Do urban African dwellers pay a premium for food quality and, if so, how much? An investigation of the Malian fonio grain market

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Summary – *Very little data is available concerning the valuation of quality on existing food markets in Sub-Saharan Africa. Using data collected from a survey of fonio (a cereal) retail markets conducted in Bamako, Mali, Africa and a hedonic price Partial Least Square regression method, this study shows that most quality attributes declared as important by consumers have a specific hedonic price that is different from zero. This is interpreted as a result of the efficient performance of so-called traditional informal markets. Among the valued attributes, some are physical (colour, degree of milling) and thus relatively easy to assess, while the assessment of others (category or country of origin) are more complicated for both parties to the transaction. These attributes, however, also have specific hedonic prices. Informal norms and a certain amount of trust are thus present in these markets and should not be underestimated. The inclusion of buyer characteristics in the model is justified by the differences in bargaining power, which are essentially linked with different levels of experience buying or using the product. We showed that women were getting better prices for the same product quality. The premiums paid for quality varied from 1 to 14% of the price. These estimates have confirmed the other few estimates done in African food markets.*

Keywords: *fonio, cereal, quality, hedonic prices, PLS method, empirical investigation*

Les urbains africains paient-ils une prime pour la qualité des aliments et si oui, combien ? Une enquête sur le marché du grain de fonio au Mali

Résumé – Il existe très peu d'études concernant la valorisation de la qualité sur les marchés alimentaires en Afrique Sub-saharienne. La présente contribution montre, à partir de données sur le marché de détail du fonio (une céréale) à Bamako au Mali, et à partir d'une estimation des prix hédoniques par la méthode des moindres carrés partiels (PLS) que la plupart des attributs de qualité importants pour les consommateurs ont un prix hédonique différent de zéro. Ce résultat signifie que ce marché informel fonctionne suffisamment bien pour permettre une segmentation des produits selon différents niveaux de qualité. Parmi les attributs valorisés, certains sont physiques (couleur, niveau de décorticage) et relativement faciles à évaluer, tandis que d'autres sont plus difficiles à évaluer par les différents acheteurs et vendeurs (catégorie ou type de fonio, pays d'origine). Pourtant ces derniers attributs ont également un prix hédonique spécifique. Un certain niveau de confiance et des normes informelles sont ainsi nécessairement présents et ne doivent pas être sous-estimés. On a par ailleurs inclus dans le modèle certaines caractéristiques des acheteurs reflétant leur pouvoir de négociation, lié en partie à leur expérience. Cela a montré que les femmes obtiennent de meilleurs prix que les hommes pour la même qualité de produit. Les primes payées pour la qualité varient de 1 à 14 % et ces estimations confirment les autres rares estimations réalisées sur les marchés alimentaires africains.

Mots-clés : fonio, céréale, qualité, prix hédoniques, méthode PLS, recherche empirique

JEL descriptors: C13, C25, C51, D12, O55

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1. Introduction

The quality of staple food in very poor countries – especially those in West Africa – is seldom questioned by agricultural and food economists. This is because it is overshadowed by other important questions such as availability (quantity available for consumption) or affordability (people's ability to access food), two pillars of the food security concept. However, questions concerning quality, quantity, and price are inter-related at all levels of the food production-trade-processing-consumption chains (Egg *et al.*, 2006). It is indeed quite straightforward to assume that markets expand more easily (in this case, farmers farm more cereals for sale, traders trade more, and consumers buy more) if trading rules (the majority of which are not written in West Africa) exist and are respected. Among these rules, the common definitions of produce and their characteristics, the clear and shared knowledge/information about produce, as well as the stability of these definitions are keystones.

In spite of very little available empirical material, it is commonly said that *"low quality food"* prevails in Africa (Vanderplas, 2009) and that formal certification schemes should be promoted (Masters and Sanogo, 2002).

This study is an empirical contribution that seeks to answer the following: do urban African consumers pay for quality attributes of produce? For which attributes and for how much? The question is not: how much are they ready to pay? But rather, how much are they actually paying? We are not concerned with consumers' willingness or intent, but really the current paid premium on existing urban markets. This not only captures the ability of consumers to pay for different quality attributes and to express their preferences, but also that of the different market stakeholders, which results in differentiated quality attributes for the same product.

There are actually very few published studies and accurate data related to this question. Langyinto *et al.*, 2003, and 2004, published a vast study concerning the premium paid for different characteristics of cowpea (*Vigna unguiculata* (L.) Walp) in West and Central Africa. Based on real prices paid in 16 markets in Ghana, Cameroon, Nigeria, and Senegal, the authors estimated different premiums ranging from 0.67% to 18% of the average retail price paid for various quality attributes such as the grain size, the "eye" or grain colour, etc. Their study *"indicates that quality characteristics are very important in West African food markets" and that "even low income consumers are willing to pay a premium for products that match their preferences, and they are vigilant in identifying products that do not meet their standards"*.

Basing their assertions on rice consumption surveys conducted in Ivory Coast and Nigeria in 2000, Lançon *et al.* (2004) insisted upon the fact that quality attributes – such as cleanliness, standardization, and ability to swell (the result of which one gets a higher cooked volume for the same dry weight) – are key factors in the consumers' preference for imported rice over local rice. In other words, they showed that urban consumers paid a premium for cleanliness and standardization. Using their data from Bouake, Ivory Coast (*op. cit.*, p. 112), we estimated that imported rice represented 68% of total consumption whereas local rice was only 32%. The prices weighed by quantity were respectively 279 FCFA/kg and 252 FCFA/kg. This means that more than two-thirds of the population paid a premium of about 10% to satisfy their preferences regarding the quality of rice. The other third, according to the authors, were either very poor (20% of the total sample) or came from a specific region and were used to eating a specific category of rice (10%).

Vandeplas *et al.* (2009) showed that the premium paid by consumers for better quality rice was higher in India (up to 45%) than in Madagascar (10% maximum), which is a poorer country. Similarly, they argued that tomatoes of "good quality" (not rotten) were relatively more expensive in India compared to Madagascar.

1.1. Fonio as a case study

Our study concerned fonio (*Digitaria exilis*) – a cereal grown in West Africa. This cereal is a "minor" product in terms of production (in Mali, for instance, it represents less than 1% of all cereals consumed, and total production in Africa was about 365,000 metric tons in 2005, Cruz, 2009 quoting FAO), yet it is well known and appreciated by most consumers (Konkobo-Yameogo *et al.*, 2004) and the market is expanding both in West African and European cities (Cruz, 2009). The miniscule size of this market acts as an advantage since it is easier to observe and analyse it in comparison to larger grain markets, such as millet (*Pennisetum glaucum, (L.)* R. Br) or sorghum (*Sorghum bicolor (L.)* Moench). There is no evidence that consumers behave differently nor similarly when buying fonio compared to millet or sorghum, which are the real staple foods of the inhabitants of the Sahelian region in West Africa. Despite this lack of "real" proof, one could arguably liken fonio to these cereals on the basis that it too is a cereal that is grown in the same regions and sold by the same type of sellers within the same kind of city markets to the final consumers (Bessler and Kergna, 2003, our observations). We hypothesise that the behaviours addressed in this study can at the very least be extrapolated for the study of other cereals. More generally, and according to several previous empirical studies (Dury *et al.*, 2002; Cheyns, 1998 and 2006; Bricas and Cheyns, 2003; Lançon *et al.*, 2004; Alpha *et al.*, 2009; Langyintuo *et al.*, 2003-2004), we suppose that this example illustrates at least one part of the West African urban consumers' attitudes toward food quality: *i.e.* most people, even the very poor, have strong quality requirements. They may not be able to afford to fulfil all of them, but they deal with them on a daily basis and use different means to "optimize" a complex system of preferences during the purchase, home processing, or cooking of food.

2. Methodology

Our methodology was based on the classical (1966) perspective of Lancaster's quality of produce, which is considered as a sum of quality attributes or characteristics, and on Rosen's (1974) hedonic estimation method, which provided a theoretical background to empirical estimations of the implicit or hedonic price of each of these characteristics. We collected the data directly through the observation of specific retail transactions in different markets of the city. After analysing the data using descriptive statistics (tables 1, 2) and a Partial Least Square (PLS) regression (table 3), we then ran different simulations (table 4).

2.1. Data collection

Our fieldwork was organized into two main activities. Using several open-ended individual interviews and 6 focus groups, the first aimed to determine the various attributes according to several different consumers. This also gave us most of the interpretation cues regarding what matters and why for fonio buyers and consumers. The second part aimed to collect market data on real fonio purchases using structured closed questionnaires. Five different marketplaces in Bamako were selected for their representativeness of fonio and, more generally, of grain markets (Bessler and Kergna, 2003). Although some of these markets have both wholesale and retail activities, we limited our scope to the retail purchases, as it was important for our research to track the variation of prices and quality at the very end of the food marketing chain.

The collection of data was implemented during September and October 2006. All 174 purchases of traditional products were surveyed in five traditional open markets. The data collected concerned the price actually paid and the characteristics of (i) the supplier (market type), (ii) the product attributes (type, size, colour, etc.), (iii) the buyer (age, education level, sex, etc.).

Most characteristics were declared by the buyer and were not assessed by an external expert or system of measure. While perhaps dissatisfying for those who prefer to objectivise the aspects of quality, this method does provide valuable information. For instance (table 2), 28% of the buyers declared that they did not know the origin nor the size of the grain, and 44% of them stated that they had no idea about the hardness of the grain. This can be interpreted into two ways: (i) these buyers did not really care about these aspects or (ii) they were not able to distinguish between the different modalities because they lacked information (problem of signal). The regression results gave more insight. In any case, it is clear that "white" is a perception declared by a specific person – the buyer – and has not been measured.

Bargaining is omnipresent in African food markets, and prices, even if not always discussed, are always up for negotiation. For most staple foods, including cereal and fonio, the produce is sold in bulk, and there are neither price tags nor any other tags or written labels. Hence the buyer is not helped by any formal institutions to determine what kind of product he/she is looking at. Instead the buyer relies on his/her personal abilities to assess the quality of the produce (using his/her knowledge) and very rarely relies an external formal institution.

As we observed in many different food retail markets in Cameroon and Mali – and as reported by other authors like Clark, 1994, in Ghana or Chaléard, 1996, in Ivory Coast – it is often the case that the price itself is not discussed, but rather the quantity of product for a given amount of money. The client asks the seller for a "gift" (which is the addition of extra product), which is either accepted or not. In the end, it is the price per kilogram (kg) that is decreasing, but not the "cost" itself. In our survey, we carefully reported all the details of the transaction concerning the amount of money paid, the purchased quantity, and the real paid price per kg (which is actually a calculated variable: amount of money paid divided by quantity in kg).

2.2. Addition of some seller characteristics to the standard hedonic model

In addition to the intrinsic characteristics of the product (as proposed by Rosen, 1974), we supposed that observed price variations also depended on the partners of the transaction. Buyers have different bargaining powers (see for instance Harding *et al.*, 2003) according to their individual characteristics.

As Harding *et al.* (2003) showed for homes in the United States, bargaining power depends on personal characteristics of the buyers or sellers, such as gender or the presence of school-age children in the family. Harding *et al.* (2003), Colwell and Munneke (2006), and Kumbhakar and Parmenter (2009) dealt with "big" durable goods, such as houses or offices, which were seldom ever bought in a lifetime. For those markets, considering both seller and buyer characteristics are necessary. In our case, we dealt with consumption goods, which are generally sold in very small quantities by a few sellers to many different buyers. Therefore, we made the assumption that sellers were more or less all the same in each marketplace and that most variations concerned the buyers.

As a consequence, the hedonic function was written as follows:

$$Y = \alpha + \beta X + \varepsilon \quad (1)$$

Where Y is the observed selling unit price of the good (in FCFA [1]/kg), X is a vector of the characteristics of the good itself and the transaction – including technical characteristics, quantity sold, and place of the transaction, as well as characteristics of the buyer that were supposed to influence his/her bargaining power.

α is the constant term, β the parameters related to the characteristic X, and ε the error.

2.3. Estimation of a Hedonic price model with the Partial Least Square Regression

Since most exogenous variables were discrete (qualitative), this model was first estimated using the Analysis of Covariance (ANCOVA) procedure. Several different ANCOVA were tested, including those with no specification, stepwise, or best R^2 procedures. The results were somehow difficult to analyse because they were quite

[1] Franc de la Communauté Financière Africaine. 656 FCFA = 1 euro (fixed parity).

sensitive to the chosen procedure and reference. This was mainly due to the collinearity between variables. This is a general statement of the fact that the regression of a quantitative variable over a large number of qualitative variables generates collinearity problems related to two different main causes. First, qualitative variables are less discriminatory than continuous ones: there are a few different modalities of each variable. Second, exogenous variables were very closely collinear (for example, cleanliness with colour).

To deal with these collinearity problems, we used the Partial Least Square (PLS) method proposed by Wold *et al.* (1984). As Stoica and Söderström (1998) mentioned: "*In ill-conditioned linear regression problems, in which regressors are nearly collinear, the use of Ordinary Least Squares (OLS) is generally to be avoided owning to its poor performance, such as large mean square errors (MSE). {...} Of the previously mentioned biased estimators, the PCA and PLS appear to be among the best.*" In a first stage, the method consists in computing an axis called "principal component", which is a linear combination of the exogenous variables, or more precisely, of the different modalities of the exogenous variables (t_1). This axis resumes the maximum variance of the model, as in a principal component analysis:

$$t_1 = w_{11}x_1 + \ldots + w_{1p}x_p$$

$$\text{where } w_{1j} = \frac{\operatorname{cov}\left(x_j, y\right)}{\sqrt{\sum_{j=1}^{p} \operatorname{cov}^2\left(x_j, y\right)}} \qquad (2)$$

$x_1 \ldots x_p$ are all the modalities of all the characteristics Xi.

In a second stage, we regressed the price (endogenous variable) over this axis (t_1):

$$Y = y_1 + c_1 t_1 + \varepsilon' \qquad (3)$$

Thus,

$$Y = y_1 + c_1 w_{11} x_1 + \ldots . c_1 w_{1p} x_p + \varepsilon' \qquad (4)$$

Where y_1 is the constant term, c_1 the parameters related to the modalities x_i , and ε' the error.

This method does not allow estimating t-Student coefficients to control the level of significance of the variables. Instead, the Variable Importance in the Projection (VIP) statistic was used as proposed by Tenenhaus (1998). As a rule of thumb, we chose the cut-off value at 0.8, as many practitioners usually do.

2.4. Estimation of the model and simulations

Different sets of variables X_i were tested (see justification below) and each corresponding PLS regression is referred to here as a "model". The results of three of them – "model 1" to "model 3" – are presented in table 3. Regressions were done using the XLSTAT software package. Once the "best" model had been chosen (model 2, table 3),

we ran simulations. Using the estimated parameters of model 2, we calculated the prices given by the model for different fonio purchases (knowing the market, type, milling degree, colour, origin of the product, profession, age, and education of the buyer, the model gave us the expected price). We chose a reference and then changed one characteristic after another to assess its specific effect on the final price (see table 4).

The estimation's results could be used for a simulation (table 4). For example, a non-professional, uneducated aged woman would buy brown, badly "decorticated" fonio from Mali at the Medina market (market-1) at the price of 351 FCFA/kg. We chose this specific transaction (a coupling of product and buyer characteristics) as a "reference" because: (i) it represents an average realistic combination of attributes that makes sense from an empirical point of view, and (ii) the estimate of the parameter is one of the estimate extremes. For example, the market-1 parameter equals −9.55, while the other extreme is the parameter of market-5, which equals +35.46.

Each simulation (sim1 to 9, table 4) consists in calculating the expected price for a slightly different coupling (product/person): sim1, where the market is different; sim2, where the type of fonio is different; etc., until sim9, where the time spent in school is different. When the characteristic had more than two modalities, the simulation was done using the other extreme, for instance, market-5.

In a sense, the difference calculated in the two last lines of table 4, in absolute and relative values, is an estimate of the maximum value of the hedonic price of each characteristic (market in sim1, type in sim2, etc.), while the value of parameters (in model 2, table 3) represents the hedonic price of each modality.

3. Results and discussion

3.1. Results of the qualitative survey and description of chosen variables

Table 1 gives the summary statistics of the two quantitative variables of the model. On average, the unit price was 410 FCFA/kg, ranging from a minimum of 250 and a maximum of 650 with a coefficient of variation equal to 17.

The purchased amounts were quite small, as expected. They varied from 0.5 to 100 kg with a median of 2 and a mean of 5.5 kg.

Table 1. Descriptive statistics of quantitative variables

Variable name	Price	Quantity
Definition	Unit price	Purchased amount
Unit	FCFA/Kg	Kg
Number of observations	174	174
Minimum	250	0.5
Maximum	650	100.0
Median	400	2.0
Mean	410	5.5
Standard deviation	69.7	14.3
Variation coefficient (%)	17	262

Table 2 presents the list of the characteristics and their modalities used in the initial regression (model 1, table 3). During the focus groups, all the variables in table 2 were quoted several times as important at one stage or another of the purchase, the processing (including milling, cleaning, washing, and cooking), and the consumption of the cereal. As such, these variables potentially impacted the price of the product. This is the reason why we have kept all of them in a first stage of regression (model 1, table 3).

Among the different attributes, three concerned the quality of the transformation process (fonio "type", level of milling, and cleanliness), three concerned the physical aspect of the grain (size, hardness, and colour), and one its geographical origin (country of production).

During the course of our different interviews, it became clear that the country of origin – as avowed by the seller – was considered by many of the buyers as proxy of the fonio quality. Even if the exact definition of this quality varied from one person to another, there was a kind of consensus (with a few exceptions) that fonio from Guinea was of better quality than that from Mali, mainly because of its cleanliness and good degree of milling. It was difficult to say which was coming first at the interview level since most buyers – except for professionals who usually dealt with larger quantities – displayed a certain amount of confusion about their ability to assess the "good quality" criteria.

The fonio types that appear here refer to how they were named by most stakeholders. It is related to the processed level. Grain in Bamako markets can be milled to various degrees: the operation of milling consists in removing the envelopes of the grain. A first type is the so-called "decorticated". It is a mixture of milled and non-milled grain. The second type is called "whitened" or "milled", during which the entire grain is dehusked. The third type is called "milled and washed": the pip, the bran, and all dust have been removed through a complex treatment with water. The definition of these categories and their boundaries were ambiguous at the end of the first phase of the survey, even if almost all consumers or other stakeholders were able to describe at least one category. This is why we finally included all of them in one single regression and did not split the model into different segments, as we had done in an earlier version (Dury *et al.*, 2007).

Finally, these discussions underlined the differences between people. There was general consensus on some issues, such as the effect of gender: men, except cereal traders, were said to be very incompetent regarding the evaluation of cereal quality in the market, while women were obviously more competent than men. Direct observation as well as interviews told us that the level of competence was quite different according to experience. In the models, we used three variables to capture the experience effect: age, professionalism, and region of birth. A "professional" refers to an individual buying fonio for processing (often cooking) and selling. This activity was usually done on a regular basis, thus these professionals were logically seen as better equipped to assess the fonio quality and negotiate the prices.

Many disputes concerned the role of wealth on the ability to recognize the "good" fonio. Some said rich people just did not care and did not spend time assessing the quality of their fonio purchases because they had servants to clean and prepare it. Others

Table 2. **Descriptive statistics of the qualitative variables**

	Variable name	Modality	Definition	n	Mean price	Sd of price	CV of price
Characteristics of the transaction	Market	1	Medina market	46	375	38	10
		2	Korofina market	44	394	16	4
		3	Lafiabougou market	19	382	25	6
		4	Magnanbougou market	44	400	56	14
		5	Riverside market	21	562	52	9
Characteristics of the product	Type	1	Decorticated	57	360	30	8
		2	Milled	101	413	47	11
		3	Milled and washed	16	566	54	10
	Milling	1	Badly decorticated	25	351	29	8
		2	Well decorticated	55	387	37	10
		3	Very well decorticated	94	438	78	18
	Clean	1	Very dirty	16	369	27	7
		2	Dirty	58	416	79	19
		3	Clean	77	410	68	17
		4	Very clean	23	422	65	15
	Colour	1	White	111	418	69	16
		2	Cream-white	14	475	66	14
		3	Grey	21	391	67	17
		4	Red/brown	28	357	32	9
	Origin	1	Guinea	102	418	63	15
		2	Mali	23	353	33	9
		3	Unknown	49	426	84	20
	Size	1	Big	44	429	83	19
		2	Small	82	406	71	18
		3	Unknown	48	398	49	12
	Hard	1	Hard	88	412	79	19
		2	Soft	9	461	108	23
		3	Unknown	77	401	48	12
Characteristics of the buyer	Prof	0	Non-professional	127	424	75	18
		1	Professional	47	372	32	9
	Age	1	Age ≤ 20 y	27	393	52	13
		2	20 < age ≤ 50	124	404	62	15
		3	Age > 50	23	461	105	23
	Sex	1	Man	19	504	90	18
		2	Woman	155	398	58	15
	Region	1	With fonio	96	403	57	14
		2	No fonio	78	419	83	20
	School	1	No school or max primary school	128	398	57	14
		2	Secondary or higher level	46	444	90	20
	Hsize	1	< 5 adults	121	409	67	16
		2	≥ 5 adults	53	426	82	19
Total				*174*	*410*	*70*	*17*

CV here stands for Coefficient of Variation, a normalized measure of dispersion. It is the ratio of the Standard deviation (Sd) to the mean.

thought rich people were exactly like others: some care and some did not, some knew and some did not. It was difficult to capture a good proxy of the wealth of the interviewees during the survey; hence we used the "level of education" as an indication of the purchasing power of the interviewees. 74% of the sample either never went to school or attended only until the primary level. Only 25% exceeded primary level education.

3.2. Results of the estimation of the hedonic model and simulations

The presented regressions were done only on one axis since the information given by a second axis was very poor. Table 3 presents the Variable Importance in Projection (VIP) of each modality and the value of the estimated parameters for the three models. Several other models were run, but are not presented here since they gave quite similar results. The best model according to the Q^2 criteria (model 2, table 3) is also the simplest.

The results of regression 1 (model 1) showed that both places of sale, product characteristics (type of fonio, level of milling, origin, and colour), and several buyer characteristics (sex, "professional", school level, and age) had a significant impact on the price. On the other hand, the quantity, cleanliness, size, and hardness of the grain, the birth region of the buyer, and the number of adults in the household had no specific effect on the price.

The most important modalities regarding the VIP indicators were by decreasing order: the Riverside market, the fonio types, the sex, and the level of milling.

The results were quite surprising concerning quantity and cleanliness. In terms of quantity, one would have expected a significant coefficient, but the VIP was less than 0.6, which is a very low value; however, in comparison to the insignificant showings all other regressions, including those not presented here, this result seems robust.

Model 2 is the same as model 1 minus all the variables that did not have a single significant modality. It is interesting to note that estimated coefficients did not change tremendously here.

Model 3 (model 2 minus "cleanliness" and plus "type") was run because of the high-expected correlation between the type and the cleanliness of fonio. Coefficients did not change much here either and cleanliness did not become significant.

Altogether, model 2 was considered the most efficient and reliable model, thus was used for further simulations.

Place of sale

Two markets, Medina (1) and Riverside (5), have a significant influence on the retail price in the model. Medina is the largest central market and directly receives products from all production areas and Niarela, the wholesale market of Bamako for millet (Bessler and Kergna, 2003) and for fonio (coming from Guinea or different regions in Mali). Medina is also both a retail and wholesale market. Change from one to the other represents 45 FCFA (13%) (sim1, table 4). The price paid in Riverside is much higher than that paid in Medina. This confirms empirical evidence and gives more precise figures.

Table 3. **Value of parameters and Variable Importance in the Projection (VIP)**

	Model 1			Model 2			Model 3	
Constant	425.170	VIP	Constant	424.22	VIP	Constant	425.86	VIP
Qty_kg	0.135	0.502						
Market-1*	– 9.021	1.033	Market-1*	– 9.55	0.86	Market-1*	– 11.39	0.99
Market-2	– 3.964	0.447	Market-2	– 4.20	0.37	Market-2	– 5.01	0.43
Market-3	– 6.092	0.493	Market-3	– 6.45	0.41	Market-3	– 7.69	0.47
Market-4	– 2.434	0.275	Market-4	– 2.58	0.23	Market-4	– 3.07	0.26
Market-5*	33.507	2.833	Market-5*	35.46	2.35	Market-5*	42.31	2.71
Type-1*	– 14.254	1.736	Type-1*	– 15.08	1.44			
Type-2	1.496	0.192	Type-2	1.58	0.16			
Type-3*	33.239	2.493	Type-3*	35.17	2.07			
Milling-1*	– 13.156	1.198	Milling-1*	– 13.92	0.99	Milling-1*	– 16.61	1.15
Milling-2*	– 6.453	0.779	Milling-2*	– 6.83	0.92	Milling-2*	– 8.15	0.75
Milling-3*	12.133	1.569	Milling-3*	12.84	1.30	Milling-3*	15.32	1.50
Clean-1	– 8.710	0.653				Clean-1	– 11.00	0.63
Clean-2	1.760	0.215				Clean-2	2.22	0.21
Clean-3	0.107	0.014				Clean-3	0.14	0.01
Clean-4	2.701	0.237				Clean-4	3.41	0.23
Colour-1	4.532	0.565	Colour-1	4.80	0.47	Colour-1	5.72	0.54
Colour-2*	13.755	0.971	Colour-2*	14.56	0.81	Colour-2*	17.37	0.93
Colour-3	– 4.057	0.343	Colour-3	– 4.29	0.28	Colour-3	– 5.12	0.33
Colour-4*	– 12.102	1.154	Colour-4*	– 12.81	0.96	Colour-4*	– 15.28	1.11
Origin-1	2.375	0.304	Origin-1	2.51	0.25	Origin-1	3.00	0.54
Origin-2*	– 12.567	1.105	Origin-2*	– 13.30	0.92	Origin-2*	– 15.87	1.06
Origin-3	4.278	0.499	Origin-3	4.53	0.30	Origin-3	5.40	0.48
Size-1	5.011	0.565						
Size-2	– 1.291	0.167						
Size-3	– 3.129	0.363						
Hard-1	0.902	0.117						
Hard-2	10.505	0.604						
Hard-3	– 3.003	0.387						
Prof-0*	9.968	1.149	Prof-0*	10.55	0.95	Prof-1*	12.59	1.10
Prof-1*	– 9.968	1.149	Prof-1*	– 10.55	0.95	Prof-0*	– 12.59	1.10
Age-1	– 3.901	0.367	Age-1	– 4.13	0.30	Age-1	– 4.93	0.35
Age-2	– 3.902	0.458	Age-2	– 4.13	0.38	Age-2	– 4.93	0.44
Age-3*	11.425	1.004	Age-3*	12.09	0.83	Age-3*	14.43	0.96
Sex-1*	20.486	1.658	Sex-1*	21.68	1.38	Sex-1*	25.87	1.59
Sex-2*	– 20.486	1.658	Sex-2*	– 21.68	1.38	Sex-2*	– 25.87	1.59
Region-1	– 3.143	0.406						
Region-2	3.143	0.406						
School-1*	– 8.989	1.029	School-1*	– 9.51	0.85	School-1*	– 11.35	0.99
School-2*	8.989	1.029	School-2*	9.51	0.85	School-2*	11.35	0.99
Hsize-1	– 4.671	0.558						
Hsize-2	4.671	0.558						
Quality index (Q^2)	0.623			0.630			0.570	

* VIP > 0.8.

Table 4. Simulations

	Reference	Sim1 Market	Sim2 Type	Sim3 Milling	Sim4 Colour	Sim5 Origin	Sim6 Prof	Sim7 Age	Sim8 Sex	Sim9 School
Constant	424.22	424.22	424.22	424.22	424.22	424.22	424.22	424.22	424.22	424.22
Market-1	−9.55		−9.55	−9.55	−9.55	−9.55	−9.55	−9.55	−9.55	−9.55
Market-2										
Market-3										
Market-4										
Market-5		35.46								
Type-1	−15.08	−15.08		−15.08	−15.08	−15.08	−15.08	−15.08	−15.08	−15.08
Type-2										
Type-3			35.17							
Milling-1	−13.92	−13.92	−13.92		−13.92	−13.92	−13.92	−13.92	−13.92	−13.92
Milling-2										
Milling-3				12.84						
Colour-1										
Colour-2					14.56					
Colour-3										
Colour-4	−12.81	−12.81	−12.81	−12.81		−12.81	−12.81	−12.81	−12.81	−12.81
Origin-1										
Origin-2	−13.30	−13.30	−13.30	−13.30	−13.30	0.00	−13.30	−13.30	−13.30	−13.30
Origin-3						4.53				
Prof-0	10.55	10.55	10.55	10.55	10.55	10.55		10.55	10.55	10.55
Prof-1							−10.55			
Age-1								−4.13		
Age-2										
Age-3	12.09	12.09	12.09	12.09	12.09	12.09	12.09		12.09	12.09
Sex-1									21.68	
Sex-2	−21.68	−21.68	−21.68	−21.68	−21.68	−21.68	−21.68	−21.68		−21.68
School-1	−9.51	−9.51	−9.51	−9.51	−9.51	−9.51	−9.51	−9.51	−9.51	
School-2										9.51
Estimated price	**351**	**396**	**401**	**378**	**378**	**369**	**330**	**335**	**394**	**370**
Difference	0.0	45.0	50.3	26.8	27.4	17.8	−21.1	−16.2	43.4	19.0
Difference in %	0	13	14	8	7	5	−6	−5	12	5

Types of fonio

Not surprisingly, fonio types are the most determinant variables (VIP = 1.44 for decorticated and 2.07 for milled and washed). The name of the category itself – *decorticated, milled, milled and washed* – has a significant impact on the price: "decorticated" fonio costs 17 FCFA (15.08 + 1.58, Model 2, Table 3) less than the average *milled* fonio and 50 FCFA (14%) less than the *milled and washed* one (sim2, Table 4). It is very interesting to note that the type of fonio is more important in explaining the price level than the perceived cleanliness. On the contrary, it does not eradicate the effects of colour nor level of milling as could have been expected.

Level of milling

This characteristic had a very significant effect on the price, from – 13.92 to + 12.84 FCFA/kg (Model 2, Table 3). For the given example, it represented 8% of the price increase from badly to very well decorticated fonio (sim3).

Colour

The hedonic price of the red/brown fonio is – 12.81 FCFA/kg, while the hedonic price of the cream-white fonio is + 14.56 FCFA/kg. The difference represented 7% of the global price (sim4).

Country of origin

The hedonic price of fonio from Mali is – 13 FCFA/kg, which completely confirmed our expectations after conducting the qualitative survey. Fonio from Guinea is valued 15.81 FCFA (+ 4%) more than the reference coming from Mali, whereas Fonio with unknown origins costs even more, +17.8 FCFA (sim5).

Profession

"Professionals" paid a lower price (– 21.1 FCFA/kg, sim6) than other buyers for final home consumption (– 6%). This is not surprising: these people are more used to the market and the product and are more able to discuss the prices.

Age

Older buyers (> 50 years old) paid more than others (+ 16.2 FCFA/kg) or + 5% (sim7) in our example. We had thought that age would be a good proxy/indicator/ determinant of knowledge, hence of bargaining power; however, this is obviously not the case. One interpretation of this unexpected result may be found in the link between health and age. During the interviews, it was indeed often said that fonio was "healthy" and good for sick or elderly people. It is thus possible that the elderly have a stronger preference for fonio than younger ones and are less reluctant to pay for it at a high price.

Sex

The price paid for fonio by a woman is 43.4 FCFA/kg less than the price paid by a man. In our example, a man pays 12% more for the same product (sim8). Sex is the fourth most important variable both in terms of absolute value and in terms of VIP,

after the Riverside market and the types of fonio (decorticated and washed). Two interpretations can be given for this result, the first being our preferred since it responds to a more positive perspective. It emphasises women's greater knowledge and their ability to recognise the different quality attributes and to discuss them. In a way, they are less "cheated" than men since they are the ones who usually cook and do the shopping. They have a comparative advantage in knowledge and bargaining. The second interpretation that must be mentioned here – fitting well with the usual feminist literature (Agarwal, 1997) – explains that women are usually poorer than men and thus have to bargain more to fulfil their requirements. Nothing in the present data and study has allowed a clear conclusion between these two interpretations since data on income and wealth is scarce.

School level

People who never went to school or only up to the primary level paid less (– 19 FCFA/kg or – 5%, sim9) than those who reached higher levels of education. This may be explained by the fact that people with more education have higher income and wealth and are less constrained by price.

3.3. Discussion

Altogether, the range of the premiums paid for quality attributes varies from 5 to 14%. These premiums are comparable to those of other studies on staple food in Africa (Languyinto, Lançon, Vandeplas *op. cit.*).

The estimation of a hedonic price for most characteristics showed that the informal market institution "works" in segmenting the quality or at least some aspects of quality.

The hedonic estimates provided a clearer image on what is valued in the existing retail market. On average, cleanliness, size, and hardness of the grain, as perceived by the buyers, had no influence on the price. On the other hand, colours as well as levels of milling (badly versus well or very well decorticated) had a very specific effect on the price.

In addition to these technical, visible characteristics, more sophisticated product characteristics – such as the type of the product, which is a really complex social construction, and the origin, which is difficult to verify – had specific effects on the price and specific hedonic prices.

In other words, the retail markets function according to the urban consumers' point of view. What most people say they like has a specific higher price than what they say they dislike.

This works for simple attributes as well as for less complex ones, which confirms that a minimum of trust (for example, fonio origin) and common norms (definition of each type) exist in these retail markets. The findings of other authors previously referred to here and those of more recent studies, such as Lyon and Porter (2009) are thus also confirmed. As a result, we advocate caution with regards to the implementation of formal norms. They may be ineffective or even costly and counterproductive for certain types of attributes.

One can, however, argue against the fact that the consumers' perceptions of quality depend on the existing available products and also that certain aspects of quality that do not exist yet would be valued if they were created and protected by some special norms or systems of certification (Masters and Sanogo, 2002; Tallec and Egg, 2009).

4. Conclusion

This example of the hedonic estimation approach has shown that Malian buyers pay, on average, a higher price for their preferred attributes, such as cream-white colour, better milling, and Guinea origin. While the difference between various products, with or without the specific attribute, is small – from 1 to 12% – it is nevertheless significant.

Most valued attributes are physical and linked to the product (level of milling, colour), but others (country of origin) are not visible and require a certain amount of trust between retailers and buyers. This study reveals that in one of the poorest countries in the world, informal market institutions/rules allow to finely distinguish several kinds of sub-products and, among these various sub-products, different kinds of qualities, including unverifiable attributes.

This is one contribution to the knowledge of existing African food markets. It does not prove that markets are fully efficient or perfect, but it has hopefully shown that, in this specific case, they can provide differentiated products, at least for most desired attributes. Other specific studies would be needed to uncover other characteristics that are not verifiable and for other products. Anyhow, it encourages developers to look closer into the existing *"informal"* market institutions before promoting formal regulation systems.

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