

# Experimental auctions with exogenous and endogenous information treatment: Willingness to pay for improved parboiled rice in Benin

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## Abstract

The impact of information as an extrinsic quality cue on consumers' valuation of intrinsic food quality attributes can be captured by incorporating 'information treatments' in experimental auctions. We combine 'exogenous' information treatments (a video broadcast and a radio transcript) on the benefits of a locally produced improved rice processing technology with an 'endogenous' information treatment which elicits word-of-mouth exchange among consumers. We assess the effects of these information treatments on consumers' choice and valuation of parboiled rice with upgraded quality in two urban markets in Benin. We find that exogenous information increases market share of the locally produced improved product by 14% at the expense of the competing, imported product, an effect which is further amplified by 11% through endogenous information. Endogenous information has a dampening effect on price premiums though; while visual and auditory information added 6–14% value to local rice, word-of-mouth reduced the value by 2%.

## KEYWORDS

Benin, collective induction, experimental auction, willingness to pay, word-of-mouth

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## JEL CLASSIFICATION

C93; O33; Q13; Q16

## 1 | INTRODUCTION

In many West African countries, agricultural extension services face challenges and are under constant pressure to help farmers to access the appropriate agricultural knowledge and information (Nederlof & Odonkor, 2006; Zossou et al., 2020). To address these challenges, videos are increasingly used in agricultural extension and easily integrated with other rural learning approaches (Van Mele, 2008; Zossou et al., 2009a, 2015, 2017, 2020). Earlier research showed that video has great potential to enhance sustainable agriculture by encouraging local innovations which take into account farmers' creativity and trigger many behavioural and institutional changes (Chowdhury et al., 2011; Van Mele et al., 2007; Zossou et al., 2009b, 2015; Zoundji et al., 2018).

As most sub-Saharan African countries have recorded a growth of rural radio stations over the past few decades as part of a broader process of democratisation, this is an opportunity for strengthening research-extension-farmer linkages. By converting the videos developed for agricultural extension to radio scripts, agricultural extension can benefit from both the reach and the relevance that local broadcasting can achieve through participatory communication approaches (Chapman et al., 2003; Zossou et al., 2015, 2017, 2020). In a context of poverty, food insecurity, high rurality and low literacy rates, the use of video and rural radio (based on the basic principles of participatory approaches) is an opportunity to promote rural peoples' access to agricultural information.

Rice markets in West Africa differentiate between 'raw' (white) and parboiled rice. Parboiling is a hydrothermal treatment applied to rice paddy that involves the three basic processes of soaking, steaming and drying to enhance the physical, chemical and organoleptic quality of rice (Chukwu, 1999; Islam et al., 2001). Because traditional processors are not well aware of improved parboiling techniques and also lack the equipment to uniformly pre-cook paddy with steam, traditional parboiling does not consistently produce good quality rice. Improved parboiling equipment can be fabricated by local artisans with available materials and skills, and consists of a large metal pot with a perforated bottom that is placed on top of a large aluminium pot containing water to pre-cook paddy with steam, without the paddy touching the water (Zossou et al., 2009a). The improved parboiler enhances the quality of the end-product through better moisture content and lower rate of cracked and burnt grains (Houssou & Amonsou, 2004).

Although white rice is popular and supplied in large quantities in both urban and rural markets (Codjo et al., 2021), parboiled rice is less available and less well known by the majority of consumers. Parboiled rice is preferred over white rice only in some West African countries such as Mali, Côte d'Ivoire, Ghana, Benin and Nigeria (Tondel et al., 2020). This gap in consumer preferences can be explained by the fact that the health benefits of parboiled rice are still largely unknown by the majority of consumers. In addition, parboiling is not cost-effective for small-scale processors. From a policy sequencing perspective, investment in quality upgrading and scaling up of parboiling plants should be accompanied by information campaigns to inform consumers about the health benefits of parboiled rice in order to help producers and processors secure a sustainable market share (Demont & Rizzotto, 2012). Consumer information campaigns can borrow from the video and radio broadcasts that are already produced for agricultural extension.

Information needs to be produced and tested before being deployed by marketers, value chain actors and policy makers. Experimental auctions allow an accurate monetary measurement of

individuals' perceived value, which can be used to test the impact of extrinsic quality cues such as information on consumers' valuation of intrinsic quality attributes of food products (Lusk & Shogren, 2007). In an experimental auction, people bid to buy real products using real money through a mechanism that provides incentives for people to truthfully reveal the value they place on each of the products. In order to capture the impact of information on consumer preferences, experimental auctions have typically incorporated 'information treatments' and distributed participants among treatment and control groups (e.g., see Canavari et al., 2019 for a review of the experimental auction literature and a discussion on the causal interpretation of information treatments). Previous experiments have focused on treatments based on 'exogenous' information sources such as advertisements, video broadcasts, radio transcripts, brochures, and so on (e.g. De Groote et al., 2011; Elbakidze & Nayga, 2012; Goldberg et al., 2009; de Magistris et al., 2014; Oparinde et al., 2016). However, once consumers have been exposed to exogenous information, it needs to be processed through individual and social cognition and word-of-mouth (WoM) (Demont, Rutsaert, et al., 2013; Zossou et al., 2020). Indeed, experimental auctions featuring an 'endogenous' information treatment have shown that consumers are also highly influenced by 'endogenous' information, that is, knowledge, information and experience that exists within consumer communities and their social networks and that is exchanged through WoM communication (Britwum & Demont, 2021; Demont et al., 2017; Demont, Rutsaert, et al., 2013).

Little is known, however, about how exogenous and endogenous information combine to affect consumers' valuation of new food products. Knowing which information source has most effect would be useful to policy makers and value chain agents in improving rice value chains in Africa (Soullier et al., 2020). We present the first experimental auction that combines 'exogenous' information treatments (a video broadcast and a radio transcript) on the benefits of an improved rice processing technology, with an 'endogenous' information treatment (WoM) to assess their effects on consumers' valuation of improved parboiled rice relative to imported rice in two urban markets in Benin.

The paper is organised as follows. In the next section, we review the literature on exogenous and endogenous information in marketing research. Section 3 describes the methodology in terms of the experimental design of the study and the analysis of the data. The results are discussed in Section 4 and Section 5 concludes.

## 2 | LITERATURE REVIEW

Stigler's (1961) theory on the economics of information is that consumers will maximise expected utility by searching for additional information until the marginal expected cost of search becomes greater than its marginal expected return. As an alternative to search, Nelson (1974) showed that consumers will use experience as a source of information when search becomes too expensive. The credibility of information mainly depends on its source. Hence, the effects of major information sources are of key interest to the marketer as influences on purchase decisions (Tyagi & Kumar, 2004).

Information sources can be of two different forms. The first form is 'exogenous' to the population of consumers: for example, radio, TV, newspapers, billboards, literature, internet, and so on. Horsky and Simon (1983) examined the effects of advertising on sales growth of new, infrequently purchased products, and suggested that firms should heavily invest in advertising early on to inform all innovators about the new product. Samuels' (1970) study on the Fruit Squash industry showed the importance of television advertising on a brand's sales and share of the market. Yiannaka et al. (2002) analysed the relationship between advertising and firms' sales in the fast-growing Greek processed meat sector and found that the effect of print media advertising on sales was significantly greater than both radio and TV advertising over

the study period 1983–1997. However, the importance of WoM today is probably greater than ever, thanks to social media and the role influencers play therein. After purchases are made, consumers will often make comparisons between their expectations and the product performance they experience. If performance is below expectation, customers may end up dissatisfied and may also sense a conflict in their beliefs, a phenomenon called ‘cognitive dissonance’ (Festinger, 1957). One available coping strategy is to share their discomfort and seek additional information through word-of-mouth (WoM) to resolve the conflict (Buttle, 1998). Hence, the second information source is ‘endogenous’ to the communities and social networks in which consumers operate: for example, experience, peers, relatives, friends, social media, and so on. Arndt (1967) defines WoM as ‘oral, person-to-person communication between a receiver and a communicator whom the receiver perceives as non-commercial, regarding a brand, product or service’. WoM has been identified as an effective driver of the diffusion of new products (Rogers, 1995). From a marketing perspective, WoM can be either positive or negative (Buttle, 1998) with opposing effects on consumers’ choice for a brand or product (East et al., 2008). Arndt (1967) found that negative WoM affects consumers’ brand evaluations more strongly than positive WoM. Firms can generate WoM to increase their market share—for instance by offering consumers promotional giveaways such as stickers, hats and sometimes the product itself—to encourage WoM communication exchange about the product (Berger & Schwartz, 2011).

Tyagi and Kumar (2004) argued that advertising has an informing function, whereas WoM has a legitimising or evaluation function. In general, advertising is effective mainly at the earlier stage of the growth cycle of new products (Goldenberg et al., 2001), while WoM becomes a more powerful driver of demand at a later stage (Bruce et al., 2012). Empirical studies on advertising and WoM indicate that they have complementary effects on market share. Hogan et al. (2004) showed that WoM generated after a purchase triggered by advertising can represent a sizeable share of the economic value of an advertising campaign.

Behrens et al. (2007) analysed consumer attitudes towards parboiled rice in Brazil and found that most consumers are unaware of its nutritional benefits, reflecting a lack of advertising and exogenous information. The authors argued that consumers’ negative attitudes towards parboiled rice could be explained through product misconceptions generated by a lack of nutrition and health information. To address these negative attitudes, Heinemann et al. (2006) proposed that marketing efforts should focus on informing consumers about the health benefits and convenience of parboiled rice. Tomlins et al. (2007) evaluated consumer acceptance, affordability and market value of local and imported parboiled and raw rice in Ghana. The majority (70%) of consumers claimed to have received information through TV and radio promoting parboiled rice by emphasising taste, quality and nutritional benefits. Most consumers (87%) expressed their interest in receiving more information, particularly through TV. The authors identified a segment of more highly educated consumers who received information about rice via the radio and who were highly aware of promotion campaigns that emphasised the nutritional benefits and quality of rice. Prior information on improved parboiling (mostly through radio) was found to affect Beninese consumers’ willingness to pay (WTP) for locally produced improved parboiled rice (Demont et al., 2012). WoM is found to be an important source of information that consumers use to value rice products in Africa (e.g., Britwum et al., 2020), and a significant driver of consumer purchase behaviour of rice with upgraded quality (e.g., Britwum & Demont, 2021; Demont et al., 2017; Demont & Ndour, 2015).

Given the importance of TV, radio and WoM in rice consumers’ preference formation (Britwum et al., 2020), we expect exogenous and endogenous information to be complementary in influencing consumers’ purchase decisions of locally produced improved parboiled rice. Following Tyagi and Kumar (2004), we hypothesise that exogenous information has first-order effects on purchase decisions, which are further fine-tuned through second-order effects from endogenous information generated by consumers evaluating and legitimising the exogenous

information they received through WoM exchange. Secondly, we deem visual information to be more persuasive than auditory information and hence we hypothesise video broadcasts to have a greater impact on purchase decisions than radio broadcasts.

### 3 | METHODOLOGY

#### 3.1 | Sampling

To capture diversity in terms of urban populations, geographical location and distance to the seaport, we selected two major urban markets in Benin where parboiled rice is commonly sold: (i) Dantokpa market in the coastal capital city Cotonou; and (ii) Malanville market in the North, located across the Niger River and known as a centre for rice cultivation and cross-border trade. In order to replicate an in-store sampling setting, we installed two labs in the field, as close as possible to the markets—we hired a classroom in a school situated on the Dantokpa market and a storage room located on the Malanville market. We conducted 18 experimental sessions over the course of 8 days in September 2011. Each lab operated for four days. To minimise costs, we conducted two sessions per day during the first three days (one in the morning and one in the afternoon) and three sessions the last day. This allowed us to verify earlier findings from rural Glazoué, where bids were found to be higher in the morning (Demont et al., 2012).

In each location, we hired three female recruiters for sampling and recruiting rice consumers in the market, who later served as enumerators during the experimental sessions (see Section 3.4). We selected women as consumers since they are typically more involved in rice purchase decision making in Africa (Demont et al., 2012; Zossou et al., 2009b). To balance out extraneous status variables or other individual difference influences during the collective induction treatment (see Section 3.2) (Kirchler & Davis, 1986), for each session, we randomly recruited an ad hoc group of 15 women from the central market. In order to include a random factor during sampling, every third female passer-by with an estimated age within the range of 18–65 was approached. Whenever we approached a group, we selected only one participant to ensure that the participants would not know each other.

Our planned sample size was primarily based on budget availability and an interest in using experimental auctions as a value elicitation mechanism for accurately estimating WTP. Secondly, given the assumed diversity between the two markets, we conservatively planned a minimum sample size of 45 participants per treatment arm and per market. With three treatment groups (see Section 3.2) and two markets, the total minimum sample size required was estimated to be 270 participants. We believe that this sample size is conservative and strikes the optimal balance between aiming for accurate WTP estimation and efficient estimation of treatment effects (Canavari et al., 2019).

#### 3.2 | Treatments

To test the impact of visual and auditory information, we prepared three-minute excerpts of video and radio broadcasts on improved parboiling and the health benefits of improved parboiled rice extracted from the video ‘Cashing in with parboiled rice’ developed by the Africa Rice Center (<http://www.accessagriculture.org/node/479/en>). Due to the technical requirements they imposed, the video and radio information treatments were organised at the experimental session level and, hence, featured a between-subjects design. Since participants for each session were randomly recruited on the market (see Section 3.1), we assume their assignment to the information treatments was also random. As a result, one third of the participants

(treatment group 1) was randomly treated with the video, another third with the radio transcript (treatment group 2) and the control group was not treated.

To capture the effect of WoM on consumer valuation, we incorporated a within-subjects collective induction treatment (CIT) between the first and the second individual auction round (see Section 3.4). The CIT is organised as a group discussion during which the group is tasked to reach consensus on a single, collective bidding value for each upgrade. The collective bidding task requires groups to engage in a 'cooperative search for descriptive, predictive, and explanatory generalizations, rules, and principles', a common group problem-solving task termed 'collective induction' in social psychology (Laughlin & Hollingshead, 1995, p. 94). Similarly to how the auction mechanism generates incentives for participants to reveal their true value through the bids they submit, the collective bidding mechanism was introduced in experimental auctions by Demont, Rutsaert, et al. (2013) to provide participants with incentives to reveal endogenous information on the products' value to peers through WoM communication. Indeed, as the collective bids are binding and subject to the same Vickrey auction (see below), it is in participants' best interest to share their best available knowledge and information on the true value of the products with the group to ensure that the collective bids reflect their individual values. While the values of the collective bids themselves have no direct relevance for our analysis, the second individual round is introduced to capture the effect of this WoM information exchange on individual valuation. Post-CIT increases of individual bids can be assumed to reveal the existence of positive endogenous information in the group, while declining bids may be an indication of negative information discounting the value of the product.

### 3.3 | Products

Analogously to Demont et al. (2012), we chose the traditionally parboiled rice produced in Glazoué as a fixed, inferior-quality benchmark. These authors found that consumers in Glazoué were willing to pay substantial price premiums for rice that was processed with upgraded parboiling equipment, relative to traditionally parboiled rice, which is clearly recognisable as being of inferior quality in terms of burnt and cracked grains. However, only two years after the 2009 study, we faced difficulties in finding traditionally parboiled rice with similar inferior quality. This was already an interesting result in its own right and suggested that previous research and information campaigns through dissemination of videos had persuaded processors to upgrade their parboiling equipment. Traditional parboilers told us they learnt from the videos and devoted more attention to grain quality since they had been exposed to them. Hence, the benchmark used in this study was superior to the benchmark in the 2009 study (Demont et al., 2012), and, as a result, we expect WTP for quality upgrading to be lower.

To assess the impact of video and radio broadcasts on improved parboiling on urban Beninese consumers' preferences for improved parboiled rice, we decided to test two upgrades, relative to the benchmark. The first upgrade was rice that was locally produced and parboiled using the improved parboiler. To ensure that both rice types were processed from a single rice variety (i.e., IR841 which is the most popular rice variety grown in Benin), we ordered both rice types from a women's association in Glazoué in the centre of Benin. We further decided to add the most commonly consumed competing product for comparison, that is, non-parboiled imported rice. After visiting several wholesalers, we decided on using Thai long grain rice. The traditional and improved parboiled rice products featured a light yellow colour while the non-parboiled imported Thai long grain rice was white. The traditional parboiled rice contained more broken and burnt grains and more impurities (sand and stone), had a higher moisture content, and was yellower than the improved parboiled product. These clearly perceptible attributes visually positioned the benchmark in a lower quality class (Houssou & Amonsou, 2004).

### 3.4 | Experimental design

We chose the Vickrey (1961) second-price auction because of its weakly dominant strategy for participants to bid their true value for the goods. We ran two auctions simultaneously and used the endow-and-upgrade method, that is, each participant was endowed with one kilogram of the benchmark rice and was invited (twice) to submit a bid for upgrading this kilogram to a kilogram of an alternative rice type, which they would keep. We explained to participants that one product and one bidding round would be binding. This decision was made to avoid the substitution effect that might arise if participants could win more than one product, which would in turn compromise bidding their true value for the products.

The three rice types were presented on coloured plates on the tables of the participants, each plate containing exactly one kilogram of the respective rice product. The products were also presented in 30 kg baskets on a presentation table in front of the room, similarly to how they are typically presented on the market. We did not use any labels on the rice baskets; the only function of the presentation table was to associate the rice types on the plates at the individual tables to a real market context. Previous research has shown that presenting rice products in a linear order following a gradient of increasing quality can bias consumers' WTP (Demont et al., 2012). Hence, to avoid this 'lining-up bias', we placed the inferior benchmark in the middle and the two upgrades left and right from the benchmark on the presentation table and the individual tables.

We developed two survey questionnaires respectively aimed at obtaining general socio-demographic data from the participants and specific follow-up information on the auctioned rice products. To avoid revealing too much about the rice types' identity and the objectives of the study (Canavari et al., 2019; Corrigan & Rousu, 2008), the first questionnaire was administered during the auctions and the second after the auctions.

Each experimental session involved nine steps:

1. *Recruitment*: The recruiters/enumerators went to the central market and randomly approached women showing them a flyer with pictures of previous experimental auctions. They explained to participants they were going to participate in a 2.5-h market test and receive a participation fee of 2000 FCFA (€3) 'for their taxi back home'. The latter pretext is commonly used in Africa to detach pecuniary endowments from their 'gift' or 'payment-for-service' context. It elegantly avoids the fee being seen as a *quid pro quo* for which participants should reciprocate (Lusk & Shogren, 2007), and which may bias the bids (Canavari et al., 2019; Loureiro et al., 2003). During recruitment, the rest of the team prepared the room.
2. *Information treatment*: Before starting our introduction, we projected a short video or broadcasted a short radio transcript of three minutes on improved parboiling to the participants. In order to cover all languages, Fon, Dindi and French versions of the video and radio broadcasts were used. The control group was not exposed to any broadcast.
3. *Introduction*: We started the experimental session in the popular local language of Fon, with translations to Dindi, French and Haoussa where necessary. We explained to participants that we endowed them with one kilogram of the benchmark rice. During the experiment, participants could examine the visual (purity and homogeneity) quality attributes of the uncooked rice types. We explained the auction procedures to the participants. First, we explained the endow-and-upgrade method. We communicated the retail market price of the benchmark to the participants—that is, 350–450 FCFA/kg or €0.53–0.69/kg—but we did not reveal and asked the participants not to reveal any price information on the upgrades. Secondly, we explained the second-price auction mechanism.
4. *Training session with biscuits*: Following Shogren et al. (1994), we used commonly known brands of biscuits to familiarise the participants with the auction procedure. Each participant

received a 'Coasters' biscuit (benchmark) and was then asked to bid on two alternative types of biscuits: 'Gin Gin' and 'Football'. We used this training session to ensure that all participants fully comprehended the auction mechanism.

5. *Individual auction 1*: We explained to participants that we would use a similar procedure for the two rice types, repeated over two individual and one collective auction trials and that we would randomly select one upgrade and one bidding round as binding. We used a two-stage approach to elicit WTP (Haines et al., 1988). For each alternative rice type, we first asked which product the participant preferred between the benchmark and the upgrade. If she chose the benchmark, we asked whether she would still choose the benchmark if both products were priced equally. If she responded positively, we recorded a dash ( $WTP < 0$ ); if she responded negatively, we recorded a zero ( $WTP = 0$ ). If the alternative was chosen, we elicited her WTP to upgrade to one kilogram of the alternative rice type. To avoid 'lining-up bias', we instructed the enumerators to collect WTP values in random order to avoid signalling any quality ranking among the two upgrades. Responses were recorded privately. During the auctions, enumerators administered a first survey questionnaire to the participants that had completed price elicitation.
6. *Collective induction treatment (CIT)*: We kindly requested the participants to split in three groups of five and gather around three separate tables and attempt to reach consensus on their collective WTP (CWTP) to upgrade the benchmark rice into each alternative rice type (Demont, Rutsaert, et al., 2013). Following common practice in group research, no specific method of doing so was imposed or implied. Groups were left alone during the discussion that followed to avoid bias from the researchers. After consensus, the group submitted the CWTP values to the enumerators through a sealed envelope.
7. *Individual auction 2*: The same procedure was used as in step 5 in order to obtain post-CIT WTP for the alternative rice types.
8. *Survey*: Enumerators administered a second survey questionnaire to collect specific information on consumer preferences and awareness of the alternative rice types used in the experiment. To test the success of the collective induction treatment, the survey included a question on whether or not the participants agreed with the collective bids reached through group consensus (Cartwright, 1971; Ito et al., 2009; Sniezek & Henry, 1989).
9. *Closing ceremony*: We randomly selected one upgrade and one of three bidding rounds as binding, deducted the second highest bid for the upgrade from the participation fees of the winning bidder(s) and distributed the rice and the adjusted participation fees to the participants. In case the collective bidding round was selected, all five participants of the winning group that had submitted the highest collective bid received the selected upgrade and paid a price equal to the second highest collective bid.

### 3.5 | Econometric model

Haines et al. (1988) argue that food consumption decisions should be modelled as a two-stage process. Participants first decide whether they are willing to upgrade their endowed kilogram of rice or not and if yes, they decide next how much they are willing to add for the upgrade. The double hurdle model introduced by Cragg (1971) correctly represents this two-stage decision process.

Let  $WTU_{ijpr}$  be the variable representing the willingness to upgrade an endowed kilogram of rice as a dichotomous 'adoption' variable (willing to upgrade or not) and let  $WTP_{ijpr}$  be the amount spent on the upgrade by the  $i$ th consumer ( $i = 1, \dots, 15$ ) in the  $j$ th session ( $j = 1, \dots, 18$ ) for the  $p$ th rice type ( $p =$  locally produced improved parboiled rice, imported rice) in the  $r$ th bidding round ( $r =$  pre-CIT, post-CIT):

$$WTU_{ijpr} = \alpha' \mathbf{x}_{ijpr} + \mu M + u_{ij} + v_{ijpr} \quad (1)$$

$$WTP_{ijpr} = \alpha' \mathbf{x}_{ijpr} + \mu M + u_{ij} + v_{ijpr} \quad (2)$$

where  $\mathbf{x}_{ijpr}$  is a vector of independent variables including a dummy variable for the post-CIT bidding round (the pre-CIT round is set as the reference) capturing the effect of WoM, a dummy variable for the time of the day (morning), a dummy variable for the city, two dummy variables for the exogenous information treatment (video and radio; the control group is set as the reference), and a vector of 16 socio-demographic variables  $\mathbf{x}_v$  ( $v = 1, \dots, 16$ ; household income, household size, *Fon* ethnic origin, age, higher education, trader, housewife, association membership, cooking housemaid, dinner preparation time, household head, involvement in rice purchase, self-reported state of being hungry, whether the participant was planning to purchase rice on the market, product awareness, and technology awareness),  $\alpha$  is a conformable vector of coefficients,  $M$  is a dummy variable for the imported product (locally produced improved parboiled rice is set as the reference) and  $\mu$  is its associated coefficient,  $u_{ij}$  is an individual specific disturbance for participant  $i$  in session  $j$ , and  $v_{ijpr}$  is the overall error term.

Following Cragg (1971),  $WTP_{ijpr}$  is the consumers' bid to upgrade the mediocre-quality benchmark rice to any of the two alternatives. The first hurdle (WTU) is the consumer's decision of whether or not to upgrade. The probability of the respondent choosing not to bid a positive amount in order to upgrade ( $WTP_{ijpr} = 0$ ) is expressed by:

$$Prob(WTP_{ijpr} = 0) = \Phi(-\alpha'_1 \mathbf{x}_{ijpr}) \quad (3)$$

where  $\Phi$  is the standard normal density function. The second hurdle captures the effect of independent variables on  $WTP_{ijpr}$ , given  $WTU_{ijpr} = 1$  and  $WTP_{ijpr} > 0$ . The distribution of  $WTP_{ijpr}$  conditional on being positive is truncated at zero and assumed normal with mean  $\alpha'_2 \mathbf{x}_{ijpr}$  and variance  $\sigma^2$ . The second hurdle is formulated as:

$$f(WTP_{ijpr} | WTP_{ijpr} > 0) = \frac{(1/\sigma)\Phi[(WTP_{ijpr} - \alpha'_2 \mathbf{x}_{ijpr})/\sigma]}{\Phi(\alpha'_2 \mathbf{x}_{ijpr}/\sigma)} \quad (4)$$

where  $\Phi$  is the standard normal density function and  $\alpha_2$  is a vector of coefficients.

Finally, since we are dealing with two competing products (i.e., local versus imported rice), we relax the assumption that the variables represented in the vector  $\mathbf{x}_{ijpr}$  affect both products in a similar way and allow for cross effects (following De Groote et al., 2011 and Morawetz et al., 2011), which are modelled as the interaction between the imported rice product dummy,  $M$ , and all the other variables in  $\mathbf{x}_{ijpr}$ :

$$WTU_{ijpr} = \alpha'_2 \mathbf{x}_{ijpr} + \beta' \mathbf{x}_{ijpr} M + \mu M + u_{ij} + v_{ijpr} \quad (5)$$

$$WTP_{ijpr} = \alpha'_2 \mathbf{x}_{ijpr} + \beta' \mathbf{x}_{ijpr} M + \mu M + u_{ij} + v_{ijpr} \quad (6)$$

where  $\alpha$  and  $\beta$  are vectors of coefficients related to locally produced improved parboiled rice and imported rice respectively to be estimated. The three treatment dummies for video, radio and WoM comprised in the vector  $\mathbf{x}_{ijpr}$  enable us to test our two hypotheses (Section 2): (i) exogenous information has a larger impact than endogenous information; and (ii) visual information has a larger effect than auditory information on WTU and WTP. Moreover, the cross effects enable identifying potential substitution effects between both competing products triggered by exposure to exogenous and endogenous information.

## 4 | RESULTS AND DISCUSSION

### 4.1 | Socio-demographic characteristic of the sample

In [Table 1](#), we provide some descriptive statistics of the socio-demographic variables collected through our survey questionnaire. Statistical significance of the differences between both consumer samples is indicated with asterisks. Sixty per cent of the participants on the Dantokpa market belonged to the ethnic group Fon, whereas this share was only 15% in Malanville where northern ethnic groups dominate. The average age recorded was 34 years which is very similar to previous experimental auctions using a similar sampling strategy (Demont, Rutsaert, et al., 2013; Demont et al., 2012). 17–25% of the women had achieved secondary or tertiary education and two thirds (61–68%) were active as traders. Northern women were more actively involved in formal associations and more female-headed households were observed in the south. Average monthly household income was about 48,000 FCFA in the south and 36,000 FCFA in the north, feeding smaller families in the south than in the north. Further, 29–40% of the households owned a house, 6% owned land and 8–16% had a cooking housemaid. In the south, households spent more time on preparing dinner, purchased and consumed rice more frequently (62–67% consumed rice on a daily basis) and women were more involved in rice purchase decision-making of the household (92% versus 72% in the north). This confirms our assumption that women are the main decision-makers in rice purchase and justifies the focus on women in our sampling strategy. The annual per capita consumption of rice in urban Benin was about 74–85 kg.

Awareness of local parboiled rice was higher in the north (93% versus 26% in the south) and of those who were aware, half (49%) reported having received the information through word-of-mouth (WoM). This confirms the value of inserting a collective induction treatment (CIT) between individual auction rounds. The lower awareness of local parboiled rice (26%) on the Dantokpa market may perhaps be explained by the fact that parboiled rice is associated with Nigerians as they are the usual customers who demand parboiled rice. Hence, many urban consumers may not be even aware that parboiled rice is also produced in Benin. Awareness of the improved parboiling technology was low (16–21%) and probably overestimated. Some of the participants may have confused the improved parboiling technology with the intermediate technologies that were local, artisanal innovations developed by female rice processors (Zossou et al., 2009b).

The consensus sessions were successful; 72–90% of the participants perceived that they had an influence during the collective induction session and 98–99% agreed with the group consensus. The latter is fairly consistent with previous experience (Demont, Rutsaert, et al., 2013; Demont et al., 2012). Nevertheless, the most trusted source of information used to judge the utility of a new rice type was TV (47%), followed by radio (33%) and WoM (33%). These findings are remarkably similar to a study in Uganda (Britwum et al., 2020), and seem to validate our hypotheses (Section 2). Preference for parboiled rice was higher in the north (85%) than in the south (38%) and almost all (89–90%) of those who preferred non-parboiled rice were willing to try parboiled rice, particularly after having been exposed to the visual characteristics and health benefits of parboiling through the video and radio broadcasts. Finally, 38–50% of the participants self-reported to be hungry during the experiment and more so in the north than in the south.

### 4.2 | Willingness to upgrade (WTU) and willingness to pay (WTP)

Mean values of consumers' bids to upgrade traditionally parboiled rice to locally produced improved parboiled rice and imported rice based on this dataset were previously published in review papers (Demont & Ndour, 2015; Demont, Ndour, et al., 2013). In [Table 2](#), we report some

TABLE 1 Descriptive statistics of socio-economic variables

Variable	Definition	Mean (SD)		
		Malanville	Dantokpa	z
<i>Fon</i>	1 = belongs to ethnic group <i>Fon</i> ; 0 = otherwise	0.15 (0.36)	0.60 (0.49)***	7.658
Age	Age in years	34 (12)	34 (11)	0.000
Higher education	1 = secondary and tertiary education; 0 = otherwise	0.17 (0.38)	0.25 (0.44)	1.637
Trader	1 = active in trading; 0 = otherwise	0.68 (0.47)	0.61 (0.49)	1.269
Housewife	1 = housewife; 0 = otherwise	0.19 (0.40)	0.21 (0.41)	0.452
Association membership	1 = member of a formal association; 0 = otherwise	0.53 (0.50)	0.38 (0.49)**	2.561
Household head	1 = presents herself as head of household; 0 = otherwise	0.13 (0.33)	0.26 (0.44)***	2.773
Household income	Monthly household income in 1000 FCFA <sup>a</sup>	36 (19)	48 (33) ***	3.439
Household size	Number of individuals in household	6.5 (3.4)	4.9 (1.8)***	4.581
House	1 = household owns a house; 0 = otherwise	0.40 (0.49)	0.29 (0.45)*	1.918
Car	1 = household owns a car; 0 = otherwise	0.11 (0.32)	0.03 (0.17) ***	2.612
Motorbike	1 = household owns a motorbike; 0 = otherwise	0.51 (0.50)	0.53 (0.50)	0.243
Land	1 = household owns land; 0 = otherwise	0.06 (0.24)	0.06 (0.24)	0.000
Cooking housemaid	1 = household has a cooking housemaid; 0 = otherwise	0.08 (0.27)	0.16 (0.36)*	1.879
Dinner preparation time	Total time (minutes) spent on preparing dinner (going to the market, preparation and cooking)	137 (58)	221 (97)***	7.845
Purchase frequency	Number of rice purchases per week	2.2 (2.9)	3.0 (2.4)**	2.578
Purchase quantity	Quantity of rice purchased per week (kg)	9.1 (4.8)	6.2 (5.6)***	4.577
Daily purchase	1 = household purchases rice on a daily basis; 0 = otherwise	0.22 (0.42)	0.17 (0.38)	1.071
Consumption frequency	Number of rice meals per week	6.8 (3.5)	8.4 (5.3)***	2.942
Daily consumption	1 = household consumes rice on a daily basis; 0 = otherwise	0.67 (0.47)	0.62 (0.49)	0.761
Per capita consumption	Annual quantity of rice consumed per capita (kg)	85 (48)	74 (68)***	3.510
Involvement	1 = is involved in rice purchase decision-making in household; 0 = otherwise	0.72 (0.45)	0.92 (0.27)***	4.255
Purchased	1 = has purchased rice today; 0 = otherwise	0.16 (0.37)	0.19 (0.40)	0.636
Plans purchase	1 = plans to purchase rice today; 0 = otherwise	0.33 (0.47)	0.53 (0.50)***	3.317
Hungry	1 = is currently hungry; 0 = otherwise	0.50 (0.50)	0.38 (0.49)**	2.080

TABLE 1 (Continued)

Variable	Definition	Mean (SD)		
		Malanville	Dantokpa	z
Product awareness	1 = is aware of local parboiled rice; 0 = otherwise	0.93 (0.25)	0.26 (0.44)***	11.267
Technology awareness	1 = is aware of improved parboiling; 0 = otherwise	0.21 (0.41)	0.16 (0.37)	0.938
Preference local	1 = household prefers local rice; 0 = otherwise	0.67 (0.47)	0.25 (0.44)***	6.826
Try local	1 = household prefers imported rice, but is willing to try local rice; 0 = otherwise	0.87 (0.34)	0.97 (0.17)**	2.341
Preference parboiled	1 = household prefers parboiled rice; 0 = otherwise	0.85 (0.36)	0.38 (0.49)***	7.989
Try parboiled	1 = household prefers non-parboiled rice, but is willing to try parboiled rice; 0 = otherwise	0.90 (0.31)	0.89 (0.31)	0.093
Influence	1 = perceives to have had influence during group discussion; 0 = otherwise	0.90 (0.30)	0.72 (0.45)***	3.880
Agreement	1 = agreed with group consensus; 0 = otherwise	0.99 (0.12)	0.98 (0.15)	0.000
Number of participants		135	135	

<sup>a</sup>Fixed exchange rate: 1000 FCFA = €1.52. \*, \*\* and \*\*\* denote significant differences between locations at 10%, 5% and 1% levels, respectively, based on the Wilcoxon rank sum test.

detailed descriptive statistics of consumers' willingness to upgrade (WTU) and willingness to pay (WTP). WTU levels were in the range of 83–99% for the locally produced improved product and lower (60–86%) for imported rice. WTU to improved parboiled rice tended to be higher after exposure to radio or video, whereas the opposite was observed for imported rice, suggesting an information-induced substitution effect. WTU to improved parboiled rice tended to increase post-CIT after exposure to endogenous information, whereas for imported rice this was only the case for participants who had not been exposed to any of the information treatments.

Price premiums for improved parboiled rice were in the range of 37–89 FCFA/kg (€0.06–0.14/kg), that is, 9–22% of the retail price of traditionally parboiled rice, and slightly higher for imported rice, that is, 86–94 FCFA/kg (€0.13–0.14/kg) or 22–24% of the retail price of traditionally parboiled rice. In line with our hypotheses, the premiums increased most after exposure to visual information, while they declined in the post-CIT round after exposure to endogenous information.

### 4.3 | Determinants of willingness to upgrade (WTU) and willingness to pay (WTP)

The coefficients and conditional marginal effects of the determinants of WTU and WTP obtained through the double hurdle model are presented in Table 3. On the Dantokpa market in the south, consumers are 26% less likely to upgrade to imported rice than to locally produced improved parboiled rice, while in Malanville in the north the opposite is found, that is, an 11 point (37% – 26%) greater likelihood to upgrade to imported rice and a 19 FCFA/kg (€0.03/kg) (21 – 2 FCFA/kg) or 5% higher value for the competing product.

**TABLE 2** Descriptive statistics of consumers' willingness to upgrade (WTU) and willingness to pay (WTP, FCFA/kg) to upgrade traditionally parboiled rice to improved parboiled rice and imported rice

Treatment	Improved parboiled rice						Imported rice					
	WTU (%)			WTP (SD)			WTU (%)			WTP (SD)		
	Pre-CIT	Post-CIT	chi <sup>2</sup>	Pre-CIT	Post-CIT	t	Pre-CIT	Post-CIT	chi <sup>2</sup>	Pre-CIT	Post-CIT	t
Control	83%	90%	2.09	42 (30)	37 (25)	2.12**	81%	86%	0.90	86 (43)	87 (46)	0.29
Radio	93%	99%	4.67**	60 (32)	51 (26)	2.35**	63%	60%	0.19	93 (44)	94 (50)	-0.34
Video	87%	93%	2.00	89 (48)	77 (35)	1.66*	64%	62%	0.08	87.5 (43)	88 (39)	0.16

Note: Fixed exchange rate: 1000 FCFA = €1.52.

Abbreviations: CIT, collective induction treatment; SD, standard deviation.

chi<sup>2</sup> = Pearson chi<sup>2</sup>'s test. \*, \*\* and \*\*\* denote significant differences between bids at 10%, 5% and 1% levels, respectively, based on the Student's *t*-test.

TABLE 3 Determinants of consumers' willingness to upgrade (WTU) and willingness to pay (WTP)

Independent variables	First hurdle: Willingness to upgrade (WTU)			Second hurdle: Willingness to pay (WTP)		
	Direct effects		Marginal effect	Direct effects		Marginal effect
	Coef. (SE)	Coef. (SE)	Coef. (SE)	Coef. (SE)	Coef. (SE)	Marginal effect
Imported	-1.13 (0.58)*	-0.26*	-0.13	-3.13 (27.81)	-2.21	
Malanville	-0.57 (0.44)	-0.13	1.63 (0.34)***	-0.29 (10.44)	-0.21	30.25 (15.82)*
Morning	0.09 (0.17)	0.02	0.13 (0.17)	13.34 (6.54)**	9.42**	5.21 (7.46)
WOM	0.48 (0.15)***	0.11***	-0.44 (0.14)***	-11.30 (5.15)**	-7.98**	11.71 (6.48)*
Video	0.03 (0.22)	0.01	-0.70 (0.18)***	69.44 (9.37)***	49.03***	-70.35 (10.63)***
Radio	0.63 (0.29)**	0.14**	-1.28 (0.25)***	31.32 (9.03)***	22.12***	-31.90 (10.71)***
Household income	-0.00 (0.00)	-0.00	0.00 (0.00)	0.00 (0.00)	-0.00	0.00 (0.00)
Household size	-0.00 (0.03)	-0.00	-0.00 (0.02)	-1.57 (1.32)	-1.11	0.78 (1.25)
Fon	0.48 (0.34)	0.11	-0.16 (0.24)	-17.30 (8.61)**	-12.22**	27.47 (11.07)**
Age	0.01 (0.01)	0.00	0.00 (0.01)	-0.56 (0.35)	-0.39	0.36 (0.39)
Higher education	0.43 (0.34)	0.09	-0.69 (0.38)*	4.73 (9.45)	3.34	8.03 (12.07)
Trader	0.53 (0.38)	0.12	-0.53 (0.37)	3.65 (11.33)	2.58	-2.68 (13.99)
Housewife	-0.04 (0.39)	-0.01	-0.20 (0.37)	-6.65 (11.40)	-4.69	11.60 (14.02)
Association membership	-0.14 (0.19)	-0.03	0.34 (0.18)*	-3.91 (6.94)	-2.76	2.26 (8.58)
Cooking housemaid	-0.28 (0.25)	-0.06	0.34 (0.27)	-7.46 (9.49)	-5.27	-4.01 (13.14)
Dinner preparation time	-0.00 (0.00)	-0.00	0.00 (0.00)**	0.03 (0.03)	0.02	-0.02 (0.04)
Household head	-0.35 (0.23)	-0.08	0.28 (0.21)	-7.81 (8.44)	-5.51	1.92 (9.68)
Involvement	-0.05 (0.24)	-0.01	0.23 (0.21)	-20.99 (13.81)	-14.82	27.89 (12.21)**
Hungry	-0.04 (0.18)	-0.01	0.18 (0.17)	1.21 (7.34)	-0.85	4.30 (8.22)
Plans purchase	0.04 (0.16)	0.01	-0.27 (0.17)	-0.65 (7.08)	-0.46	-10.44 (7.75)
Product awareness	0.16 (0.27)	0.04	-0.48 (0.26)*	-8.20 (8.36)	-5.79	0.48 (12.50)

(Continues)

TABLE 3 (Continued)

Independent variables	First hurdle: Willingness to upgrade (WTU)			Second hurdle: Willingness to pay (WTP)				
	Direct effects		Cross effects with 'Imported'	Direct effects		Cross effects with 'Imported'		
	Coef. (SE)	Marginal effect	Coef. (SE)	Marginal effect	Coef. (SE)	Marginal effect		
Technology awareness	0.16 (0.33)	0.04	-0.13 (0.28)	-0.03	-4.29 (7.2)	-3.03	11.17 (9.75)	7.88
Constant	0.82 (0.60)				62.22 (25.61)**			
Sigma = 47.50 (5.88)								
Number of observations = 1056								

Note: Conditional marginal effects are evaluated at the mean of the explanatory variables. Values in parentheses are standard errors (SE). \*, \*\*, and \*\*\* denote variables significant at 10%, 5% and 1% levels, respectively. WOM = word-of-mouth; fixed exchange rate: €1 = 655.957 FCFA; price of the benchmark rice = 350 FCFA/kg in Malanville and 400–450 FCFA in Dantokpa.

However, consumers in both cities are equally likely to upgrade to locally produced improved parboiled rice.

Exogenous information treatments such as the radio transcript are found to strengthen the market share of the locally produced improved product by 14% at the expense of imported rice which loses 15% of market share (= 14%–29%). This substitution effect is further amplified by an 11% gain in market share induced by the exchange of endogenous information (WoM). Due to high initial WTU levels for improved parboiled rice—even without exposure to exogenous information (83–90%, [Table 2](#))—the additional effect of the video broadcast on WTU is insignificant, but it leads to a similar contraction of the market share of imported rice by 15% (= 1%–16%). Consistent with our second research hypothesis, visual information adds more than double the value (49 FCFA/kg or €0.07/kg) to the ‘advertised’ product than auditory information (22 FCFA/kg or €0.03/kg). Endogenous information, on the other hand, has a dampening effect on value; whereas video and radio add 6–14% value to local rice, WoM slightly reduces the value by 2%. The sign reversal of WoM’s conditional marginal effects between the two hurdles suggests that WoM generally increased the propensity of upgrading (and hence the overall value of the upgrades as perceived by the sampled population), but that the sub-population of upgraders tended to slightly adjust their bids downwards after exposure to WoM. These findings support our first research hypothesis that exogenous information has first order effects on shaping consumer preferences, whereas endogenous information legitimises and ‘fine-tunes’ these preferences. The results also provide support to earlier recommendations that information campaigns on the health benefits of parboiled rice can make a difference in shaping consumer attitudes towards parboiled rice ([Behrens et al., 2007](#); [Heinemann et al., 2006](#); [Tomlins et al., 2007](#)).

Finally, less educated women, members of a formal group, those who spend more time on cooking and those who are unaware of locally produced parboiled rice tend to have higher preferences for imported rice. Awareness of local parboiled rice was higher in the north (93% versus 26% in the south) and of those who were aware, half (49%) noted receiving the information through word-of-mouth. This shows the importance of endogenous information on awareness. Participants who were aware of the local parboiled rice were 7% (4%–11%) less likely to upgrade to imported rice. Imported rice is valued higher by Fon people in the south—who discount locally produced improved parboiled rice and which is consistent with findings by [Demont et al. \(2012\)](#) who argued that Fon traditionally prefer maize over rice—and by those who are involved in rice purchase decision-making in the household. WTP is generally higher in the morning, a result which is consistent with previous findings ([Demont, Rutsaert, et al., 2013](#); [Demont et al., 2012](#)). This suggests that information campaigns, whether through radio or television, should be broadcast in the morning, before women go to the market.

## 5 | CONCLUSION

In this study, we assessed the combined effect of exogenous and endogenous information on urban Beninese consumers’ valuation of locally produced improved parboiled rice, relative to imported rice. The innovative contribution of this study is that we combined exogenous (video and radio) and endogenous (collective induction) information treatments in order to estimate the impact of information on consumer preferences. We found that intrinsic quality attributes play an important role in driving consumer preferences. However, without information consumers cannot make informed choices. Our results suggest that more communication with consumers would be helpful. Indeed, consistent with the literature, we found that the video documentary, the radio transcript and even the mere exhibition of parboiled rice tended to influence consumer preferences. Market shares were further increased as a result of word-of-mouth (WoM) communication, although this community consensus had a slightly

dampening effect on value. Perhaps consumers' initial enthusiastic WTP response to the radio transcript and video broadcast was revisited and 'fine-tuned' after communication with their peers (endogenous information). We found empirical support for our research hypotheses in that purchase decisions are strongly affected by exogenous information, particularly visual information such as videos simulating TV broadcasts, whereas endogenous information has second-order effects.

We conclude that information campaigns on the benefits of improved processing not only play a role in informing poor female processors about new technologies that may add value to produce and reduce poverty, but also in informing consumers on the value of the end-product. To maximise reach in a cost-effective manner, consumer awareness campaigns can benefit from the investment made in agricultural learning videos and radio programs for farmers. This is of interest to donors, policy makers, value chain actors and marketers promoting the consumption of more nutritious, parboiled rice in developing countries with low literacy rates and high level of rurality.

Finally, this study has a few limitations. First, since the data were collected in 2011, some of the conditions may have changed. However, we believe that the novel insights on the interaction of exogenous and endogenous information will remain relevant over time. Secondly, in auctions with large groups, there is a trade-off between maximising the sample size per auction and losing interest of off-margin bidders. Indeed, a reviewer noted that in groups of 15 participants, off-margin bidders may have little interest in taking the auction seriously due to the low probability of winning the auction, especially after discovering the other participants' bids during the collective auction. Indeed, although bids were sealed and we did not post any prices after each bidding round, the collective auctions may have partly cancelled out these mitigation strategies and reduced off-margin bidders' incentives to bid truthfully in the final individual round. However, since any of the three rounds (two individual and one collective) could be randomly selected as the binding round, participants knew there would be a one-third chance the collective bidding round would be selected, where they would have a one-third chance of winning as a group. This may have helped keep all bidders engaged in the auction. Moreover, urban households in Benin feature inelastic demand for rice as it is an essential staple consumed on a daily basis (Codjo et al., 2021). The endow-and-upgrade mechanism furthermore tends to involve participants more than the absolute bidding mechanism (Lusk & Shogren, 2007), as it endows them with a benchmark product and requires lower out-of-pocket bids to participate in the auction of the upgrades. Both factors are expected to have further reduced the occurrence of off-margin bidders.

Since the findings of our study are novel, further research is needed on the interaction of exogenous and endogenous information by replicating our study over time in other geographical contexts and with other food (and non-food) products, while testing (i) other experimental mechanisms (e.g., choice experiments); (ii) other treatment designs (e.g., using between-subject designs for both the endogenous and exogenous information treatments as opposed to the mixed design used in this study) and treatment orderings (e.g., preceding exogenous by endogenous information treatments); and (iii) other group configurations (e.g., running three parallel auctions for smaller groups of five participants, see Canavari et al., 2019).

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