been Vickrey-style sealed-bid auctions with endogenously determined market prices and the Becker–DeGroot–Marschak (BDM) mechanism with exogenously determined prices (Vickrey, 1961; Becker *et al*., 1964). Recently, researchers have also used non-hypothetical choice (Lusk and Schroeder, 2004; Alfnes *et al*., 2006) and price-list experiments[2] (Kahneman *et al*., 1990; Andersen *et al*., 2006; Corrigan *et al*., 2009). In these experimental valuation methods, the participants submit a bid, choose a product, or state at which prices they are interested in buying a product. For the methods to be incentive compatible, products must be sold and it must be in the best interest of the participants to reveal their true preferences.

The methods used in the literature differ with respect to how easy it is to explain the rules, how easy it is to understand the dominant strategy, how time consuming they are, and how many participants are needed at a time. In this paper, we use four experimental valuation methods that are relatively easy to explain, have a dominant strategy that is not very difficult to understand, are relatively quick to conduct, and can be conducted with one participant at a time. The four methods are the BDM, the multiple price list (MPL), the multiple-price-list with stated quantities (MPLX) and the real-choice experiments (RCE).[3]

Both the ease of explaining and understanding the four methods and the fact that they can be done relatively quickly with one participant at a time makes them suitable for eliciting willingness to pay (WTP) in a busy market environment like a traditional African food market. These markets often include illiterate consumers, product information given orally by the seller, no labels or information on the products, only one seller and one buyer involved in each transaction, and a buying behaviour that involves consumers being part of the price setting.

We contribute to the literature by illustrating the use of four easily conducted WTP elicitation methods in a busy field setting. We use people going to the market to buy as respondents (almost no recruitment costs), and they buy in the experiment using their own money (no windfall money). The paper also contributes to the knowledge about consumer preferences for food-safety and organic foods in Africa. The results have implications for researchers' choice of methods and implications for project evaluation and policy recommendations.

[2]Multiple price lists are also referred to as payment cards.

[3]It is worth noting here that we do not include the popular Vickrey-type auctions. The reason for this is that these auctions have several features that make them difficult to conduct in a sometimes chaotic traditional market. First, they include multiple bidders bidding simultaneously on the same product. This moves the buying process far away from the typical one-on-one haggling process between the buyer and the seller in these markets. Second, the price-setting mechanism using the highest losing bid is a bit confusing for most participants, and needs extensive explanations and training, which can be hard to conduct in such a market place.

2. Background

2.1. Traditional food markets in an African context

Traditional markets in many developing countries are characterised by fresh produce being sold in piles in open air. The products are not labeled and the seller is the only source of information about credence attributes like origin and product variety.[4] Consumers choose their produce mainly based on its physical attributes, including size, freshness, shape, cosmetic damage and colour.

Consumers in these markets are used to finding a posted price on piles of produce; the various piles can be differentiated by variety, origin or physical characteristics. A consumer chooses the amount he/she wants and either pays the price or negotiates on the price for the chosen product. Similar traders selling the same produce are found in the same open market, mostly just a metre or two away from each other. Hence, the markets are highly competitive, often giving the consumer some market power when negotiating.

Despite the markets being characterised by poor hygiene and sanitation, the traditional markets are in many countries the main points of purchase for urban consumers (Tschirley, 2007; Tschirley and Ayieko, 2008). For example in a consumer study, Tschirley and Ayieko (2008) reported that consumers living in Nairobi, Kenya believed that vegetables from the high-end markets were the safest, but still the traditional market had 90% of the market share during the time of the study (Tschirley and Ayieko, 2008). In Tanzania, fresh produce has only recently been introduced in high-end markets and these markets hold a very low market share for fresh produce. According to Lagerkvist *et al.* (2013), the products in these markets are usually perceived to be safer than those from the traditional markets, but unfresh and expensive.

2.2. Consumer studies on organic and food-safety-inspected food in Africa

Due to increasing awareness and health concerns among consumers, healthy eating is currently one of the major trends in the world's food markets. Healthy eating encompasses nutrition and safety, and both are important for wellbeing. This revolving trend for healthy eating is also evident in developing African countries. For example, Ngigi *et al.* (2011) and Lagerkvist *et al.* (2012) found that nutrition and food safety were among the factors driving food choices in Kenya; Alphonce and Alfnes (2012) found that organic and food safety were among the factors considered by respondents in Tanzania, and Demont and Ndour (2015) found that urban consumer preference for imported rice could be outweighed, if intrinsic and extrinsic quality attributes for domestic rice were tailored in line with urban consumer preferences.

Only in recent years have consumer studies related to food safety started to emerge in developing countries. The African studies include a study on the WTP for safer leafy vegetables in Nairobi (Ngigi *et al.*, 2011), a study of consumer perceptions and WTP for synthetic pesticide-free vegetables in Benin (Coulibaly *et al.*, 2011); a WTP study for organic vegetables in the food vending sector in Benin, Ghana and Bukina

[4]Credence attributes are attributes that consumers cannot ascertain by themselves either before or after consumption, but have to rely on information from the seller. Such attributes include the vitamin, nutrition, safety or eco-friendly status of products.

Faso (Probst *et al*., 2012); and a study on WTP for safer tomatoes in Tanzania (Alphonce and Alfnes, 2012). All studies found that consumers in these markets were willing to pay a significant and positive premium for safer foods. In addition, the majority found that the WTP premium was positive and significant across income and gender groups, and that women were willing to pay higher premiums for food safety related attributes.

Other consumer studies related to food safety in Africa include: studies on genetically modified (GMO) products conducted in Tanzania, Uganda, and Kenya (Kimenju and De Groote, 2008; Lewis *et al*., 2010; Kikulwe *et al*., 2011); and a study on the perceptions of health risks among players in the vegetable value chain (Lagerkvist *et al*., 2013).

3. Experimental Design and Methods

3.1. Experimental design

The experiment was conducted in a traditional food market in Morogoro, Tanzania in May 2011. Morogoro Municipal is a town with a population of about 602,114 (Population Distribution by Administrative Units, 2013), located 169 km west of Dar es Salaam. The main economic activities are agriculture and educational services, and Morogoro is often called Tanzania's food basket.

We sold tomatoes using four different elicitation methods by setting up a table close to other tomato sellers. The elicitation methods were selected from the food-valuation literature based on their ability to be conducted with one respondent at a time (for an overview of the non-market valuation methods, see Alfnes and Rickertsen, 2011). The selected methods were the BDM, RCE, MPL and MPLX.

By conducting experiments in the field, we are able to elicit preferences in the market context we are interested in studying. Compared with conducting a lab experiment, where participants show up at some university or hotel and make their choices, a field experiment allow us to include several sought-after field characteristics. The traditional market is where consumers in Morogoro usually make most of their purchases for fresh produce. The participants came to the market to buy tomatoes among other things and used their own money to buy the tomatoes in the experiment. The experiments were conducted just a few metres away from other sellers with competing products. In the experimental economics literature, this means real context, real consumers, real economic incentives (no windfall money) and real outside options, all of which are highly sought-after characteristics for a food valuation experiment. The downside is reduced control over the sample and framing of the experiment, and reduced time to explain and train the participants.

Even though our study avoids hypothetical bias by using experiments with real economic incentives, we still have at least two validity challenges: curiosity bias (the extent to which people try to buy the new product just to try them out) and social desirability bias (the extent to which people behave more in line with norms and expectations because they are observed by researchers). In our case, curiosity bias would arise as a consequence of people, who had not tested organic or inspected tomatoes before, being willing to pay more for these tomatoes than their expected consumption value so as to obtain information of how the new tomatoes fit into their preference set (Alfnes, 2007). Social desirability bias could arise through people

stating higher WTP for the products that they thought the moderator supported, possibly the new products presented by the moderator; or because they would be seen by their fellow buyers participating in the experiment (Falk and Heckman, 2009; Alfnes and Rickertsen, 2011).

3.2. Products

The products were 500 g portions of tomatoes. We included four types of tomatoes: (i) conventional tomatoes similar to the ones found elsewhere in the market, (ii) organic tomatoes, (iii) food-safety-inspected conventional tomatoes, and (iv) food-safety-inspected organic tomatoes. Here, we refer to the latter two types as inspected tomatoes and inspected organic tomatoes, respectively. Our first type represents the typical tomatoes found in this market, while the latter three types, have credence attributes not normally available in the traditional markets. We presented the four tomato alternatives and answered any questions the consumers had about the products. We tried our best to present each participant with four alternatives that looked as similar as possible with respect to weight and freshness, but with fresh produce it is always a possibility that there were some differences for some of the participants. We did not conduct any test of the appearance, but are unaware of any reason there should be a systematic differences in the appearance of the tomatoes across methods.

We choose to focus on food safety and sustainability elements, because in recent years, production of many food products has shifted from a subsistence basis to a commercial basis. In this process, there has been a growing concern about bad agricultural practices, as examples have been revealed of poor pest-management practices, use of unsafe irrigation water, and production in areas highly susceptible to heavy metal pollution (Ngowi *et al*., 2007; Shemdoe, 2010). Tomatoes were chosen because they are used by the majority of households and food vendors, and therefore represent a familiar and frequently purchased product where there are likely to be worries about the production processes.

3.3. Subjects

Consumers attending the market were asked to participate in a study on food market decision making conducted by researchers from the local agricultural university. Consumers were asked two screening questions: (i) whether they were interested in buying tomatoes that day, and (ii) whether they were involved in the family's food decision making. Only those who answered 'yes' to both questions were invited to participate in the experiment. Since we were only interested in recruiting people that wanted to buy tomatoes and because we wanted to avoid a windfall money effect (Ackert *et al*., 2006; Harrison, 2007), we did not pay the participants money to take part in the experiment. Instead, participants were rewarded with a small bag of onions for their participation after the experiment. In other words, the money they used in the experiment was the money they had brought to the market to purchase food.

The experiment took 5 days, and we recruited a total of 254 participants. The number of participants in each method depended on the turn up and time needed to explain and conduct the experiments. The MPL (69 participants) and RCE (65 participants) were conducted during the weekend when there were many people in the

Table 1
Descriptive statistics for the samples

Valuation	*N*	Descriptive	Income*	Age	Gender†	Education‡
BDM	76	Mean	563	40	0.83	2.35
		Std. dev	894	10.81		
		Min	30	25	0	1
		Max	7,000	65	1	4
MPL	69	Mean	748	36	0.89	2.03
		Std. dev	1,392	7.25		
		Min	30	25	0	1
		Max	10,000	53	1	4
MPLX	44	Mean	584	41	0.86	2.18
		Std. dev	622.95	10.78		
		Min	50	21	0	1
		Max	3,000	62	1	4
RCE	65	Mean	749	38	0.85	2.12
		Std. dev	1,553	10.57		
		Min	30	16	0	1
		Max	12,000	60	1	4

Notes: *Monthly income in 1,000 TZS. TZS 1,000 = USD 0.64. Hence, TZS 30,000 = USD 19.20 and TZS 12,000,000 = USD 7,680 (31 May 2011 values according to www.oanda.com).
†One if female, zero if male.
‡Graduate and above = 1, Certificate, Diploma, and high school = 2, Secondary O-level = 3, Primary or less = 4.
BDM, Becker–DeGroot–Marschak; MPL, multiple price list; MPLX, multiple-price-list with stated quantities; RCE, real-choice experiments.

market, while the BDM were conducted over two weekdays (76 participants) and the MPLX on one weekday (44 participants).[5]

We used quota sampling to avoid systematic variation in gender and income between the four methods. The income sampling was based on appearance, and in the survey, the income assessment was confirmed or corrected. We aimed at recruiting 2/3 women and 1/3 men to each valuation method. This was done because in Tanzania women are the main shoppers and food decision makers. However, due to very few men in the food market we came up short of male participants (only 15%). The characteristics of the participants in each method are summarised in Table 1.

An ANOVA test failed to reject the null hypothesis of no differences between the samples used in the different valuation methods.

[5]The referees found this to be an unnecessary weakness in the design, and pointed out that people coming to the market can differ between days, and that WTP can differ between when the experiment is conducted. One of the potential strengths of a one-to-one experimental method is that one can easily make changes in methods, information and framing between participants. This possibility should be utilised in further research interested in comparing experimental treatments.

3.4. Experimental valuation methods

Each participant valued four tomato products (conventional, organic, food-safety-inspected conventional tomatoes, and food-safety-inspected organic tomatoes) using only one of the valuation methods. To enhance the participants' understanding, we explained the selected method and procedures one-to-one (details of the experimental procedures are available online at the publishers' website in Appendix S1 and S2), and training was conducted using examples.[6] Due to the market setting and time constraint, more intensive training was not possible; however the example was repeated when needed to ensure understanding. Since selection for the experiment was based on the participant's interest in buying tomatoes, all participants are expected to have a value for the tomato products that is equal or above the price of tomatoes in the market. Participants who consider the conventional tomatoes sold in the experiment to be identical to the tomatoes sold in the market should not be willing to pay more than the field price in the experiment (Harrison *et al*., 2004). With the heterogeneity of most products sold in an African market, there is no one field price for a product, but rather a range of prices. Valuations outside this range can either mean that the participants perceive the tomatoes sold in the experiment to be somehow different from the other tomatoes in the market, or that they have not clearly understood the rational choice in the valuation methods, (Corrigan and Rousu, 2008). In this study, 38% of the participants valued conventional tomatoes outside the price range, but unfortunately, we are not able to separate these two explanations of bids that are too high or too low compared to those expected.

The treatments were as similar as possible, and in all treatments we followed nine steps: (i) the four different tomatoes were presented with logos and their attributes explained; (ii) the participants were told how the respective experimental valuation method worked; (iii) an example of the method was given; (iv) the participants made a bid or choice; (v) a binding product was randomly drawn; (vi) a binding price or choice set was randomly drawn; (vii) the participants who were to buy tomatoes did so at the price determined by the random choices in steps 5 and 6; (viii) the participants received onions for their participation; and (ix) the participants completed a short survey.

3.4.1. Becker–DeGroot–Marshak mechanism

In the BDM mechanism, a participant is asked to bid for a product, and he/she has to buy the product at a randomly drawn price if the bid equals or exceeds the drawn price. Each participant bids on the four tomato products simultaneously. To avoid diminishing effects from multiple purchases, only one of the products was randomly selected as binding. As the price is randomly drawn, the participants' bids only determine if they are allowed to buy or not. Therefore, their dominant bidding strategy is to bid their WTP for the product and thereby reveal their true preferences.

[6]In the illustrative examples, we used TZS 500 as the price, which is somewhat above the market price for conventional tomatoes. Using a numerical price in the example has both pros and cons. It is good for making the example less abstract, which was very important in our case. The somewhat high price we used also illustrated that the price in our experiment might be higher than can be found other places in the market. The disadvantage of this is price affiliation, where there is a possibility of participants being affected by the prices used in the example.

3.4.2. Multiple price lists

In the MPL format, participants are given a payment card with prices ordered from low to high, and asked to indicate whether they are willing to buy a product at each price level. Then, one of the prices is randomly drawn as binding. Since our experiment had four products, the payment card had four price lists, one for each product. The price lists had a new price point for every 50 TZS.

Each participant indicated their willingness to buy the different tomatoes at the various prices on the payment card. Then one price and one product was randomly drawn as binding, and participants who had indicated that they would buy the drawn product at the drawn price did so.

As the price is randomly drawn, the participants' choices do not affect the price, only determine if they are allowed to buy or not at a drawn price. Therefore, their dominant strategy is to say 'yes' at all prices up to their WTP, and thereafter 'no'. Thereby, revealing the interval containing their true WTP.

One of the potential weaknesses of the MPL method is that the consumers' stated valuations might be affected by the range of prices on the price list (Andersen *et al.*, 2006). A price list with a very low minimum, secures that the researcher gets a narrow valuation interval also for those less interested in the product, but can potentially send a signal about a low value or the possibility of getting the product cheap. To test for such an anchoring effect, a between-sample design using two different price lists was used. A price list with lower prices started at 50 TZS and ended at 1,000 TZS, and a price list with higher prices started at 350 TZS and ended at 1,250 TZS. To differentiate between the two price lists, we refer to them as MPL-L and MPL-H, respectively. The market price for a 500 g portion of conventional tomatoes was approximately 350 TZS (ranging between 300 TZS and 400 TZS) in the market at the time of the experiment. The large price ranges were used because we wanted to treat all four alternatives equally, find both an upper and lower limit for most participants value intervals, and had limited knowledge of how the participants would value the three labeled alternatives.

3.4.3. Multiple price list with quantity statements (MPLX)

The MPLX has the same setup as the MPL, but instead of indicating whether they want to buy or not, the participants indicate the number of units of the product they want to buy at the different prices. The price range was the same as the MPL-H, with prices between 350 TZS and 1,250 TZS. As in the first two methods, one of the products and one of the prices were randomly drawn as binding. However, in the MPLX a participant buys the number of units indicated for the binding product at the binding price. As the price is randomly drawn, the participant's choice only determines if and how many units they are going to buy. Therefore, their dominant strategy is to state the number of units they want to buy at each of the prices. Thereby, they reveal the interval where their true WTP for one product is, and in addition, they reveal their WTP for additional products.

The MPLX design is inspired by Corrigan *et al.*'s (2009) open-ended choice experiments, in which they fixed the price for the generic product (conventional rice) and had a price list for the new product (GMO rice). Participants were asked to indicate how much they wanted of the two alternatives at the various prices. In our experiment, we wanted to test multiple products and treat all four products equally; therefore we used a price list for all four products, including the conventional tomatoes

(the generic product in our study). To our knowledge, this is the first paper using the MPLX in a food field experiment.

3.4.4. *Real-choice experiment*

In the RCE, participants were given a form with four columns and eight rows of prices. Each row represented one choice scenario, and for each choice scenario the participants had to choose one of the four alternatives. Then, one of the scenarios was randomly drawn as binding. We adopted the design by Lusk and Schroeder (2004), by letting all the products be available in each of the choice sets, and only used a fractional factorial design to vary the prices between the choice sets.

The fractional factorial design was generated from SPSS, with 16 profiles, which were divided into two blocks of 8 independent pricing scenarios.

To get as much information as possible about consumer's valuation of the credence attributes, we conducted the choice experiment with forced choices.[7] This was chosen bearing in mind that we only included consumers who were at the market to buy tomatoes, and the lowest prices in the experiment were below the market price for generic tomatoes. As a result, in the RCE we are only able to estimate WTP for tomato characteristics, but not WTP for the whole tomato.[8]

The dominant strategy for participants is to choose the alternative that they think gives them the highest utility in each of the choice sets, thereby revealing their true preferences. In contrast to the other methods, the choice experiment does not give WTP values or WTP intervals on an individual level without estimating a model.

4. Data Analysis

4.1. *WTP estimates from the four methods*

We investigated consumer WTP for organic and food-safety-inspected tomatoes using four different elicitation methods, as described above. The data from the different methods come in different formats. Three of these formats use non-comparative scales (BDM, MPL and MPLX), where the participants indicate their WTP for each type of tomato, and one format (RCE) uses a comparative scale, where the participants compare the alternatives and choose one of them. The BDM where the participants state a reservation price yields continuous WTP data for 500 g of tomatoes. The MPL, where the participants indicate the prices they would be willing to buy at from a list of prices,

[7]We are aware of the discussion in the literature about opt-out options, but to our knowledge there is nothing in the literature indicating that this should bias the marginal WTP results in one specific direction.

[8]One can argue that rational participants coming to the market to buy tomatoes and being aware that there are similar tomatoes sold close by should be willing to pay the same for conventional tomatoes as the field price, and that this could be a basis for calculating WTP estimates from the RCE. However, it is neither certain that the participants consider the tomatoes in the experiment similar to those sold in the market nor can we assume that they all behave rationally. The difference between the field price and the WTP estimates for conventional tomatoes from the other methods indicates that we have either one of these problems or both. Hence, we have chosen not to use the field price of approximately TZS 350 as a basis for estimating the full WTP for the tomatoes in the RCE. If one wants to do so, one simply has to add TZS 350 to the marginal WTP estimates.

yields interval WTP data for 500 g of tomatoes. The MPLX yields interval WTP data for both 500 g of tomatoes and multiples of 500 g. Finally, the RCE yields discrete choice data that can be used to estimate the average WTP for 500 g of one type of tomato relative to another type.

Owing to the differences in data, the four methods have different estimation methods. Therefore, we focus on the results that all four methods have in common: estimates of consumers' average WTP for one unit of the three premium varieties of tomatoes (organic, inspected, and organic inspected) relative to the conventional tomatoes.

We use the four types of data to estimate the following money metric WTP equation:

$$\widehat{\boldsymbol{WTP}}_j = \hat{\boldsymbol{\beta}}_{\boldsymbol{0}} + \hat{\boldsymbol{\beta}}_{\boldsymbol{1}}\boldsymbol{Organic}_j + \hat{\boldsymbol{\beta}}_{\boldsymbol{2}}\boldsymbol{Inspected}_j + \hat{\boldsymbol{\beta}}_{\boldsymbol{3}}\boldsymbol{Organicinspected}_j \quad (1)$$

where $\widehat{WTP}_j$ is the estimated average WTP for 500 g of product j; $Organic_j$ is a dummy for the organic tomatoes; $Inspected_j$ is a dummy for the inspected tomatoes; $OrganicInspected_j$ is a dummy for the inspected organic tomatoes; the constant term β_0 is the estimated WTP for the conventional tomatoes; and the other betas are the corresponding money metric parameters representing the price premiums the participants are willing to pay for the labeled products compared to the conventional tomatoes. For the RCE without an opt-out option, the reference point (=0) is the conventional tomatoes, therefore a constant is not included. Hence, in the RCE we only find the price premiums presented with β_1, β_2 and β_3. Owing to the differences in the data described above, we use three different estimation methods to estimate this money metric WTP equation.

4.2. Econometric models

For the BDM data, we follow the common practice used in BDM studies and estimate a panel Tobit model censored at zero (Lusk and Shogren, 2007).[9] This gives the following Tobit model:

$$WTP_{ij} = \beta_0 + \beta_1 Organic_j + \beta_2 Inspected_j + \beta_3 OrganicInspected_j + v_i + \varepsilon_{ij}, \quad (2)$$

where WTP_{ij} is the WTP of participant i for 500 g of product j; v_i is the individual specific random term, and ε_{ij} is the normally distributed error term. The rest is as in equation (1). The model is estimated with the *xttobit* command in STATA 13.

For data from the MPL and MPLX, we follow the common practice used in other MPL studies and estimate an interval regression model (Andersen *et al.*, 2006). For the MPLX, we examine only the WTP for the first unit. This is done to make the results more directly comparable across the four methods. When using only the WTP for the first unit, there is no difference between the data from the MPL and MPLX method, so we also use the interval regression model for the MPLX method. This gives the following interval regression model for both the MPL and the MPLX method:

[9]With all participants saying that they plan to buy tomatoes at the market, zero bids is not a big problem. Only 3.19% of the bids in the BDM were zero, and a random effect model without censoring gives almost identical results. We have kept the Tobit to be consistent with the literature.

$$WTP^{*}_{ij} = \beta_0 + \beta_1 Organic_j + \beta_2 Inspected_j + \beta_3 OrganicInspected_j + v_i + \varepsilon_{ij}, \quad (3)$$

where WTP^{*}_{ij} is the WTP of participant i for 500 g of product j. WTP^{*}_{ij} is not directly observed, but we observe an interval around WTP^{*}_{ij}, or at least an upper or lower limit for WTP^{*}_{ij}. The lower limit is the highest price at which the participant wanted to buy and the upper limit is the lowest price at which they did not want to buy. The rest is as in equations (1) and (2). The model is estimated with the *xtintreg* command in STATA 13.

For the RCE data, we follow the common practice used in choice experiment studies and estimate a mixed logit model (McFadden and Train, 2000). This gives us the following random utility model:

$$U_{ij} = \alpha_{1i} Organic_j + \alpha_{2i} Inspected_j + \alpha_{3i} OrganicInspected_j + \alpha_P Price_j + \varepsilon_{ij}, \quad (4)$$

where U_{ij} is the utility of participant i for 500 g of product j; similar to equations (1–3) $Organic_j$ is a dummy for the organic tomatoes; $Inspected_j$ is a dummy for the inspected tomatoes and $OrganicInspected_j$ is a dummy for the inspected organic tomatoes. In addition to the other equations is $Price_{j,}$ which is the price for product j. The alphas are the utility parameters; where α_{1i}, α_{2i} and α_{3i} are random parameters and α_p is a fixed parameter; ε_{ij} are iid extreme value distributed error term. The model is estimated with the *mixlogit* command in STATA 13.

To transfer the results of the random utility model to a money metric WTP model such as equation (1), we divide all the other parameters in the random utility model by the negative of the price parameter. As discussed above, because we did not include a non-choice option in the RCE design, the resulting money metric WTP model only includes the marginal WTP for organic and inspected attributes, and not the total WTP for the whole tomato. Thus, the RCE yields the following WTP model that provides the marginal WTP for the attributes:

$$\overline{WTP_j} = -\left[\frac{\alpha_1}{\alpha_P} Organic_j + \frac{\alpha_2}{\alpha_P} Inspected_j + \frac{\alpha_3}{\alpha_P} OrganicInspected_j\right]. \quad (5)$$

5. Results and Discussion

We start with the implementation challenges we experienced related to the four methods and then present and discuss the WTP results from the four methods.

5.1. Implementation challenges in a traditional African food market

The four methods we implemented differed on how easy it was for the participants to understand them. This is an important characteristic in the choice of methods because the participants are in the market to shop and might not be prepared to take part in a lengthy experiment. Furthermore, it is difficult to implement extensive training in a busy market. Since some of the consumers were illiterate, all the information about the methods and products was given orally. We sometimes had to explain the methods and the differences between the products several times to ensure understanding.

The participants asked the fewest questions in relation to the methods based on price lists (MPL and MPLX). But, as we will later see, the range of the price lists affected their behaviour, indicating that not all understood their dominant strategy.

The choice in the RCE was very easy to explain, but some of the participants had problems understanding the independence of the various choice scenarios.

The BDM was the method that raised most questions, and where the participants needed most repetition of the instructions. A seller that first asks how much the buyer is willing to pay and then wants to sell the product at a lower price than the price offered by the buyer seemed counter-intuitive to many participants. The BDM is also the only method of the four methods we tested where the seller asks the participants to state a price. This might resemble a bargaining position common for African consumers in many markets (although not that common in food markets).

Whenever in a bargaining position in a real market, it is common that consumers strategically lower their starting price to get a good price. As a result, they struggled to understand their dominant bidding strategy in the BDM and thought that they could influence the price through their bidding. This is also a common finding in bid-based valuation methods in Europe and the US, and therefore extensive training with other products is usually conducted in the BDM and other bidding-based valuation methods (Drichoutis *et al.*, 2011).

5.2. WTP estimates from econometric models

Table 2 presents the estimated WTP results from the money metric models for the four valuation methods estimated using equations (2), (3) and (5). The WTP associated with the labels are the marginal WTP (MWTP), a premium for the labeled tomatoes over the conventional tomatoes. The total WTP for the labeled tomatoes is the constant plus the premiums. For the conventional tomatoes, the WTP is the only

Table 2

WTP premium estimation results from the econometric models in TZS

	BDM (N = 76)	MPL-L (N = 33)	MPL-H (N = 36)	MPLX (N = 44)	RCE (N = 65)
Organic and inspected	211.19***	307.12***	153.95***	132.93***	578.64***
	(20.37)	(33.91)	(22.96)	(12.69)	(47.07)
Organic	80.92***	151.55***	86.50***	101.51***	272.82***
	(20.37)	(34.08)	(23.08)	(12.72)	(37.81)
Inspected	94.55***	151.40***	84.24***	67.50***	123.58**
	(20.38)	(33.99)	(23.12)	(12.86)	(55.91)
Constant	273.68***	162.33***	348.87***	308.00***	
	(20.60)	(30.87)	(24.76)	(13.67)	
Sd $v^{\dagger}$	127.95***	107.32***	106.51***	57.87***	
	(12.97)	(18.10)	(15.09)	(7.53)	
Sd $\varepsilon^{\ddagger}$	125.16***	133.30***	89.71***	44.72***	
	(5.96)	(1.30)	(2.46)	(1.06)	

Notes: Numbers in parentheses are standard errors. When interpreting the price, recall that the market price for conventional tomatoes was around 350 TZS during the experiment. BDM, Becker–DeGroot–Marschak; MPL, multiple price list; MPLX, multiple-price-list with stated quantities; RCE, real-choice experiments; WTP, willingness to pay.

*$P < 0.10$, **$P < 0.05$, ***$P < 0.001$.

†Sd v is the standard deviation of the individual specific random term.

‡Sd ε is the standard deviation of the error term.

constant. As discussed above, for the RCE we could not estimate the constant, and therefore only have the MWTP for the labeled products.

The results show that consumers are willing to pay a premium for organic and food-safety-inspected tomatoes in all methods. And in all the five models, organic inspected tomatoes are the most valued tomatoes and conventional tomatoes the least valued. Using a nonlinear Wald test, we find that the difference in WTP between organic and inspected tomatoes is significant in the MPLX ($P < 0.01$) and RCE ($P < 0.01$), but not in the BDM ($P = 0.05$) and MPL ($P = 0.92$).

We also use a nonlinear Wald test to see if there is an embedding effect; the marginal WTP for organic inspected being smaller than the sum of organic and inspected. We are not able to reject the hypothesis of no embedding effect in the BDM ($P = 0.18$) and MPL ($P = 0.67$), but do reject it in the RCE ($P = 0.006$) and MPLX ($P = 0.03$). In other words, in two of the models, organic plus inspected equals organic inspected, and in the other two models, organic plus inspected is greater than organic inspected. So there is no clear conclusion with respect to embedding.

Despite the similarities and difference between the four methods, it is worth observing two very notable differences between the methods.

First, MPL-L, and to some degree the BDM, have very low WTP for the conventional tomatoes. Recall that all participants had indicated that they were interested in buying tomatoes at the market and that during the experiment there were no tomatoes available for <300 TZS anywhere in the market. Many of the participants in the MPL-L indicated that they were only willing to buy conventional tomatoes at prices that were below the market price that day. Also for the other tomato types, the MPL-L gave lower WTP estimates than the other methods, but the differences were less severe there. Hence, the price premiums for the organic and inspected tomatoes are larger in the MPL-L, than in the MPL-H and MPLX. More generally, the results indicate that using a price list with prices below market price has a negative effect on the WTP, and this effect is largest for the least valued product.

Second, the size of the premiums is significantly larger when consumers choose between alternatives in the RCE than when they use the non-comparative valuation scales in the other methods. For example, consumers in the RCE are willing to pay a premium that is more than four times higher for organic inspected tomatoes than consumers in the MPLX method. This could be a result of the attention to prices being higher when you evaluate products one by one in the non-comparative methods (BDM, MPL, MPLX) than when you choose between products in the RCE.

Unfortunately, there is no independent research on these attributes in Tanzania to help us determine which of the results is more likely to be accurate. Furthermore, more research is needed to see how robust these results are to changes in the design of the RCE.

5.3. WTP distributions

Figure 1 presents the WTP distributions for the four types of tomatoes. Only the BDM gives direct WTP estimates for each participant. Therefore, in the figure we: (i) used the midpoints of the intervals as the WTP for the price-list methods (MPL-L, MPL-H, MPLX); and (ii) zero WTP to participants that were not interested in buying at any price on the price list. Our RCE only provided WTP for the organic and inspected attributes and not for the whole tomato, therefore WTP distribution for

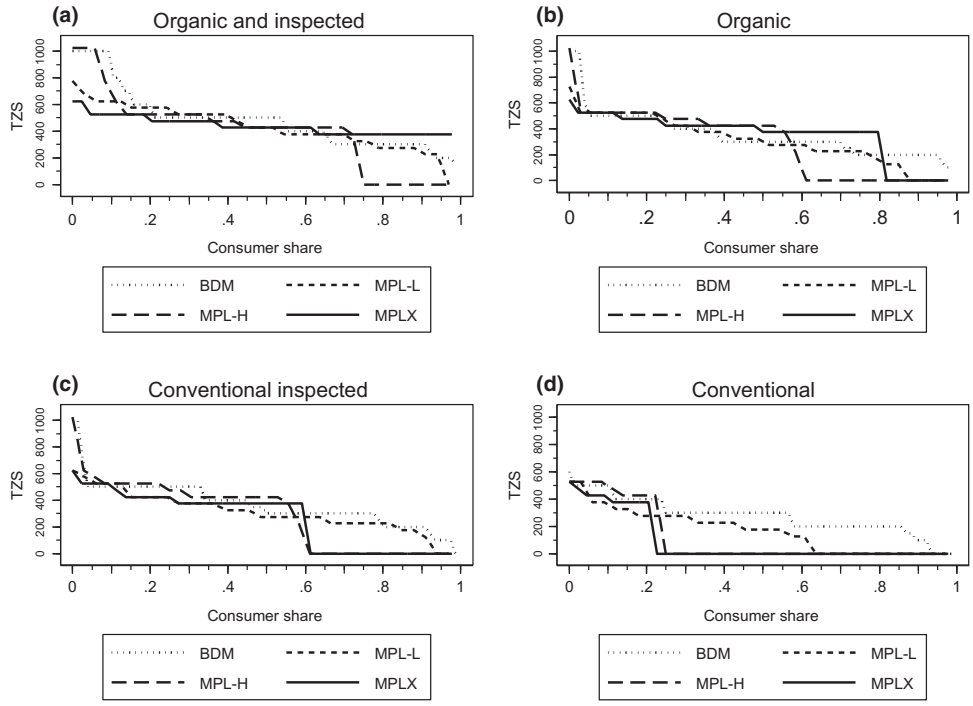

Figure 1. Total willingness to pay for the four types of tomatoes.
***Notes*:** The price list in MPL-L ranges from 50 to 1,000 TZS whereas the price list in MPL-H and MPLX ranges from 350 to 1,250 TZS. If participants are not willing to buy at the lowest price on the price list, their willingness to pay is presented here as zero.

tomatoes elicited in the RCE are not included. Figure 1 fits well with the estimated WTP results in Table 2.

The choice of method has a major impact on the valuation, but has less impact on the ordering of the products (see Table 2, and Figures 1 and 2). Conventional tomatoes have the lowest WTP, and organic-inspected tomatoes have the highest WTP in all methods. The two types of tomatoes with only one label either share second place, or one of them comes second and the other third.

Combining data from the BDM, MPL and MPLX, we find that only 9% of the participants were willing to pay more than 400 TZS for the conventional tomatoes. This seems reasonable, as 400 TZS was at the high end of the prices observed in the market at the time of the experiment. For the tomatoes with the organic label and the tomatoes with the inspection label, about 25% were willing to pay at least 400 TZS, whereas for the tomatoes with the organic and inspected label, 50% of the participants were willing to pay more than 400 TZS.

5.4. Distribution of marginal WTP

The MWTP represents the price premiums the consumers are willing to pay for the labeled products, and can be calculated for all four methods. Only the BDM gives continuous MWTP data. For the other methods, we can estimate the distribution of MWTP. Figure 2 presents the MWTP distributions for the BDM, MPL-L, MPL-H,

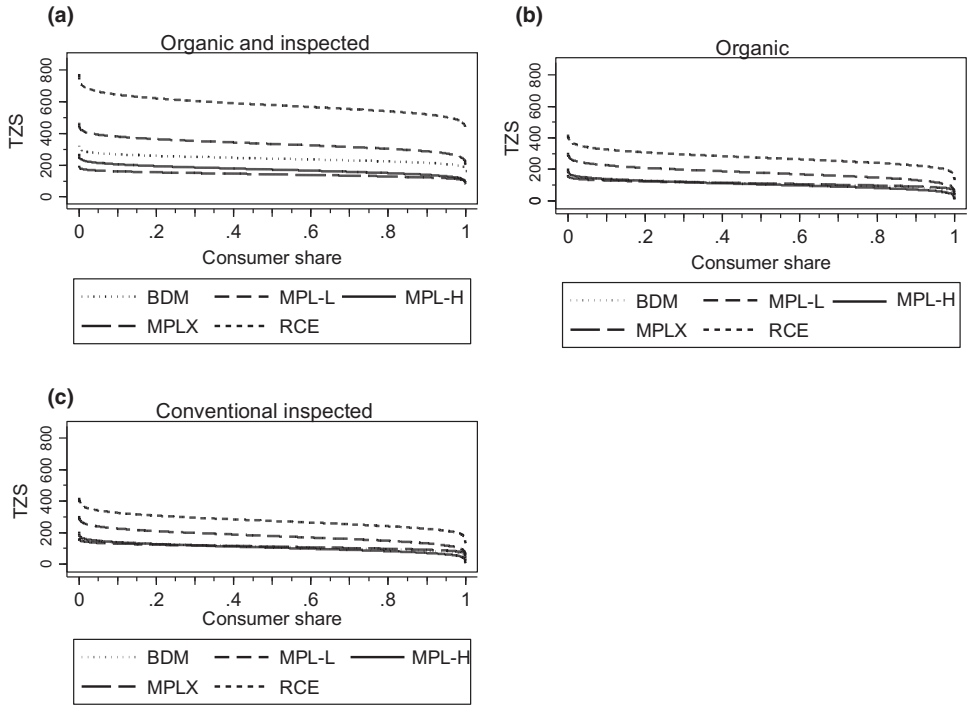

Figure 2. MWTP for three tomato attributes.

MPLX, and RCE based on resampling with 1,000 draws from the estimated parameter distributions.

We use an ANOVA and k-means non-parametric test (Siegel, 1957) on the resampled data and reject the hypothesis of equality of means ($P < 0.01$) between the MWTP for all the product attributes. Then, a post-estimation Bonferroni test[10] (Dunn, 1961) was performed and it also shows a significant difference ($P < 0.01$) in MWTP between all the valuation methods.

The results from the post-estimation test confirm the previous findings and show that the greatest difference is between the comparative and non-comparative methods, with the RCE method giving generally higher values than all the other methods for all product attributes.

We assess the relative efficiency[11] in the MWTP estimates by dividing the Krinsky and Robb confidence intervals (CI) by the means. Table 3 presents the Krinsky and Robb CI and relative efficiency measures for the four valuation methods. From the table, we can see that the RCE gives the widest CIs, whereas the MPLX gives the most efficient WTP estimates, and the results are consistent for all products.

[10]The Bonferroni test is a post-estimation test used to counteract the problem of multiple comparisons. Unlike the *t*-test, it reduces the chances of committing type I errors when multiple pair-wise tests are performed on a single dataset.

[11]The relative efficiency measure is the CI normalised by the mean/median WTP

Table 3
Krinsky and Robb confidence interval at 95% level

Attributes	Method	Mean	Lower limit	Upper limit	Width	Efficiency*
Organic inspected	BDM	211.1	171.3	251.3	79.9	0.38
	MPL-L	307.1	239.4	374.2	134.5	0.44
	MPL-H	153.9	109.4	198.9	89.5	0.58
	MPLX	132.9	108	158	50	0.38
	RCE	577.7	488.5	675.2	186.7	0.32
Organic	BDM	80.9	40.5	121.2	80	1
	MPL-L	151.5	84.3	220.6	136.3	0.9
	MPL-H	86.5	41.4	132.3	90.9	1.05
	MPLX	101.5	76.8	126.9	50.1	0.49
	RCE	271.9	200.8	349.7	148.9	0.55
Inspected	BDM	94.5	54.5	134.2	79.7	0.84
	MPL-L	151.4	85.9	217.6	131.7	0.87
	MPL-H	84.2	38.6	129.6	91	1.08
	MPLX	67.5	41.4	93.1	51.6	0.77
	RCE	117.1	8.1	228.9	220.7	1.88
Conventional	BDM	273.6	233	313.4	80.3	0.29
	MPL-L	162.3	101.4	223	121.5	0.75
	MPL-H	348.8	299.8	396.6	96.8	0.28
	MPLX	308	280.8	335.1	54.2	0.18

Note: *The most efficient method yields lower ratios of CI/mean; i.e. efficiency = width/mean.

6. Conclusions and Recommendations

In this study we investigate the WTP for organic and food-safety-inspected tomatoes in a typical African food market using four different elicitation techniques. All the four methods revealed that consumers are willing to pay a price premium for organic and food-safety-inspected tomatoes. We find that WTP estimates from the methods where participants indicated the price at which they were interested in buying (BDM, MPL and MPLX) are closely related.

The RCE, which uses choices between products to elicit preferences, gave much higher WTP estimates for the attributes than the other methods. The high WTP estimates from the RCE are consistent with findings from studies conducted in the US and Europe (Lusk and Schroeder, 2006; Gracia *et al.*, 2011). The differences in WTP between the valuation methods could partly be explained by the fact that different valuation techniques assess preferences differently (Lusk and Schroeder, 2006). However, the difference could also be attributed to design effects or the specific context. More research is needed to understand how design elements affect choice in choice experiments with real products and real payments. Keeping the products fixed and presenting all price scenarios on one form might affect the price sensitivity, and thereby the WTP estimates. The same could also be true when excluding the none-of-these options option.

Based on the findings, we make five recommendations for conducting experiments in a developing context such as in a traditional African food market.

First, we recommend conducting the experiments as field experiments. It gives the experiment the right context, the participants are real consumers coming to the market to buy the products at the market, they bring money and can therefore use their own money to make purchases in the experiment, and it eases the recruitment of participants.

Second, using methods that can be done one-on-one have several benefits in this type of setting. Participants come into the market at different times, and one cannot expect them to wait so that one can create a group to conduct for example a Vickrey auction. With the one-on-one methods, each participant can conduct the experiment when he arrives. Since they do not have to wait, participation rates are likely to be higher and selection bias smaller. The one-on-one methods also easily allows randomisation of treatments for each participant so that the treatments are not confounded with time in any sense.

Third, we recommend using a method that is as transparent as possible so that it is easy to explain to the participants; and it avoids misconceptions or misinterpretations of the method. The participants have limited time, and the busy market setting is a less than optimal place to teach participants complex methods. With illiterate participants, the methods must be explained by a moderator, and this must often be done one-on-one and can be very time consuming. The BDM is the method where the participants are put in a position most resembling a bargaining position, 'state your price', but was the method most difficult for the participants to understand. Hence, considering the experiences in the field, we recommend the price-list methods (MPL-L, MPL-H, MPLX). These methods seemed very easy to understand, even by illiterate consumers. It was also relatively easy for participants to see that truthful revelation was in their best interest; hence it can reduce errors caused by misconceptions or misunderstandings of methods.

Fourth, we recommend avoiding price lists that have prices that are much lower than the market price of the substitute products. We found that the price list that started at <20% of the market price for the generic tomatoes, induced attempts at strategic behaviour, where participants who had said they were interested in buying tomatoes in the recruitment phase only indicated interest in buying the generic tomatoes at prices much lower than the market price. This kind of misguided strategic behaviour could be reduced through extensive training using other products. However, as discussed above, extensive training is difficult in this setting, and we therefore recommend using a price list starting just below the market price.

Fifth, among the price-list methods, MPLX seems to have a comparative advantage over the other methods. It provided the smallest CI, closely reflected the market price for conventional tomatoes, and allowed heterogeneity with respect to the amount purchased. In the other methods where the quantity is fixed, consumer's WTP could have been affected because they were only allowed to buy one portion.

Summing up, more research is needed to understand how and why the results of comparative and non-comparative valuation methods differ in experiments with real products and real payments. The MPLX method seems promising for WTP elicitation when one wants to conduct the experiment in a busy setting and/or wants to conduct it with one consumer at a time.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Instruction and experimental procedures for the market experiments.
Appendix S2. Valuation forms.
Appendix S3. Bonferroni post-estimation test comparing MWTP between methods in TZS.

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